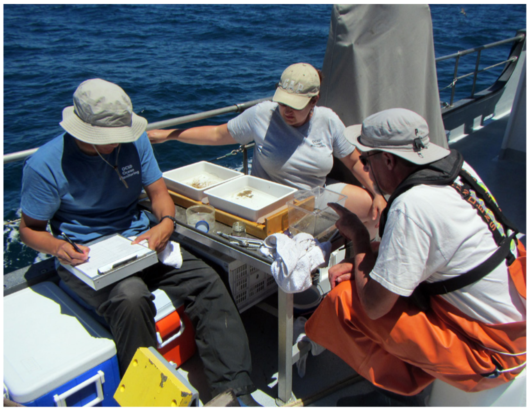

Orange County Sanitation District

Ocean Monitoring Report

Year 2014-2015

ANNUAL REPORT 2014-15

MARINE MONITORING

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March 14, 2016

Kurt V. Berchtold, Executive Officer
California Regional Water Quality Control Board
Santa Ana Region 8
3737 Main Street, Suite 500
Riverside, CA 92501-3339

SUBJECT: Board Order No. R8-2012-0035, NPDES Permit No. CA0110604
2014-15 Marine Monitoring Annual Report

Enclosed is the Orange County Sanitation District's 2014-15 Marine Monitoring Annual Report. This report focuses on the findings and conclusions for the monitoring period July 1, 2014 to June 30, 2015. Overall, the results of the monitoring program document that the disposal of our treated and disinfected effluent into coastal marine waters continues to protect the environment and human health.

The results of the 2014-15 monitoring effort showed no impacts to the benthic infaunal community within and adjacent to the zone of initial dilution (ZID). Invertebrate and fish communities in the monitoring area were healthy, with all sites classifying as reference condition. Permit-regulated sediment contaminants remained at or near background levels. The low levels of contaminants in fish tissues and the low incidence of external abnormalities and diseases in fish populations demonstrated that the outfall was not an epicenter of disease.

There were limited and minimal changes in the receiving water conditions. Plume-related changes in temperature, salinity, dissolved oxygen, pH, and transmissivity beyond the ZID were well within the range of natural variability, and compliance with numeric receiving water criteria was achieved over 97% of the time. Consequently, our ocean monitoring program continues to demonstrate that the coastal receiving water environment outside the ZID has not been degraded by the District's wastewater discharge. Finally, the low concentrations of bacteria in water contact zones, together with the limited distributions of ammonium, suggest that the wastewater discharge posed no human health risk and did not compromise recreational use.

Should you have questions regarding the information provided in this report, or wish to meet with the District's staff to discuss any aspect of our ocean monitoring program, please feel free to contact me at (714) 593-7400.

However, you may also contact Dr. Jeff Armstrong, the supervisor of our Ocean Monitoring section, who may be reached at (714) 593-7455 or at jarmstrong@ocsd.com.

Robert P. Ghirelli, D.Env.
Assistant General Manager

cc: Jared Blumenfeld, U.S. EPA, Region IX

JA:ja
Enclosure

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10844 Ellis Avenue, Fountain Valley, CA 92708
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March 14, 2016

Certification Statement

The following certification satisfies Section A.10 and A.15 of the Orange County Sanitation District's Monitoring and Reporting Program No. R8-2012-0035, NPDES No. CA0110604, for the submittal of the attached OCSD Annual Report 2016 – Marine Monitoring.

> I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for known violations.

Robert P. Ghirelli — 3/8/2016

Robert P. Ghirelli, D.Env.
Assistant General Manager

Date

JA:ja

To protect public health and the environment by providing effective wastewater collection, treatment, and recycling.

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ACKNOWLEDGMENTS

The following individuals are acknowledged for their contributions to the Marine Monitoring Volume of the 2014-15 Annual Report:

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IT and LIMS Data Support:

Matthew Garchow.

Laboratory Team:

Miriam Angold, Jim Campbell, Dr. Sam Choi, Kim Christensen, Arturo Diaz, Ben Ferraro, Joel Finch, Elaine Galvez, Michelle Kim, Thang Mai, Joe Manzella, Lori McKinley, Ryan McMullin, Dawn Myers, Canh Nguyen, Thomas Nguyen, Paulo Pavia, Vanh Phonsiri, Anthony Pimentel, Diane Poeske, Luis Ruiz, Dr. Yu-Li Tsai, Michael Von Winkelmann, Kathy Waldron, Norman Whiteman, and Brandon Yokoyama.

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The Orange County Sanitation District (District) conducts extensive ocean monitoring to evaluate potential environmental and public health risks from its discharge of highly treated wastewater off of Huntington Beach and Newport Beach, California. The effluent is released over 7 km offshore in 60 m of water. The data collected are used to determine compliance with receiving water conditions as specified in the District's National Pollution Discharge Elimination System (NPDES) permit (R8-2012-0035, CA0110604), jointly issued in 2012 by the U.S. Environmental Protection Agency (EPA), Region IX and the Regional Water Quality Control Board (RWQCB), Region 8. This report focuses on monitoring results and conclusions from July 2014 through June 2015.

WATER QUALITY

Minor plume-related changes in temperature, salinity, dissolved oxygen (DO), acidity (pH), and transmissivity were measured beyond the zone of initial dilution (ZID) during some surveys. However, compliance with California Ocean Plan (COP) criteria remained high (97–100%) for these water quality parameters. These results were consistent with previous findings and none of these changes were determined to be environmentally significant, since they fell within natural ranges to which marine organisms are exposed.

Offshore monitoring of nutrients (ammonium) and bacteria—2 measures of the wastewater plume—showed only minor impacts to the receiving environment. Ninety percent of the ammonium samples were below detection limits. When ammonium was detected, maximum concentrations were 20–30 times less than the COP objective for chronic toxicity to marine organisms. Bacterial concentrations remained low and were predominantly below measurement detection levels. The low levels of ammonium, along with the lack of association with chlorophyll-*a*, suggests that these concentrations were not environmentally significant.

Overall, the measured environmental effects to the receiving water continue to be relatively small, with values remaining within the ranges of natural variability for the monitoring area. These results support the conclusion that the discharge is not greatly affecting the receiving water environment and that beneficial uses were maintained.

SEDIMENT QUALITY

Sediment parameter values were comparable for within-ZID and non-ZID station groups. Values were below levels of biological concern (Effects Range-Median values) at all but one non-ZID station. The exceedance did not appear to be effluent discharge-related. Whole sediment toxicity tests showed no measureable toxicity. Overall, these results were consistent with those of previous years, suggesting the wastewater discharge has minimal potential for adverse impact on biota outside the ZID.

BIOLOGICAL COMMUNITIES

Infaunal Invertebrate Communities

The infaunal communities were similar within the monitoring area, as within- and non-ZID stations had comparable community measure values and equivalent species assemblages based on multivariate analyses. Also, the infaunal communities at within- and non-ZID station groups remain healthy based on their low Benthic Response Index values and high Infaunal Trophic Index values. These results demonstrated that the outfall discharge had an overall negligible effect on the benthic community structure within the monitoring area.

Demersal Fishes and Macroinvertebrates

Results for the epibenthic macroinvertebrates (EMIs) and demersal fishes were generally consistent with past findings. Community measure values of the EMIs and fishes were comparable between outfall and non-outfall stations. Multivariate analyses of the EMI and fish species also showed that the biological communities at the outfall and non-outfall station groups were generally similar. Furthermore, fish communities at outfall and non-outfall station groups can be classified as reference condition based on their low Fish Response Index values. These results indicated that the outfall area was not degraded and that it supported normal fish and EMI populations.

Contaminants in Fish Tissue

Consistent with previous results, 2014-15 tissue concentrations of mercury, DDT, PCB, and other chlorinated pesticides in fishes collected by otter trawling and hook-and-line methods at outfall and non-outfall locations were below federal and state human consumption guidelines. These results demonstrated that the outfall is not an epicenter of disease due to the bioaccumulation of contaminants in fish tissue.

Fish Health

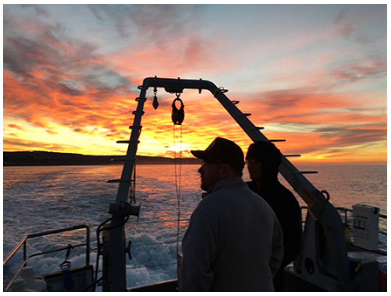
The lack of tumors, fin erosion, and skin lesions showed that fishes in the monitoring area were healthy. External parasites and other external abnormalities occurred in less than 1% of the fishes collected. These results were consistent with previous years and indicate that the outfall is not an epicenter of disease.

CONCLUSIONS

The results for the 2014-15 monitoring effort were consistent with long-term findings that showed limited impacts to the receiving water, sediment, and infaunal, demersal fish, and EMI communities. Plume-related changes to receiving water DO, pH, and transmissivity detected beyond the ZID were well within the range of natural variability. Low concentrations of bacteria in water contact zones, in concert with the limited distributions of ammonium and absence of associations of the wastewater plume with phytoplankton blooms, suggest that the discharge had no discernible impact on the environment and posed no human health risk. The low levels of contaminants in fish tissues and the low incidence of external abnormalities and diseases in fish demonstrated that the outfall was not an epicenter of disease.

THE OCEAN MONITORING PROGRAM

Chapter 1



Chapter 1
THE OCEAN MONITORING PROGRAM

INTRODUCTION

The Orange County Sanitation District (District) operates 2 wastewater treatment facilities located in Fountain Valley (Plant 1) and in Huntington Beach (Plant 2), California. The District discharges treated wastewater (effluent) to the Pacific Ocean through a submarine outfall located offshore of Huntington Beach and Newport Beach, California (Figure 1-1). This discharge is regulated by the US Environmental Protection Agency (EPA), Region IX and the Regional Water Quality Control Board (RWQCB), Region 8 under the Federal Clean Water Act, the California Ocean Plan, and the RWQCB Basin Plan. Specific discharge and monitoring requirements are contained in a National Pollutant Discharge Elimination System (NPDES) permit issued jointly by the EPA and the RWQCB (Order No. R8-2012-0035, NPDES Permit No. CA0110604) on June 15, 2012.

A large percentage of the local economies in southern California rely on beach use and its associated recreational activities, which are highly dependent upon water quality conditions (Turbow and Jiang 2004, Leeworthy and Wiley 2007). The region's Mediterranean climate and convenient beach access results in high, year-round public use of beaches. For example, although the highest visitation occurs during the summer months, beach usage at the Huntington Beach and Newport Beach city beaches during the winter months can each exceed 545,000 visitors per month (City of Huntington Beach, City of Newport Beach, California State Department of Parks and Recreation, unpublished data, 2015).

For 2014-15, total beach attendance for Seal Beach, Bolsa Chica State Beach, Huntington Beach City Beach, Huntington Beach State Beach, Newport Beach City Beach, and Crystal Cove State Beach was ≈25 million (Figure 1-2a; City of Seal Beach, City of Huntington Beach, City of Newport Beach, California State Department of Parks and Recreation, unpublished data, 2015). Total monthly visitations ranged from 691,033 in December 2014 to 5,551,782 in July 2014 (Figure 1-2b). The 2014-15 seasonal visitation patterns were similar to those of previous years.

DESCRIPTION OF THE DISTRICT'S OPERATIONS

The District's mission is to safely collect, process, recycle, and dispose of treated wastewater while protecting human health and the environment in accordance with federal, state, and local laws and regulations. These objectives are achieved through extensive industrial pre-treatment (source control), secondary treatment processes, biosolids management, and

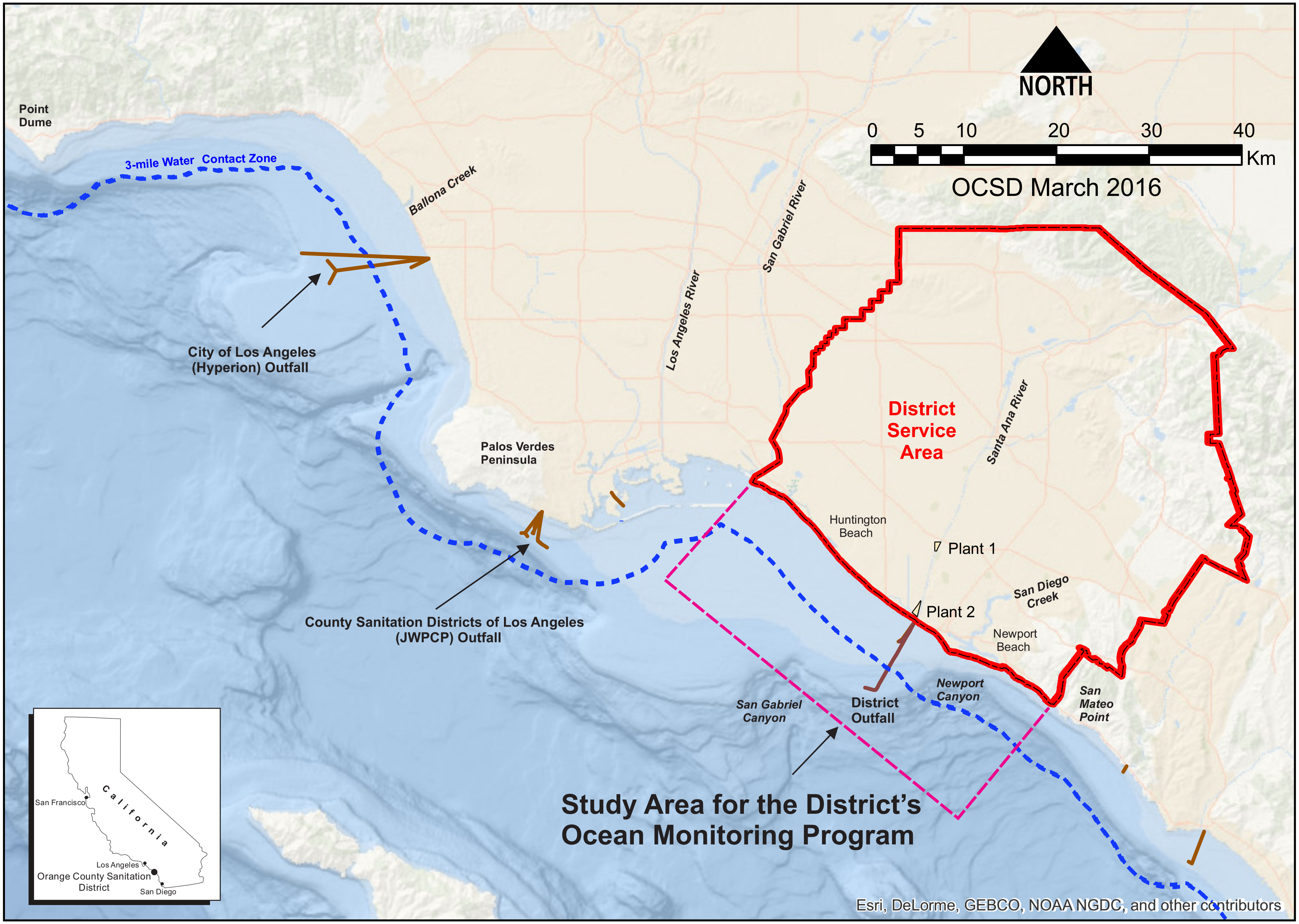


Figure 1–1. Regional setting for the District's ocean monitoring program.

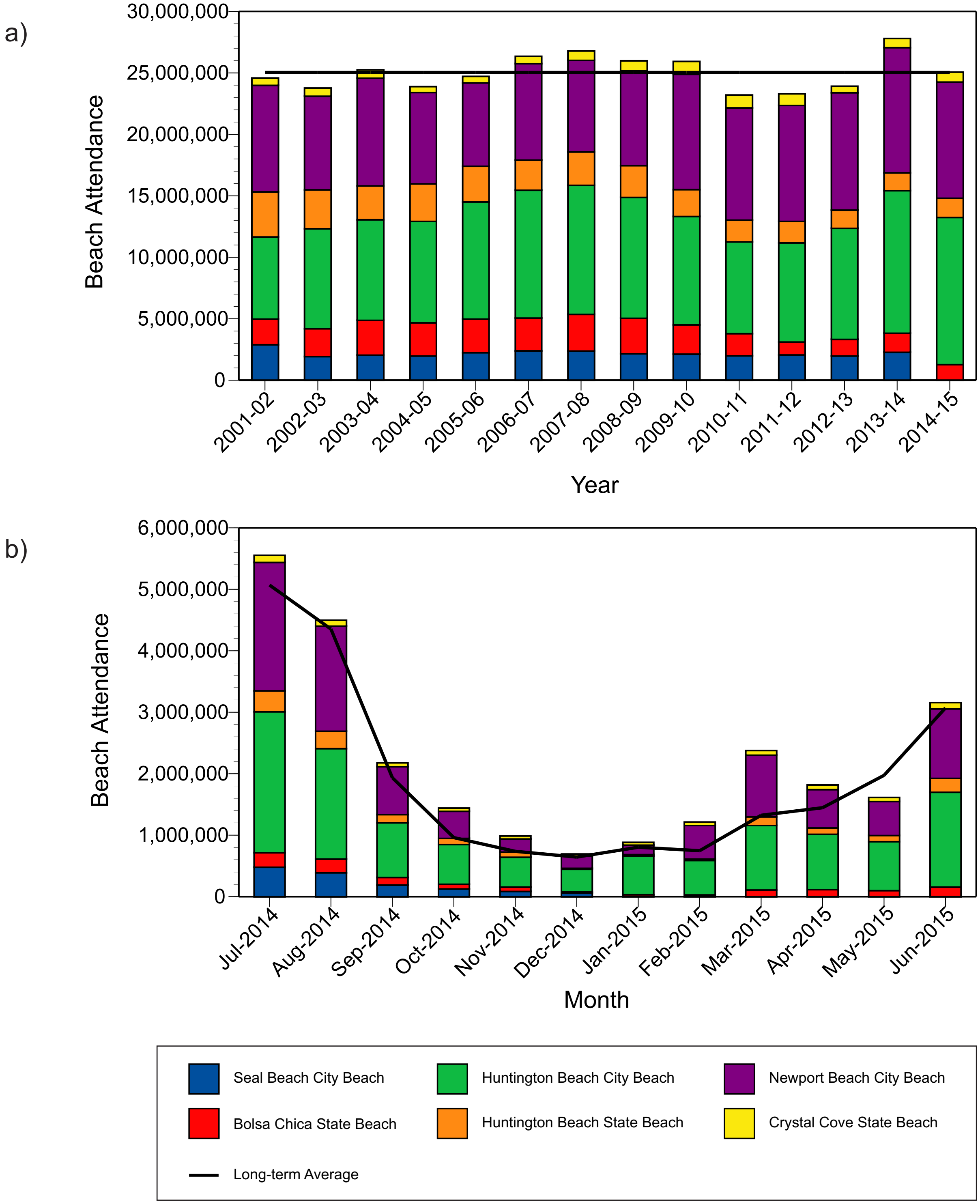


Figure 1–2. **a) Annual total beach attendance from 2001-2015 and b) monthly total beach attendance during 2014-15 for Seal Beach City Beach, Bolsa Chica State Beach, Huntington Beach City Beach, Huntington Beach State Beach, Newport Beach City Beach, and Crystal Cove State Beach. Annual values represent beach attendance from July 1 to June 30 for each program year. Solid black line on each plot represents historical mean beach attendance (2001-2015). Note: data for Seal Beach City Beach were not available for 2015.**

Source: City of Seal Beach Marine Safety/Lifeguards Department, City of Huntington Beach – Fire Department/ Marine Safety Division, City of Newport Beach – Fire Department/Marine Operations Division, State Beaches, California State Department of Parks and Recreation – Orange Coast District.

water reuse programs. During the 2012-13 program year, the District completed construction and testing of new full secondary treatment facilities and brought these facilities permanently on-line.

Together, the District's 2 wastewater treatment plants receive domestic sewage from approximately 80% of the county's 3.1 million residents and industrial wastewater from 688 permitted businesses within the District's service area. Under normal operations, the effluent is discharged through a 120-in (305-cm) diameter ocean outfall, which extends 4.4 miles (7.1 km) from the Huntington Beach shoreline (Figure 1-1). The last 1.1 miles (1.8 km) of the outfall consists of a diffuser with 503 ports that discharge the treated effluent at an approximate depth of 197 ft (60 m).

Since 1999, the District has accepted 8.3 billion gallons (3.2×10^{10} L) of dry-weather urban runoff from 20 diverted urban runoff locations in North and Central Orange County that would otherwise have gone into the ocean without treatment (OCSD 2015). These include storm water pump stations owned by the City of Huntington Beach (n=11), the City of Newport Beach (n=2), the Irvine Ranch Water District (n=2), the PH Finance, LLC (n=1), and from 4 diverted flood control channels owned by the Public Works Department of Orange County. The collection and treatment of dry-weather runoff is part of a regional effort to reduce beach bacterial and chemical (e.g., selenium) pollution associated with chronic dry-weather flows within the watershed. For 2014-15, the diverted daily discharge per month ranged from 0.70–1.49 million gallons ($2.6–5.6 \times 10^6$ L) during dry weather and the total average daily discharge was 1.50 million gallons (5.7×10^6 L). There are 4 new urban runoff diversions proposed for the coming year. Construction of 1 new diversion is nearly underway, with the diversion expected to go on-line by the end of 2016. Three additional diversions, the Delhi, Santa Fe, and Lane flood control channels in the City of Santa Ana, are still in the proposal stage with no projected timeline for completion.

Since July of 1986, approximately 10 million gallons per day (MGD) (3.8×10^7 L/day) of the final effluent had been transferred daily to the Orange County Water District (OCWD) where it received further (tertiary) treatment to remove residual solids. The effluent from this process was then used for public landscape irrigation (e.g., freeways, golf courses) as part of the Green Acres Project (GAP) or pumped into a local aquifer to provide a saltwater intrusion barrier. In 2007-08, the District began diverting ≈35 MGD ($\approx 1.3 \times 10^8$ L/day) of secondary effluent to OCWD's Groundwater Replenishment System (GWRS). The diversion was increased to ≈68 MGD ($\approx 2.6 \times 10^8$ L/day) in 2008-09, averaged 84 MGD ($\approx 3.2 \times 10^8$ L/day) in 2013-14, and was increased to ≈100 MGD ($\approx 3.8 \times 10^8$ L/day) in February 2015. This flow is treated using microfiltration, reverse osmosis, and ultraviolet disinfection to achieve constituent levels that meet or exceed drinking water standards.

During 2014-15, the 2 wastewater treatment plants received and processed influent volumes averaging 187.3 MGD (7.1×10^8 L/day). Treatment plant processes achieved a 98% reduction in suspended solids concentration. After diversions to the GWRS, the District discharged an average of 117.2 MGD (4.4×10^8 L/day) of treated wastewater to the ocean (Figure 1-3). Peak flow in 2014-15 was 134.5 MGD (5.1×10^8 L/day) in July of 2014, which was well below the historical peak flow of 550 MGD (2.1×10^9 L/day) that occurred during an extreme rainfall event in the winter of 1996. Seasonal and interannual differences in flow volumes are due to the variability in the amount of rainfall, infiltration of the treatment system by runoff,

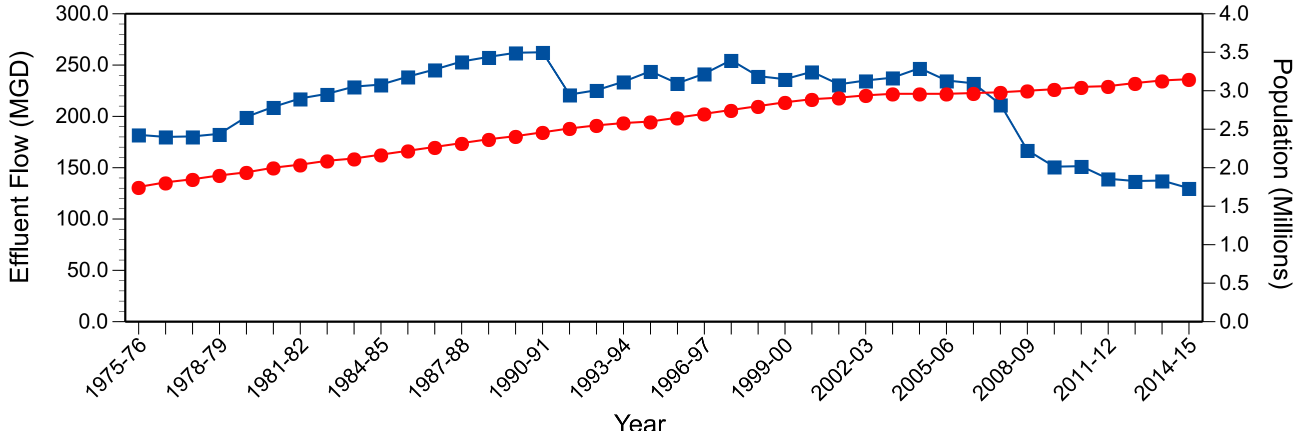


Figure 1–3. **Annual final effluent flow (blue line) for the District and annual population (red line) for Orange County, California, 1975-2015.**
Source: OC Population: California Dept. of Finance

and reclamation. The 2014-15 total rainfall for Newport Harbor was 5.55 inches (141 mm) (Orange County, CA Department of Public Works 2015), well below the long-term historical mean of 10.9 inches (277 mm) (Figure 1-4). As a result, annual flows in the Santa Ana River were below average (Figure 1-5).

Prior to 1990, wastewater discharge volumes gradually increased due to continuing population growth within the District's service area (Figure 1-3). However, wastewater flows decreased in 1991-92 and remained stable through 2007 due to drought conditions and water conservation measures despite the increasing population. Since 2007, average flows have declined dramatically due to the conservation measures of our member agencies and the startup of the GWRS, which reclaims water that previously would have been discharged to the ocean.

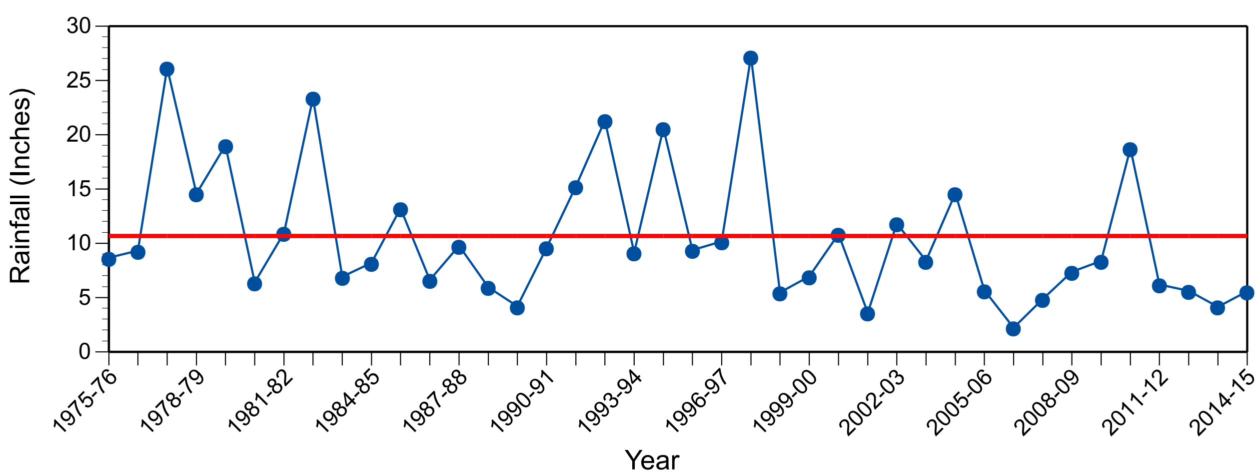


Figure 1–4. **Annual rainfall for Newport Harbor, 1975-2015. Red line represents the historical annual mean value.**
Source: Rainfall: OC Public Works; Station 88/Newport Beach.

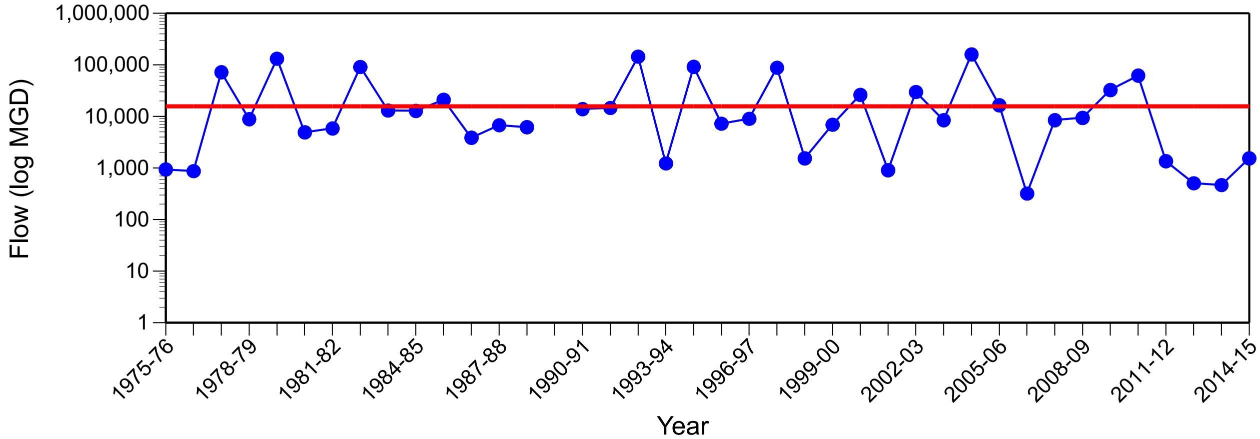


Figure 1–5. Annual flow for the Santa Ana River, 1975-2015. Red line represents the historical annual mean value.
Source: Santa Ana River: USGS, 5th Street Station, Santa Ana.

REGULATORY SETTING FOR THE OCEAN MONITORING PROGRAM

The District's permit includes requirements to monitor influent, effluent, and the receiving water. Effluent flows, constituent concentrations, and toxicity are monitored to determine compliance with permit limits and to provide data for interpreting changes to receiving water conditions. Wastewater impacts to coastal receiving waters are evaluated by the District's ocean monitoring program (OMP) based on 3 inter-related components: Core monitoring, Strategic Process Studies (SPS), and Regional monitoring. In addition, the District conducts other special studies not required under the existing NPDES permit. Information obtained from each of these program components is used to further the understanding of the coastal ocean environment and improve interpretations of the monitoring data. These program elements are summarized below.

The Core monitoring program is designed to measure compliance with permit conditions and trend analysis. Four major components comprise the program: (1) coastal oceanography and water quality, (2) sediment quality, (3) benthic infaunal community health, and (4) demersal fish and epibenthic macroinvertebrate community health, which include fish tissue contaminant concentrations.

The District conducts SPS to provide information about relevant coastal processes that are not addressed by Core monitoring. These studies have included evaluating the physical and chemical processes that affect the fate and transport of the discharged wastewater, tracking wastewater particles, contributing to the development of ocean circulation models, and studying the effects of endocrine disrupting compounds (EDCs) on fish. The District recently concluded a series of studies conducted over 3 years to examine recent changes in infaunal assemblages near the outfall, collectively referred to as the ZID (zone of initial dilution) Investigation. Presently, the District is continuing a sediment mapping study to determine the optimal sediment station array to accurately generate a map of the District's outfall footprint for sediment geochemistry analytes and benthic infaunal community metrics.

Since 1994, the District has participated in 5 regional monitoring studies of environmental conditions within the Southern California Bight (SCB): 1994 Southern California Bight

Pilot Project (SCBPP), Bight'98, Bight'03, Bight'08, and Bight'13. The District has played a considerable role in all aspects of these regional projects, including program design, sampling, quality assurance, data analysis, and report writing. Results from these efforts provide information that is used by individual dischargers, resource managers, and the public to improve region-wide understanding of environmental conditions and to provide a regional perspective for comparisons with data collected from individual point sources. Final reports for the Bight'13 program will be available in December 2017. Program documents, data, and reports on the previous studies can be found at the Southern California Coastal Water Research Project's (SCCWRP) website (http://sccwrp.org). Since 1997, the District has also participated in the Central Bight Water Quality Program, a collaborative regional water quality effort of the City of Oxnard, the City of Los Angeles, the County Sanitation Districts of Los Angeles, the District, and the City of San Diego.

Other collaborative projects organized by SCCWRP include "Characteristics of Effluents from Large Municipal Wastewater Treatment Facilities" and "Comparison of Mass Emissions among Sources in the Southern California Bight." Both of these projects involve historical data mining from large publicly owned treatment works (POTWs), including the District. Finally, the District has been working with the Southern California Coastal Ocean Observing System (SCCOOS; http://www.sccoos.org) to provide real time meteorological data and historical and ongoing offshore and beach water quality data to further understand region-wide oceanographic trends. The District also partnered with SCCWRP, other local POTWs, and the OC Health Care Agency in conducting studies not mandated by the NPDES permit. Recent examples include continuing research on source tracking of bacterial contamination and evaluating rapid tests for fecal indicator bacteria.

The District's OMP has contributed substantially to the understanding of water quality and environmental conditions along the beaches and in the area adjacent to the submarine outfall. This monitoring program has generated a large data set that provides a broad understanding of both natural and anthropogenic processes that affect coastal oceanography and marine biology.

ENVIRONMENTAL SETTING

The District's ocean monitoring area is located on the southern portion of the San Pedro Shelf, adjacent to one of the most highly urbanized areas in the United States. The shelf is composed primarily of soft sediments (sands with silts and clays) and inhabited by biological communities typical of these environments. The seafloor increases in depth gradually from the shoreline to a depth of approximately 262 ft (80 m), after which the depth increases rapidly as it slopes down to the open basin. The outfall diffuser lies at about 60 m depth on the shelf between the Newport and San Gabriel submarine canyons, which are located southeast and northwest, respectively (Figure 1-1). The 120-inch outfall represents one of the largest artificial reefs in this coastal region and supports communities typical of hard substrates that would not otherwise be found in the monitoring area (CDFG 1989, OCSD 2000). Together with the District's 78-inch (198-cm) outfall, approximately 1.1×10^6 ft^2 (102,193 m^2) of seafloor was converted from a flat, sandy habitat into a raised, hard-bottom substrate.

Conditions within the District's monitoring area are affected by large regional-scale current patterns that influence the water characteristics and the direction of water flow along the Orange County coastline. The predominant low-frequency current flows in the monitoring area are alongshore (i.e., either upcoast or downcoast) with minor across-shelf (i.e., toward the beach) transport (OCSD 1997, 1998, 2004, 2011; SAIC 2001, 2009, 2011). The specific direction of the flows varies with depth and is subject to reversals over time periods of days to weeks (see SAIC 2011 for detailed long-term analyses).

Other natural oceanographic processes, such as upwelling and eddies, also influence the characteristics of receiving waters on the San Pedro Shelf. Tidal flows, currents, and internal waves mix and transport the District's wastewater discharge with coastal waters and resuspended sediments. Tidal currents in the study region are relatively weak compared to lower frequency currents, which are responsible for transporting material over long distances (OCSD 2001, 2004). Combined, these processes contribute to the variability of seawater movement observed within the monitoring area.

Episodic storms, drought, and climatic cycles influence environmental conditions and biological communities within the monitoring area. For example, storm water runoff has a large influence on sediment movement in the region (Brownlie and Taylor 1981, Warrick and Millikan 2003). Major storms contribute large amounts of contaminants to the ocean and can generate waves capable of extensive shoreline erosion, sediment resuspension, and movement of sediments along the coast as well as offshore. Some of the greatest effects are produced by wet weather cycles, periods of drought, and periodic oceanographic events, such as El Niño and La Niña conditions. An understanding of the effects of the inputs from rivers and watersheds, particularly non-point source runoff, is important for evaluating trends in the environmental quality of coastal areas. River flows, together with urban storm water runoff, represent significant, episodic sources of freshwater, sediments, suspended particles, nutrients, bacteria and other contaminants to the coastal area (Hood 1993, Grant *et al*. 2001, Warwick *et al*. 2007), although recent studies indicate that the spatial impact of these effects may be limited (Ahn *et al*. 2005, Reifel *et al.* 2009). While many of the materials supplied to coastal waters by rivers are essential to natural biogeochemical cycles, either an excess or a deficit may have important environmental consequences.

Nearshore coastal waters of the SCB receive municipal and industrial wastes from a variety of human-related sources, such as wastewater discharges, dredged material disposal, oil and gas activities, boat/vessel discharges, urban and agricultural runoff, and atmospheric fallout. The majority of these sources are located between Point Dume and San Mateo Point (Figure 1-1). Discharges from the Los Angeles, San Gabriel, and Santa Ana Rivers are also responsible for substantial inputs of contaminants to the SCB (Schafer and Gossett 1988, SCCWRP 1992, Schiff and Tiefenthaler 2001).

A goal of the District's OMP is to provide an understanding of the effects of its wastewater discharge on beneficial uses of the ocean. However, distinguishing the effects of the District's discharge from those of natural and other human influences is difficult, especially as the "signal" (impact) from the outfall has been greatly reduced since the 1970s. The complexities of the environmental setting and related difficulties in assigning a cause or source to a pollution event are the reasons for the District's extensive monitoring program.

This report presents OMP compliance determinations for data collected from July 2014 through June 2015. Compliance determinations were made by comparing OMP findings to the criteria specified in the District's NPDES permit. Any related special studies or regional monitoring efforts are also documented. This report and earlier annual reports are available digitally at the District's website: http://www.ocsd.com/opengov/annual-reports/-folder-385.

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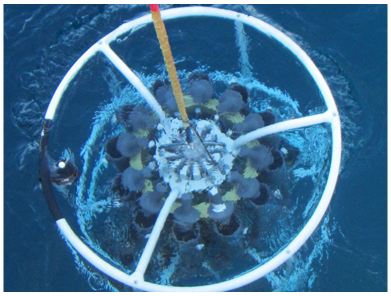
COMPLIANCE DETERMINATIONS

Chapter 2



Chapter 2
COMPLIANCE DETERMINATIONS

INTRODUCTION

This chapter provides compliance results for the 2014-15 monitoring year for the Orange County Sanitation District's (District) ocean monitoring program (OMP). The program includes sample collection, analysis, and data interpretation to evaluate potential impacts of wastewater discharge on the following receiving water characteristics:

- Bacterial
- Physical
- Chemical
- Biological
- Radioactivity

Each of these characteristics have specific criteria (Table 2-1) for which permit compliance must be determined each monitoring year.

The Core OMP sampling locations include 28 offshore water quality stations, 68 benthic stations to assess sediment chemistry and bottom-dwelling communities, 14 trawl stations to evaluate fish and macroinvertebrate communities, and rig fishing zones for assessing human health risk from the consumption of sport fishes (Figures 2-1 to 2-3, Table A-1). Monitoring frequencies varied by component, and ranged from 2–5 days per week for surfzone water quality to annual assessments of fish health and tissue analyses.

WATER QUALITY

Offshore bacteria

The majority (78–91%; n=2097) of fecal indicator bacteria (FIB) counts collected at the 8 REC-1 stations were below the method detection limit (MDL) of 10 MPN/100 mL (Tables B-1 to B-3). The highest density observed for any single sample for total coliforms, fecal coliforms, and enterococci was 5794, 234, and 52 MPN/100 mL, respectively. Compliance for all 3 FIB were achieved 100% for both state and federal criteria, indicating no impact of bacteria to offshore receiving waters.

In addition to the required REC-1 stations, the District sampled an additional 7 stations along the 10-m depth contour as part of a study to evaluate potential changes in bacteria counts due

Table 2–1. Listing of compliance criteria from NPDES ocean discharge permit (Order No. R8-2012-0035, Permit # CA0110604) and compliance status for each criterion in 2014-15.

Criteria	Criteria Met
Bacterial Characteristics	
V.A.1.a. For the Ocean Plan Water-Contact Standards, total coliform density shall not exceed a 30-day Geometric Mean of 1,000 per 100 mL nor a single sample maximum of 10,000 per 100 mL. The total coliform density shall not exceed 1,000 per 100 mL when the single sample maximum fecal coliform/total coliform ratio exceeds 0.1.	Yes
V.A.1.a. For the Ocean Plan Water-Contact Standards, fecal coliform density shall not exceed a 30-day Geometric Mean of 200 per 100 mL nor a single sample maximum of 400 per 100 mL.	Yes
V.A.1.a. For the Ocean Plan Water-Contact Standards, *Enterococcus* density shall not exceed a 30-day Geometric Mean of 35 per 100 mL nor a single sample maximum of 104 per 100 mL.	Yes
V.A.1.b. For the USEPA Primary Recreation Criteria in Federal Waters, *Enterococcus* density shall not exceed a 30 day Geometric Mean (per 100 mL) of 35 nor a single sample maximum (per 100 mL) of 104 for designated bathing beach, 158 for moderate use, 276 for light use, and 501 for infrequent use.	Yes
V.A.1.c. For the Ocean Plan Shellfish Harvesting Standards, the median total coliform density shall not exceed 70 per 100 mL, and not more than 10 percent of the samples shall exceed 230 per 100 mL.	N/A
Physical Characteristics	
V.A.2.a. Floating particulates and grease and oil shall not be visible.	Yes
V.A.2.b. The discharge of waste shall not cause aesthetically undesirable discoloration of the ocean surface.	Yes
V.A.2.c. Natural light shall not be significantly reduced at any point outside the initial dilution zone as a result of the discharge of waste.	Yes
V.A.2.d. The rate of deposition of inert solids and the characteristics of inert solids in ocean sediments shall not be changed such that benthic communities are degraded.	Yes
Chemical Characteristics	
V.A.3.a. The dissolved oxygen concentration shall not at any time be depressed more than 10 percent from that which occurs naturally, as the result of the discharge of oxygen demanding waste materials.	Yes
V.A.3.b. The pH shall not be changed at any time more than 0.2 units from that which occurs naturally.	Yes
V.A.3.c. The dissolved sulfide concentration of waters in and near sediments shall not be significantly increased above that present under natural conditions.	Yes
V.A.3.d. The concentration of substances, set forth in Chapter II, Table B of the Ocean Plan, in marine sediments shall not be increased to levels which would degrade indigenous biota.	Yes
V.A.3.e. The concentration of organic materials in marine sediments shall not be increased to levels which would degrade marine life.	Yes
V.A.3.f. Nutrient materials shall not cause objectionable aquatic growths or degrade indigenous biota.	Yes
V.A.3.g. The concentrations of substances, set forth in Chapter II, Table B of the Ocean Plan, shall not be exceeded in the area within the waste field where initial dilution is completed.	Yes
Biological Characteristics	
V.A.4.a. Marine communities, including vertebrate, invertebrate, and plant species, shall not be degraded.	Yes
V.A.4.b. The natural taste, odor, and color of fish, shellfish, or other marine resources used for human consumption shall not be altered.	Yes
V.A.4.c. The concentration of organic materials in fish, shellfish, or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health.	Yes
V.A.5. Discharge of radioactive waste shall not degrade marine life.	Yes

N/A = Not Applicable.

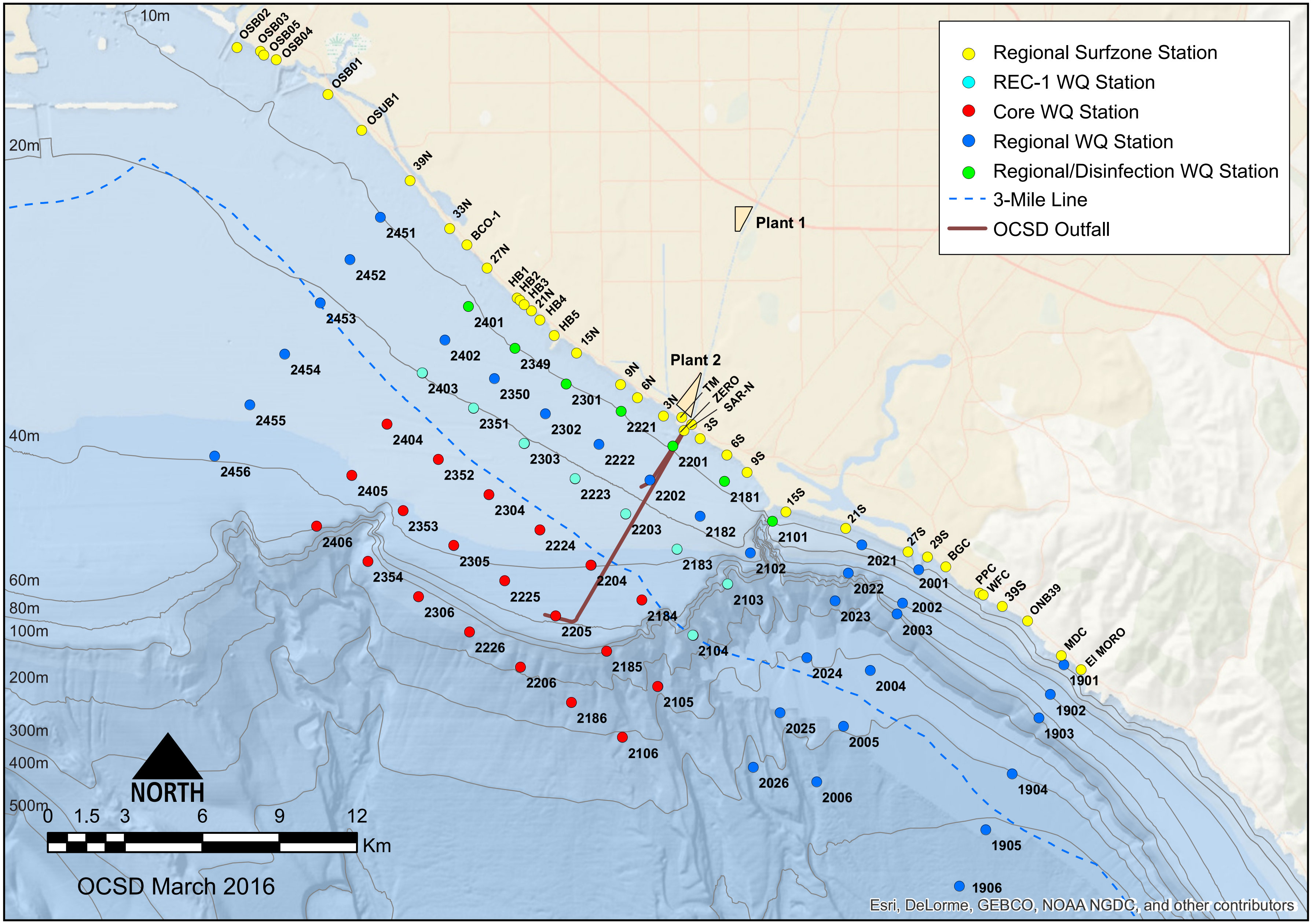


Figure 2–1. Offshore and Nearshore (surfzone) water quality monitoring stations for 2014-15.

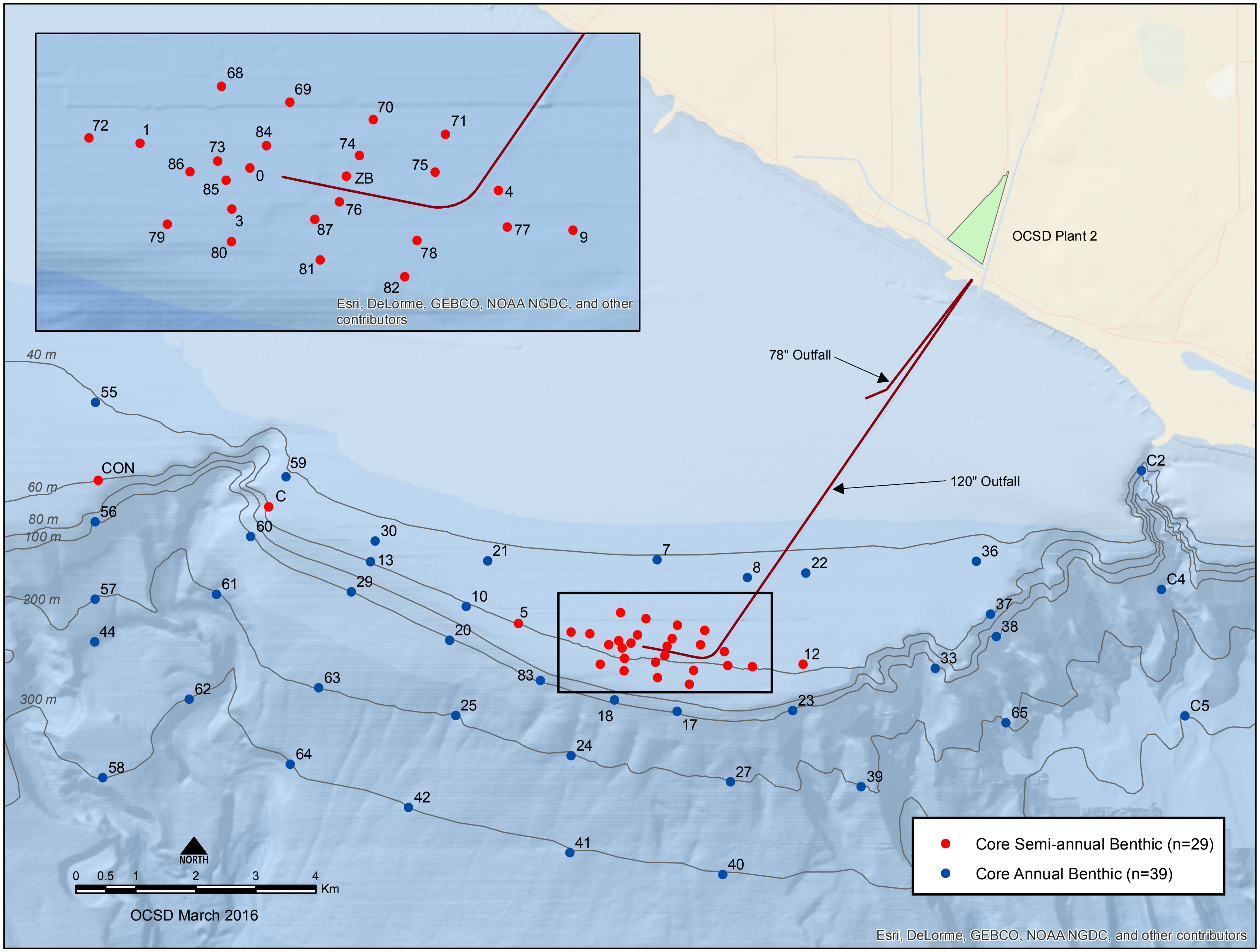


Figure 2–2. **Benthic (sediment geochemistry and infauna) monitoring stations for 2014-15.**

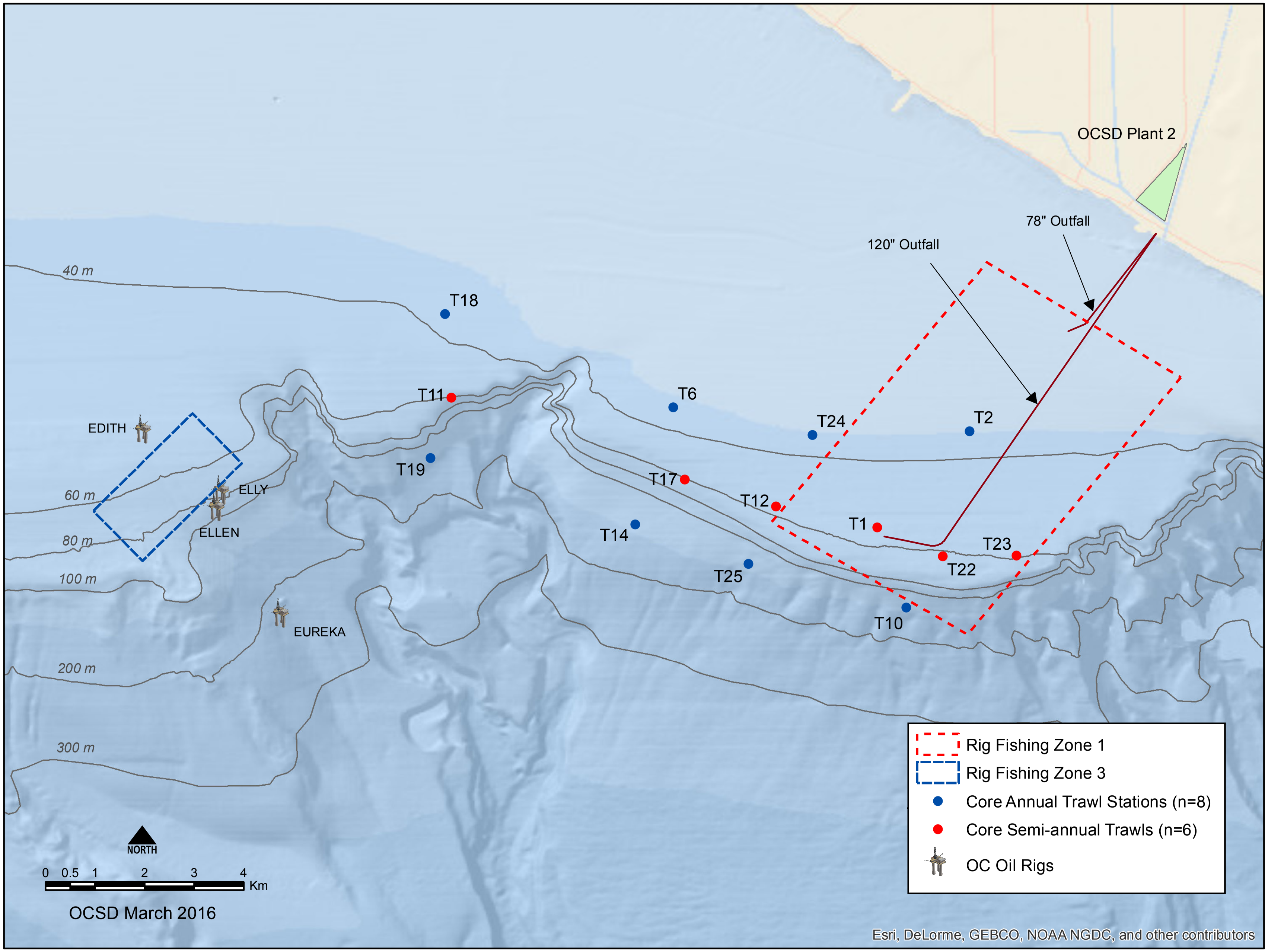


Figure 2–3. Trawl monitoring stations, as well as rig-fishing locations, for 2014-15.

to the cessation of disinfection of the final effluent (Figure 2-1). At these stations, 84-100% of the samples (n=210) were below the MDL. The highest value measured was 201, <10, and 10 MPN/100 mL for total coliforms, fecal coliforms, and enterococci, respectively.

Floating Particulates and Oil and Grease

There were no observations of oils and grease or floating particles of sewage origin at any offshore or nearshore station in 2014-15 (Tables B-4 and B-5). Therefore, compliance was achieved.

Ocean Discoloration and Transparency

The water clarity standards were met 97.4% of the time for both Zone A and B station groups combined (Table 2-2). Compliance was slightly lower than the previous year's value of 100% though it was within the range seen since 1985 (Figure 2-4). All transmissivity values (Table B-6) were within natural ranges of variability to which marine organisms are exposed (OCSD 1996a). There were no impacts from the wastewater discharge relative to ocean discoloration at any offshore station.

Dissolved Oxygen

In 2014-15, compliance was met 99.4% and 99.6% of the time for Zone A and B station groups, respectively (Table 2-2). Overall compliance was met 99.5% of the time for all stations combined. This represents an increase in compliance of 2.1% from the 2013-14 monitoring year (Figure 2-4), and is the highest dissolved oxygen compliance value seen

Table 2–2. Summary of offshore water quality compliance testing results for dissolved oxygen, pH, and transmissivity for 2014-15.

Parameter	Number of Observations	Number of Out-of-Range Occurrences	Percent Out-of-Range Occurrences	Number Out-of-Compliance	Percent Out-of-Compliance
Zone A Stations					
Dissolved Oxygen	494	16	3.2	3	0.6
pH	494	18	3.6	0	0
%Transmissivity	494	196	39.7	0	0
Zone B Stations					
Dissolved Oxygen	468	8	1.7	2	0.4
pH	468	4	0.9	2	0.4
%Transmissivity	468	103	22	25	5.3
Total (Zone A and Zone B Stations Combined)					
Dissolved Oxygen	962	24	2.5	5	0.5
pH	962	22	2.3	2	0.2
%Transmissivity	962	299	31.1	25	2.6

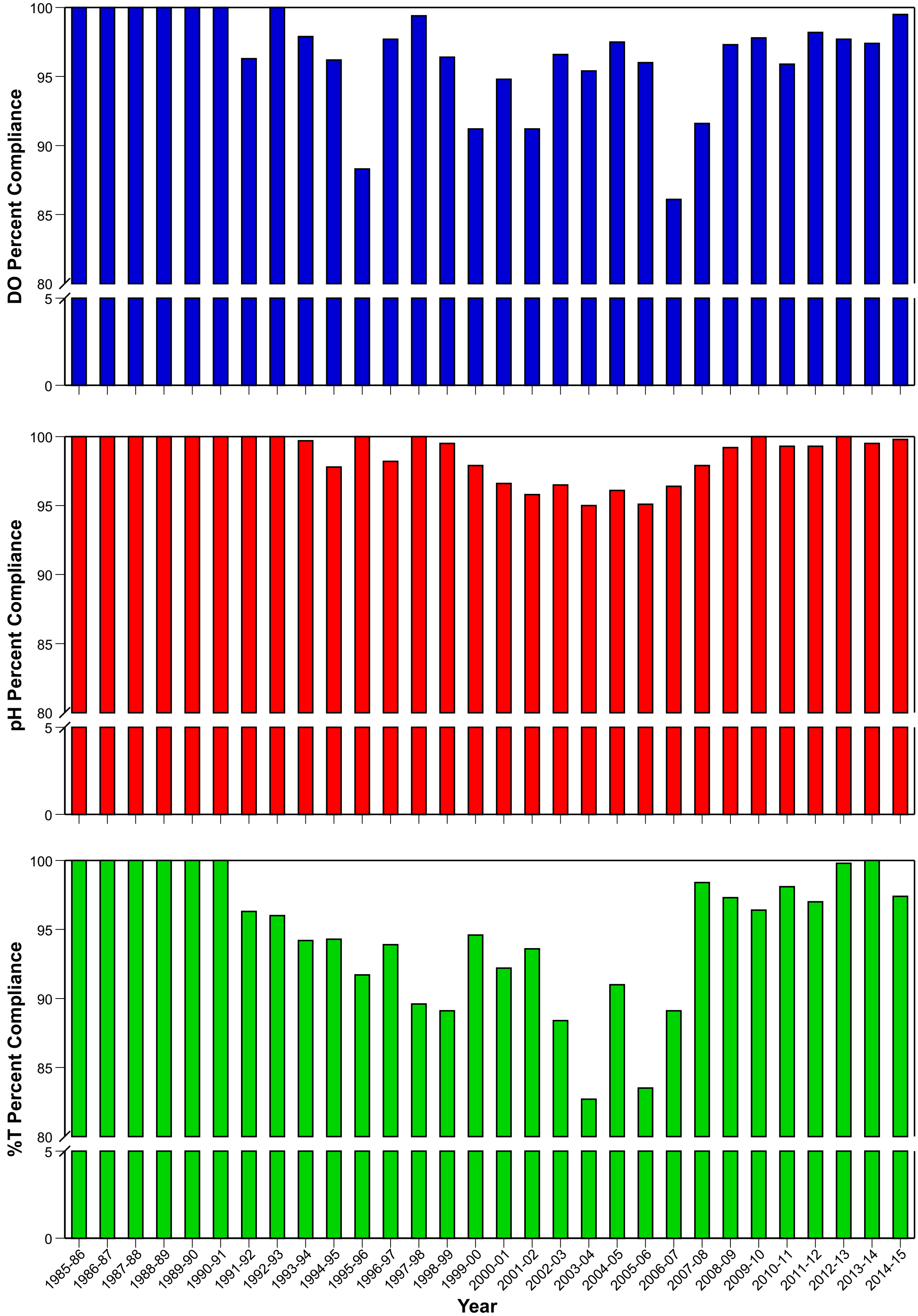


Figure 2–4. Summary of mean percent compliance for dissolved oxygen (DO), pH, and light transmissivity (%T) for all compliance stations, 1985–2015.

since 1998 (86.1–99.5%). The DO values (Table B-6) were well within the range of long-term monitoring results (OCSD 1996b, 2004b). No environmentally significant effects to DO from the wastewater discharge were observed.

Acidity (pH)

Compliance was met 100% and 99.6% of the time for Zone A and B station groups, respectively (Table 2-2). Overall compliance was met 99.8% of the time for all stations combined, a slight increase from the previous year's value, and within the range seen since 1985 (Figure 2-4). There were no environmentally significant effects to pH from the wastewater discharge as the measured values (Table B-6) were within the range to which marine organisms are naturally exposed.

Nutrients (Ammonium)

During 2014-15, 90% (n=1,307) of the samples were below the MDL (<0.02 mg/L). Detectable ammonium concentrations ranged from 0.02 to 0.27 mg/L, with 95% (n=146) of the detected values collected from samples taken below 15 m (Table B-6). Plume-related changes in ammonium were not considered environmentally significant as maximum values were 15 times less than the chronic (4 mg/L) and more than 20 times less than the acute (6 mg/L) toxicity standards of the California Ocean Plan (OCSD 2004a). In addition, there were no detectable plankton associated impacts (i.e., excessive plankton blooms caused by the discharge).

Organics in the Water Column

Only 8 constituents from Table B of the Ocean Plan have effluent limitations established in the District's NPDES permit. During the period from July 2014 through June 2015, none of these constituents exceeded the effluent limitations established in the permit.

Radioactivity

The District measures the effluent for radioactivity, but not the receiving waters. The results of the effluent analyses during 2014-15 indicated that both state and federal standards were consistently met and are published in the District's Discharge Monitoring Reports (DMR). As fish and invertebrate communities are diverse and healthy, compliance is considered to be met.

Overall, results from the District's 2014-15 water quality monitoring program detected minor changes in measured water quality parameters related to the discharge of wastewater to the coastal ocean. This is consistent with previously reported results (e.g., OCSD 2015). Plume-related changes in temperature, salinity, DO, pH, and transmissivity were measurable beyond the initial mixing zone during some surveys. This usually extended only into the nearfield stations, typically <2 km away from the outfall, similar to what has been seen in the past. None of these changes were determined to be environmentally significant since they fell within natural ranges to which marine organisms are exposed (OCSD 1996a, 2004b; Wilber and Clarke 2001, Chavez *et al*. 2002, Jarvis *et al*. 2004, Allen *et al*. 2005, Hsieh *et al*. 2005). Overall, the public health risks and measured environmental effects to the receiving water continue to be small. All values were within the ranges of natural variability for the study area, and reflected seasonal and yearly changes of large-scale regional influences. The limited observable plume effects occurred primarily at depth, even during the winter when stratification was weakest. In summary, staff concluded that the discharge, in 2014-15, did not greatly affect the receiving water environment, and that beneficial uses were protected and maintained.

SEDIMENT GEOCHEMISTRY

Means of sediment geochemistry parameter values in 2014-15 were comparable between within-ZID and non-ZID station groups and were similar to or well below regional values (Tables 2-3 to 2-6). Sediment geochemistry values were also below levels of biological concern (Effects Range-Median (ERM) values), except for silver (>3.7 mg/kg) at non-ZID Station C in Summer 2014. This exceedance was considered to be due to natural variability, as the concentration of silver at Station C was below the ERM in the previous monitoring years (OCSD 2014, 2015) and in Winter 2015. These results, coupled with the absence of sediment toxicity in amphipod survival tests (Table 2-7) and the presence of healthy fish and invertebrate communities both near and away from the outfall (see below), suggest good sediment quality in the monitoring area. Therefore, we conclude that compliance was met.

BIOLOGICAL COMMUNITIES

Infaunal Communities

A total of 658 invertebrate taxa comprising 31,188 individuals were collected in the 2014-15 monitoring year. As with previous years (OCSD 2013, 2014), there were marked declines in mean species numbers (richness) and abundances of infauna at stations deeper than 120 m (Table 2-8). Mean community measure values were comparable between within- and non-ZID stations, and all station values were within regional and District historical ranges in both surveys (Tables 2-8 and 2-9). The infaunal communities in both surveys can be classified as reference condition based on their low (<25) mean Benthic Response Index (BRI) values and/or high (>60) mean Infaunal Trophic Index (ITI) values. Results of the multivariate analyses, particularly the similarity profile (SIMPROF) test, of the infaunal species and abundances showed that the infaunal community composition at non-ZID and within-ZID stations were similar in each survey (Figure 2-5). In terms of indicator species, just 1 specimen of the pollution-tolerant polychaete species *Capitella capitata* Cmplx was collected at within-ZID Station 0 and at 5 non-ZID stations in the summer survey, but none was present in the winter samples. In addition, the abundances of the pollution-sensitive amphipod genera *Ampelisca* and *Rhepoxynius* remained high at within-ZID stations, with a survey mean of 43 individuals. These multiple lines of evidence suggest that the outfall discharge had an overall negligible effect on the benthic community structure within the monitoring area. We conclude, therefore, that the biota outside the ZID was not degraded by the outfall discharge, and as such, compliance was met.

Epibenthic Macroinvertebrate Communities

A total of 49 epibenthic macroinvertebrate (EMI) species, comprising 12,945 individuals and a total weight of 46.9 kg, were collected from the monitoring area during trawls conducted in

Table 2–3. **Physical properties and organic contaminant concentrations of sediment samples collected at each semi-annual and annual station (*) in Summer 2014 compared to Effects Range-Median (ERM) values and regional measurements.**

Station	Depth (m)	Total LAB (µg/kg)	Median Phi	Fines (%)	TOC (%)	Sulfides (mg/kg)	Total P (mg/kg)	Total N (mg/kg)	Total PAH (µg/kg)	Total DDT (µg/kg)	Total Pest (µg/kg)	Total PCB (µg/kg)
						Middle shelf Zone 1 (31-50 m)						
7 *	41	37.4	3.81	33.9	0.38	2.61	1300	350	388.5	10.80	ND	0.21
8 *	44	25.0	3.88	40.0	0.41	6.41	1100	390	77.5	3.34	ND	0.71
21 *	44	33.9	3.79	34.7	0.37	6.47	1200	370	60.6	2.34	ND	1.78
22 *	45	23.8	3.95	45.8	0.38	4.67	1100	330	61.0	3.38	ND	1.98
30 *	46	27.8	3.66	28.0	0.33	2.30	1100	280	59.4	1.63	ND	0.24
36 *	45	11.0	3.91	43.9	0.35	5.10	1100	250	49.3	1.60	ND	ND
55 *	40	26.1	2.88	7.0	0.20	3.34	720	200	29.5	1.32	ND	ND
59 *	40	14.1	3.34	18.1	0.33	2.95	940	350	40.5	1.05	ND	ND
	Mean	**24.9**	**3.65**	**31.4**	**0.34**	**4.23**	**1070**	**315**	**95.8**	**3.18**	**ND**	**0.62**
						Middle shelf Zone 2, Non-ZID (51-90 m)						
1	56	43.3	3.65	24.9	0.34	3.93	1200	340	79.8	2.29	ND	5.13
3	60	52.5	3.52	17.5	0.30	3.00	950	230	54.7	8.69	ND	6.28
5	59	30.8	3.78	32.7	0.37	4.02	360	340	88.0	1.96	ND	3.4
9	59	27.6	3.37	14.5	0.28	4.69	880	260	65.6	1.87	ND	0.35
10 *	62	37.7	4.22	60.4	0.37	6.65	1100	340	61.9	2.02	ND	0.46
12	58	38.6	3.31	16.5	0.33	4.17	810	310	52.3	1.28	ND	ND
13 *	59	34.5	3.79	34.7	0.37	2.17	1200	340	58.3	1.79	ND	0.66
37 *	56	34.2	2.96	19.6	0.35	11.30	690	280	51.8	1.75	ND	ND
68	52	45.0	3.74	30.4	0.36	2.86	980	280	59.5	1.56	0.78	1.88
69	52	37.7	3.65	24.8	0.38	5.10	960	280	49.5	1.54	ND	0.67
70	52	60.1	3.55	20.9	0.35	5.66	710	470	60.1	3.30	ND	0.37
71	52	36.2	3.42	16.0	0.31	4.32	760	360	31.9	1.27	ND	0.52
72	55	34.7	3.68	27.5	0.36	6.33	790	330	89.3	2.28	ND	2.58
73	55	83.8	3.44	15.9	0.41	7.04	970	230	207.7	1.75	ND	6.81
74	57	54.9	3.45	18.1	0.34	4.18	870	300	65.0	1.25	ND	0.91
75	60	48.2	3.42	15.6	0.32	9.75	930	260	62.3	1.04	ND	ND
77	60	15.7	3.41	17.7	0.31	3.00	1100	290	18.9	1.22	ND	ND
78	63	43.8	3.42	15.3	0.31	3.16	910	280	70.0	1.27	ND	0.41
79	65	39.2	3.58	20.8	0.34	3.40	1100	280	59.4	1.61	ND	1.55
80	65	34.7	3.70	31.3	0.36	5.70	1100	300	46.3	1.25	ND	6.78
81	65	34.6	3.47	17.8	0.28	4.90	1000	270	39.6	1.04	ND	0.18
82	65	30.7	3.37	14.6	0.27	7.59	850	290	42.0	1.12	ND	ND
84	54	74.1	3.46	17.1	0.35	3.93	1000	310	71.4	1.16	ND	1.27
85	57	85.2	3.41	14.0	0.39	6.27	1100	280	210.9	5.36	ND	8.26
86	57	91.5	3.46	15.6	0.39	7.55	1100	270	240.9	1.72	ND	3.74
87	60	64.5	3.46	18.3	0.35	3.90	990	330	60.5	1.40	ND	2.06
C	56	18.00	3.43	21.3	0.35	4.17	1400	84	59.1	1.96	ND	ND
C2 *	56	27.00	4.54	76.1	1.27	8.83	1100	740	367.4	19.83	ND	7.77
CON	59	73.4	3.58	24.7	0.33	8.24	1200	350	43.6	2.91	ND	0.36
	Mean	**45.9**	**3.56**	**24.0**	**0.37**	**5.37**	**969**	**311**	**85.1**	**2.67**	**0.03**	**2.15**
						Middle shelf Zone 2, Within-ZID (51-90 m)						
0	56	143.4	3.36	10.8	0.50	4.34	1200	520	758.3	1.96	ND	10.4
4	56	38.1	3.41	16.4	0.32	3.66	870	370	185.3	0.87	ND	ND
76	58	35.7	3.47	21.0	0.32	3.93	940	250	49.1	1.03	1.1	0.72
ZB	56	49.8	3.45	15.9	0.31	6.74	1100	330	59.0	1.06	ND	1.36
	Mean	**66.8**	**3.42**	**16.0**	**0.36**	**4.67**	**1028**	**368**	**262.9**	**1.23**	**0.28**	**3.12**

Table 2-3 continues.

Table 2-3 continued.

Station	Depth (m)	Total LAB (µg/kg)	Median Phi	Fines (%)	TOC (%)	Sulfides (mg/kg)	Total P (mg/kg)	Total N (mg/kg)	Total PAH (µg/kg)	Total DDT (µg/kg)	Total Pest (µg/kg)	Total PCB (µg/kg)
Middle shelf Zone 3 (91-120 m)												
17 *	91	26.5	3.95	45.7	0.36	7.23	1200	520	42.2	2.19	ND	0.20
18 *	91	13.0	3.77	31.4	0.41	5.88	1000	310	42.7	1.84	ND	0.20
20 *	100	37.5	4.04	51.6	0.47	6.52	1100	430	86.1	3.80	ND	2.05
23 *	100	25.8	3.43	19.5	0.34	7.14	910	350	24.7	1.45	ND	ND
29 *	100	85.8	4.29	64.0	0.54	2.59	1200	560	92.2	2.92	ND	1.87
33 *	100	48.1	3.64	33.6	0.47	13.00	850	300	54.0	2.21	ND	2.08
38 *	100	14.5	2.65	31.4	0.45	12.60	820	230	60.1	2.98	ND	0.27
56 *	100	38.2	4.09	53.3	0.61	7.40	1100	540	88.8	6.48	ND	1.76
60 *	100	71.3	3.92	43.2	0.49	6.11	1000	540	70.5	5.88	ND	3.80
83 *	100	35.3	3.77	28.2	0.43	5.68	920	370	70.6	1.96	ND	0.23
	Mean	**39.6**	**3.76**	**40.2**	**0.46**	**7.42**	**1010**	**415**	**63.2**	**3.17**	**ND**	**1.25**
Outer shelf (121-200 m)												
24 *	200	39.9	4.67	83.1	0.95	9.97	1100	640	103.8	10.42	ND	3.03
25 *	200	51.5	4.77	81.5	1.24	15.60	1100	940	114.5	10.75	ND	5.60
27 *	200	19.1	4.28	60.4	0.70	6.82	1200	650	69.4	5.43	ND	0.21
39 *	200	42.8	3.78	36.8	0.56	6.50	950	490	50.0	3.06	ND	2.66
57 *	200	223.6	5.42	90.2	1.96	10.40	980	1200	269.4	13.94	ND	10.15
61 *	200	210.5	4.80	83.6	1.31	18.70	1100	780	216.3	11.10	ND	9.26
63 *	200	75.6	5.14	81.1	1.13	11.70	1100	810	119.2	10.99	ND	3.39
65 *	200	25.3	4.28	58.8	0.79	13.00	1100	530	128.0	3.88	ND	0.64
C4 *	187	50.3	5.53	87.7	1.73	23.90	1000	780	255.6	4.37	ND	2.14
	Mean	**82.0**	**4.74**	**73.7**	**1.15**	**12.95**	**1070**	**758**	**147.4**	**8.22**	**ND**	**4.12**
Upper slope/Canyon (201-500 m)												
40 *	303	49.9	4.76	82.3	1.48	12.00	1000	1000	98.6	10.43	ND	2.78
41 *	303	96.8	4.89	81.6	1.59	8.81	990	1100	180.1	14.09	ND	5.51
42 *	303	96.6	5.40	92.8	1.94	13.80	920	1300	180.4	15.59	ND	5.71
44 *	241	390.5	5.85	92.6	2.38	36.60	1000	1700	295.0	10.65	ND	10.33
58 *	300	91.4	5.73	96.4	2.40	14.80	1000	770	219.2	23.78	ND	8.22
62 *	300	167.3	5.51	93.5	2.38	25.40	920	1700	274.7	24.56	ND	10.19
64 *	300	18.00	6.33	92.5	0.85	22.80	1000	1000	87.9	2.11	ND	ND
C5 *	296	131.2	6.13	97.1	2.41	33.40	850	1700	252.9	8.38	ND	4.21
	Mean	**130.2**	**5.58**	**91.1**	**1.93**	**20.95**	**960**	**1284**	**198.6**	**13.70**	**ND**	**5.87**
Sediment quality guidelines and regional summer values												
ERM [1]		N/A	N/A	N/A	N/A	N/A	N/A	N/A	44,792	46.10	N/A	180
Bight'08 AWM Middle shelf [2]		N/A	N/A	46.8	1	N/A	N/A	N/A	179	16	N/A	13
Bight'08 AWM Outer shelf [2]		N/A	N/A	60	1.5	N/A	N/A	N/A	231	56	N/A	19
Bight'08 AWM Upper slope [2]		N/A	N/A	81.3	2.6	N/A	N/A	N/A	234	238	N/A	36

Abbreviations: ZID = Zone of Initial Dilution, AWM = Area Weighted Mean, ND = Not Detected, N/A = Not Applicable.

[1] Long *et al*. (1995).

[2] Schiff *et al*. (2011).

Table 2–4. Metal concentrations (mg/kg) in sediment samples collected at each semi-annual and annual (*) station in Summer 2014 compared to Effects Range-Median (ERM) values and regional measurements.

Station	Depth (m)	Sb	As	Ba	Be	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn
Middle shelf Zone 1 (31-50 m)														
7 *	41	ND	3.31	42.7	0.21	0.24	21.80	10.50	4.37	0.02	9.7	0.62	0.17	37.7
8 *	44	ND	3.07	44.2	0.23	0.27	26.10	9.66	4.10	0.02	9.4	0.47	0.13	38.7
21 *	44	ND	3.75	35.1	0.25	0.19	20.30	9.01	5.32	0.01	9.3	0.37	0.14	37.6
22 *	45	ND	3.34	43.0	0.25	0.27	24.50	11.00	4.56	0.02	10.9	0.59	0.15	43.6
30 *	46	0.1	2.62	36.8	0.21	0.20	21.20	8.62	3.86	0.02	8.6	0.54	0.13	34.6
36 *	45	0.1	2.99	41.5	0.22	0.24	18.50	8.09	3.91	0.02	9.1	0.34	0.08	37.1
55 *	40	0.1	1.85	26.7	0.14	0.12	14.30	4.81	2.47	0.01	6.4	1.50	0.04	25
59 *	40	ND	2.35	33.3	0.21	0.16	16.80	6.55	4.20	0.02	7.4	0.34	0.10	29.9
	Mean	**0.1**	**2.91**	**37.9**	**0.22**	**0.21**	**20.44**	**8.53**	**4.1**	**0.02**	**8.8**	**0.60**	**0.12**	**35.52**
Middle shelf Zone 2, Non-ZID (51-90 m)														
1	56	ND	2.68	36.8	0.27	0.32	21.40	37.00	5.97	0.02	9.1	0.35	0.28	42.9
3	60	ND	2.60	33.5	0.27	0.27	20.90	9.77	4.23	0.01	8.4	0.33	0.17	41.3
5	59	0.1	2.47	39.4	0.25	0.29	22.80	11.00	3.78	0.02	9.8	0.47	0.20	42.8
9	59	ND	2.45	31.5	0.26	0.19	19.70	8.50	4.06	0.01	8.7	0.35	0.12	38.6
10 *	62	ND	2.83	46.4	0.29	0.29	23.20	11.60	5.44	0.02	11.0	0.35	0.21	44.8
12	58	ND	2.79	31.2	0.25	0.19	18.30	7.24	4.11	0.01	8.5	0.38	0.10	35.9
13 *	59	ND	2.69	41.2	0.24	0.24	23.00	10.10	4.57	0.02	9.6	0.45	0.16	40
37 *	56	ND	2.49	36.8	0.26	0.21	17.50	8.01	4.06	0.01	9.8	0.33	0.08	40.1
68	52	ND	2.38	35.7	0.23	0.32	21.90	11.00	3.83	0.02	9.9	0.52	0.20	41.7
69	52	0.1	3.02	38.6	0.25	0.33	21.50	10.90	5.14	0.03	9.7	0.43	0.19	40.9
70	52	ND	2.92	33.9	0.22	0.31	21.80	9.94	4.17	0.02	9.5	0.44	0.15	40.5
71	52	ND	2.38	29.1	0.23	0.33	20.00	8.79	3.67	0.02	8.5	0.41	0.14	39
72	55	ND	2.57	37.6	0.24	0.30	23.40	11.80	4.9	0.02	10.1	0.38	0.22	42.2
73	55	ND	2.72	32.0	0.24	0.46	23.00	15.40	4.13	0.03	8.9	0.44	0.22	44.7
74	57	ND	2.88	32.6	0.27	0.28	20.60	8.52	7.83	0.01	8.7	0.37	0.11	39.4
75	60	ND	3.14	34.7	0.23	0.30	20.70	9.40	3.06	0.02	9.7	0.53	0.12	42.4
77	60	ND	2.57	28.4	0.25	0.20	20.00	8.20	2.93	0.01	8.6	0.39	0.11	37.8
78	63	ND	2.41	29.6	0.23	0.19	20.70	8.19	3.43	0.02	8.6	0.44	0.11	38.2
79	65	ND	2.42	34.2	0.22	0.24	36.10	10.70	3.42	0.02	9.7	0.43	0.17	42.6
80	65	ND	2.96	38.0	0.33	0.17	22.30	10.80	4.48	0.02	10.7	0.36	0.11	45.2
81	65	ND	2.21	29.6	0.24	0.18	19.80	8.18	2.79	0.01	8.6	0.32	0.10	37.7
82	65	ND	2.46	28.8	0.26	0.17	20.70	7.99	2.89	0.01	8.7	0.47	0.10	38.4
84	54	ND	3.32	32.9	0.26	0.44	20.10	12.30	12.3	0.02	9.0	0.34	0.19	47
85	57	ND	2.23	29.9	0.23	0.50	22.20	15.90	3.34	0.06	8.9	0.38	0.19	44.6
86	57	0.1	2.49	32.3	0.28	0.44	21.30	11.60	5.69	0.04	8.9	0.39	0.22	43.6
87	60	0.2	6.57	202.0	95.20	1.04	95.00	45.50	17	0.06	26.8	1.67	0.86	93.9
C	56	5.1	9.27	22.9	8.36	8.78	10.40	9.36	4.85	0.01	7.9	8.88	**4.10**	20
C2 *	56	0.2	5.33	105.0	0.51	0.44	32.10	19.40	10.5	0.03	18.5	0.76	0.17	87.7
CON	59	0.1	2.99	43.9	0.24	0.18	22.40	9.28	4.51	0.02	10.3	0.41	0.11	39.6
	Mean	**0.9**	**3.11**	**42.4**	**3.81**	**0.61**	**24.23**	**12.63**	**5.21**	**0.02**	**10.2**	**0.75**	**0.32**	**43.91**
Middle shelf Zone 2, Within-ZID (51-90 m)														
0	56	0.1	3.46	31.9	0.24	0.57	23.80	12.20	4.92	0.07	9.9	0.40	0.18	46.2
4	56	ND	2.74	29.6	0.21	0.20	20.10	7.88	2.81	0.01	8.0	0.34	0.10	36.3
76	58	ND	2.77	33.4	0.29	0.23	19.40	10.20	3.78	0.02	9.5	0.35	0.13	41.9
ZB	56	ND	2.54	33.5	0.24	0.39	20.70	9.47	2.68	0.01	10.0	0.50	0.14	43.2
	Mean	**0.1**	**2.88**	**32.1**	**0.24**	**0.35**	**21.00**	**9.94**	**3.55**	**0.03**	**9.3**	**0.40**	**0.14**	**41.9**

Table 2-4 continues.

Table 2-4 continued.

Station	Depth (m)	Sb	As	Ba	Be	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn
Middle shelf Zone 3 (91-120 m)														
17 *	91	ND	2.30	36.6	0.29	0.20	22.00	11.30	3.45	0.01	12.5	0.51	0.10	46.5
18 *	91	ND	2.65	40.3	0.27	0.18	22.90	9.39	4.34	0.01	10.8	0.50	0.10	45
20 *	100	0.1	3.22	52.5	0.30	0.30	25.90	12.80	5.74	0.02	12.5	0.46	0.19	49.5
23 *	100	ND	2.89	32.2	0.27	0.20	18.10	6.75	4.13	0.01	8.8	0.37	0.08	37.2
29 *	100	0.1	2.39	64.2	0.29	0.34	27.50	15.20	4.94	0.02	13.0	0.64	0.25	50
33 *	100	ND	3.00	47.6	0.27	0.36	23.40	10.30	3.77	0.01	12.5	0.65	0.12	47.7
38 *	100	ND	2.56	34.6	0.20	0.28	18.30	7.82	3.20	0.01	9.0	0.51	0.08	32.2
56 *	100	0.1	2.63	66.4	0.31	0.32	28.70	14.90	4.94	0.02	13.5	0.60	0.21	52.9
60 *	100	0.1	3.28	62.0	0.32	0.33	26.00	13.30	6.21	0.02	12.1	0.50	0.22	48
83 *	100	ND	2.54	46.4	0.29	0.22	24.20	10.30	4.62	0.01	11.1	0.51	0.15	45.4
	Mean	**0.1**	**2.75**	**48.3**	**0.28**	**0.27**	**23.70**	**11.21**	**4.53**	**0.01**	**11.6**	**0.52**	**0.15**	**45.44**
Outer shelf (121-200 m)														
24 *	200	0.1	3.10	82.6	0.36	0.48	33.90	17.90	5.34	0.02	17.0	0.83	0.21	62.2
25 *	200	0.2	3.68	101.0	0.42	0.56	35.70	19.80	7.98	0.03	17.8	0.80	0.27	64.2
27 *	200	0.1	2.91	65.5	0.35	0.38	29.20	13.50	6.91	0.02	15.4	0.57	0.13	53.2
39 *	200	0.1	3.49	50.1	0.33	0.31	26.50	11.50	4.9	0.02	13.7	0.52	0.10	50
57 *	200	0.2	6.03	171.0	0.50	0.94	83.10	40.00	11.1	0.04	24.0	1.16	0.82	89
61 *	200	0.2	4.94	137.0	0.43	0.85	69.80	31.60	9	0.04	20.6	1.09	0.67	79.5
63 *	200	0.2	3.60	195.0	0.36	0.54	59.20	21.80	6.37	0.03	17.4	0.83	0.34	64.7
65 *	200	0.1	4.69	70.6	0.42	0.53	29.10	15.60	6.56	0.02	16.2	0.68	0.18	58.1
C4 *	187	0.2	6.08	103.0	0.52	0.71	38.90	22.50	9.48	0.03	22.1	0.90	0.23	83.7
	Mean	**0.2**	**4.28**	**108.4**	**0.41**	**0.59**	**45.04**	**21.58**	**7.52**	**0.03**	**18.2**	**0.82**	**0.33**	**67.18**
Upper slope/Canyon (201-500 m)														
40 *	303	0.1	3.62	95.2	0.43	0.52	34.90	18.40	7.61	0.02	17.9	0.86	0.19	64.3
41 *	303	0.2	3.49	97.0	0.42	0.49	55.10	20.50	6.15	0.02	19.7	1.28	0.22	67.4
42 *	303	0.2	4.78	46.4	0.45	0.63	69.50	26.20	9.88	0.03	21.6	1.27	0.33	78
44 *	241	0.1	1.89	32.0	0.25	0.23	20.60	9.65	3.59	0.01	9.1	0.47	0.14	41.2
58 *	300	0.2	5.41	188.0	0.56	0.72	86.80	33.30	9.83	0.03	26.5	1.60	0.43	91.5
62 *	300	0.2	6.91	164.0	0.53	0.86	71.30	35.90	10.8	0.03	26.4	1.70	0.55	92.6
64 *	300	0.1	7.93	88.5	0.81	0.45	43.00	32.60	9.68	0.03	31.7	0.86	0.16	88.6
C5 *	296	0.2	7.57	137.0	0.64	0.99	77.70	33.90	16.8	0.04	27.5	1.28	0.45	100
	Mean	**0.2**	**5.20**	**106.0**	**0.51**	**0.61**	**57.36**	**26.31**	**9.29**	**0.03**	**22.6**	**1.16**	**0.31**	**77.95**
Sediment quality guidelines and regional summer values														
ERM [1]		N/A	70	N/A	N/A	9.60	370	270	218	0.70	51.6	N/A	3.70	410
Bight'08 AWM Middle shelf [2]		N/A	6.1	N/A	0.30	0.32	31	10.7	7.8	0.05	12	0.72	0.24	46
Bight'08 AWM Outer shelf [2]		N/A	6.1	N/A	0.19	0.47	36	12.3	9.1	0.05	17	0.54	0.25	52
Bight'08 AWM Upper slope [2]		N/A	8.8	N/A	0.29	1.40	68	22.8	15	0.09	29	1.60	1.60	79

Bolded station value indicates ERM exceedance.

Abbreviations: ZID = Zone of Initial Dilution, AWM = Area Weighted Mean, ND = Not Detected, N/A = Not Applicable.

¹ Long *et al*. (1995).

² Schiff *et al*. (2011).

Table 2–5. Physical properties and organic contaminant concentrations of sediment samples collected at each semi-annual station in Winter 2015 compared to Effects Range-Median (ERM) values and regional measurements.

Station	Depth (m)	Total LAB (μg/kg)	Median Phi	Fines (%)	TOC (%)	Sulfides (mg/kg)	Total P (mg/kg)	Total N (mg/kg)	Total PAH (μg/kg)	Total DDT (μg/kg)	Total Pest (μg/kg)	Total PCB (μg/kg)
Middle shelf Zone 2, Non-ZID (51-90 m)												
1	56	NA	3.61	23.7	0.35	5.15	1000	330	65.2	2.31	ND	4.03
3	60	NA	3.43	16.3	0.36	2.12	950	280	48.4	1.18	ND	0.39
5	59	NA	3.72	29.7	0.36	1.41	970	290	44.8	2.08	ND	1.71
9	59	NA	3.34	15.4	0.34	4.74	820	260	42.3	1.36	ND	0.19
12	58	NA	3.26	14.0	0.30	2.71	760	220	32.4	1.80	ND	0.21
68	52	NA	3.76	32.7	0.40	8.04	1000	400	118.4	1.79	ND	3.22
69	52	NA	3.54	22.3	0.36	3.60	950	300	41.1	2.04	ND	14.27
70	52	NA	3.61	24.1	0.41	13.70	940	280	34.1	1.84	ND	3.78
71	52	NA	3.39	14.3	0.32	7.73	970	250	30.1	1.06	ND	14.64
72	55	NA	3.57	22.5	0.35	1.19	1000	330	84.4	1.50	ND	0.82
73	55	NA	3.40	13.1	0.44	3.27	1300	340	527.9	3.48	ND	19.89
74	57	NA	3.41	16.4	0.34	3.26	870	310	98.0	1.34	ND	0.90
75	60	NA	3.42	15.2	0.37	13.50	860	330	20.8	1.24	ND	0.64
77	60	NA	3.38	14.7	0.28	6.34	930	310	16.8	1.20	ND	0.38
78	63	NA	3.38	13.7	0.28	10.70	860	240	96.8	1.07	ND	ND
79	65	NA	3.62	22.1	0.33	2.39	930	350	35.6	2.01	ND	1.04
80	65	NA	3.71	31.1	0.31	1.33	980	250	19.1	1.93	ND	0.88
81	65	NA	3.48	18.4	0.29	2.81	930	300	23.9	1.81	ND	0.61
82	65	NA	3.42	16.8	0.30	3.20	870	260	14.5	1.13	ND	ND
84	54	NA	3.47	16.8	0.36	8.80	1000	350	61.1	1.57	36.26	3.20
85	57	NA	3.36	11.0	0.43	9.12	1000	290	152.4	2.12	ND	7.64
86	57	NA	3.44	14.3	0.38	8.86	920	370	78.4	1.84	ND	2.86
87	60	NA	3.43	16.6	0.30	3.78	930	310	78.6	1.09	ND	1.13
C	56	NA	3.45	20.9	0.34	ND	980	420	45.6	1.32	ND	ND
CON	59	NA	3.58	23.2	0.32	7.69	940	300	51.7	2.11	ND	ND
	Mean	**N/A**	**3.49**	**19.2**	**0.34**	**5.64**	**946**	**307**	**74.5**	**1.69**	**1.45**	**3.3**
Middle shelf Zone 2, Within-ZID (51-90 m)												
0	56	NA	3.27	9.1	0.45	6.01	1700	280	69.5	2.83	ND	29.36
4	56	NA	3.39	15.4	0.37	3.47	900	260	59.1	1.21	ND	ND
76	58	NA	3.43	18.2	0.40	12.40	940	250	60.1	1.39	ND	1.54
ZB	56	NA	3.45	18.3	0.38	8.01	930	390	49.5	1.08	ND	1.58
	Mean	**N/A**	**3.38**	**15.2**	**0.40**	**7.47**	**1118**	**295**	**59.6**	**1.63**	**ND**	**8.12**
Sediment quality guidelines and regional summer values												
ERM [1]		N/A	N/A	N/A	N/A	N/A	N/A	N/A	44,792	46.10	N/A	180
Bight'08 AWM Middle shelf [2]		N/A	N/A	46.8	1	N/A	N/A	N/A	179	16	N/A	13

Abbreviations: ZID = Zone of Initial Dilution, AWM = Area Weighted Mean, ND = Not Detected, NA = Not Analyzed, N/A = Not Applicable.

[1] Long *et al*. (1995).

[2] Schiff *et al*. (2011).

Table 2–6. Metal concentrations (mg/kg) in sediment samples collected at each semi-annual station in Winter 2015 compared to Effects Range-Median (ERM) values and regional measurements.

Station	Depth (m)	Sb	As	Ba	Be	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn
Middle shelf Zone 2, Non-ZID (51-90 m)														
1	56	0.1	2.25	37.3	0.27	0.37	23.20	11.90	5.76	0.02	10.7	0.36	0.22	43.4
3	60	0.1	2.33	36.7	0.28	0.26	43.80	10.10	5.45	0.06	15.4	0.37	0.16	43
5	59	ND	2.81	39.6	0.26	0.28	24.00	11.00	5.58	0.04	10.7	0.38	0.18	44.7
9	59	ND	2.70	26.7	0.23	0.21	35.90	7.75	4.65	0.01	18.2	0.29	0.09	36
12	58	ND	2.27	30.0	0.23	0.20	30.50	7.52	4.53	0.01	15.5	0.31	0.10	36.5
68	52	ND	2.97	42.8	0.26	0.30	29.60	11.80	5.98	0.05	14.3	0.39	0.20	44.7
69	52	0.1	3.36	33.9	0.25	0.29	37.20	9.77	5.46	0.02	20.1	0.32	0.15	42.3
70	52	0.1	3.11	39.8	0.27	0.31	27.70	9.24	5.39	0.02	13.4	0.40	0.14	41.1
71	52	0.1	3.00	34.2	0.28	0.33	34.90	8.34	4.21	0.03	18.3	0.38	0.11	38.7
72	55	0.1	2.86	37.0	0.27	0.29	41.20	11.00	5.28	0.02	23.2	0.42	0.19	40.2
73	55	0.1	3.11	34.1	0.25	0.57	33.00	15.70	5.74	0.02	15.3	0.31	0.22	47.4
74	57	ND	2.70	33.5	0.23	0.34	22.80	9.71	4.75	0.02	9.6	0.35	0.15	42.9
75	60	0.1	2.79	36.0	0.29	0.38	25.40	8.70	4.31	0.01	13.2	0.38	0.11	42.4
77	60	0.1	2.43	33.9	0.31	0.28	20.80	9.17	4.80	0.01	9.5	0.36	0.13	41.8
78	63	ND	2.14	31.3	0.26	0.23	35.30	8.53	4.25	0.01	17.9	0.35	0.12	38.3
79	65	ND	2.45	36.8	0.28	0.22	42.70	10.10	4.78	0.06	23.7	0.35	0.13	44.2
80	65	ND	2.52	39.2	0.31	0.21	22.00	10.30	5.52	0.01	11.2	0.33	0.11	45.4
81	65	0.1	2.26	38.1	0.28	0.21	21.30	8.97	4.54	0.01	9.8	0.35	0.13	42.3
82	65	ND	2.44	31.8	0.30	0.17	29.70	7.63	3.92	0.01	16.9	0.40	0.08	39.3
84	54	0.1	2.66	35.0	0.27	0.48	39.10	13.10	5.41	0.03	20.1	0.41	0.22	45.4
85	57	ND	2.44	33.1	0.26	0.43	24.50	11.70	5.04	0.02	10.4	0.39	0.21	48.3
86	57	ND	2.83	33.9	0.25	0.41	48.00	12.20	5.26	0.02	24.7	0.36	0.20	44.6
87	60	ND	2.65	29.2	0.27	0.24	30.30	9.47	4.78	0.02	14.9	0.34	0.12	44.3
C	56	0.1	2.58	43.5	0.25	0.21	50.40	9.38	5.46	0.02	20.5	0.36	0.11	41.7
CON	59	0.1	2.67	43.5	0.28	0.20	37.00	8.73	5.43	0.01	21.0	0.43	0.10	39.6
	Mean	**0.1**	**2.65**	**35.6**	**0.27**	**0.30**	**32.41**	**10.07**	**5.05**	**0.02**	**15.9**	**0.36**	**0.15**	**42.34**
Middle shelf Zone 2, Within-ZID (51-90 m)														
0	56	0.1	3.37	35.9	0.27	0.70	27.20	17.00	10.6	0.03	11.8	0.38	0.22	48.9
4	56	0.2	2.46	32.5	0.26	0.24	33.60	8.64	4.59	0.06	16.2	0.37	0.11	39.7
76	58	ND	2.21	34.9	0.29	0.29	98.40	11.10	4.60	0.02	35.0	0.36	0.16	44.8
ZB	56	ND	2.59	34.9	0.26	0.34	34.70	9.95	4.52	0.05	17.4	0.34	0.14	43.5
	Mean	**0.1**	**2.66**	**34.6**	**0.27**	**0.39**	**48.48**	**11.67**	**6.08**	**0.04**	**20.1**	**0.36**	**0.16**	**44.22**
Sediment quality guidelines and regional summer values														
ERM [1]		N/A	70	N/A	N/A	9.60	370	270	218	0.70	51.6	N/A	3.7	410
Bight'08 AWM Middle shelf [2]		N/A	6.1	N/A	0.30	0.32	31	10.7	7.8	0.05	12	0.72	0.24	46

Abbreviations: ZID = Zone of Initial Dilution, AWM = Area Weighted Mean, ND = Not Detected, N/A = Not Applicable.

[1] Long *et al*. (1995).

[2] Schiff *et al*. (2011).

Table 2–7. Whole-sediment *Eohaustorius estuarius* (amphipod) toxicity test results for 2014-15.

Station	% Survival	% of home	p-value	Assessment
home *	100	N/A	N/A	N/A
0	94	94	0.28	Nontoxic
1	96	96	0.11	Nontoxic
4	96	96	0.28	Nontoxic
72	99	99	0.75	Nontoxic
73	98	98	0.52	Nontoxic
76	97	97	0.28	Nontoxic
77	100	100	0.91	Nontoxic
CON	95	95	0.75	Nontoxic
ZB	98	98	0.52	Nontoxic
ZB Dup	97	97	0.28	Nontoxic

* home sediment represents the control.
N/A = Not Applicable.

the 2014-15 period (Tables B-7 and B-8). The mean species richness, species diversity (H′), and Simpson's Diversity Index (SDI) for EMIs at non-outfall stations were lower than from other stations in both surveys (Table 2-10). Large numbers (>1,000) of *Lytechinus pictus* (sea urchin), *Ophiura luetkenii* (brittlestar), and *Sicyonia penicillata* (shrimp) at non-outfall Stations T23, T17, and T11 contributed to the low species richness, H′, and SDI values (Tables B-7 and B-8). These 3 species accounted for 89% of the total abundance and 55% of the total biomass. Nevertheless, community measure values at each non-outfall station, including those at all other stations, were within District historical ranges (Table 2-10). Multivariate analyses (non-metric multidimensional scaling (nMDS) and cluster analyses) of the EMI species and abundance data revealed that the EMI community composition was similar between outfall and non-outfall stations in both surveys (Figure 2-6). This suggests that the outfall discharge had an overall negligible effect on the EMI community structure within the monitoring area. Based on these overall results, we conclude that the EMI communities within the monitoring area were not degraded by the outfall discharge, and consequently, compliance was met.

Fish Communities

A total of 34 fish taxa, comprising 7,162 individuals and a total weight of 232.1 kg, were collected from the monitoring area during the 2014-15 trawling effort (Tables B-9 and B-10). The mean species richness, abundance, biomass, H′, and SDI values of demersal fishes were comparable between outfall and non-outfall stations in both surveys, with values falling within historical ranges (Table 2-11). More importantly, the fish communities at outfall and non-outfall stations were classified as reference condition based on their low (<45) mean fish response index (FRI) values in both surveys. Multivariate analyses (nMDS and cluster analyses) of the demersal fish species and abundance data further demonstrated that the

Table 2–8. Summary of infaunal community measures for each semi-annual & annual (*) station sampled during the Summer 2014 benthic survey, including regional and District historical values.

Station	Depth (m)	Total No. of Species	Total Abundance	H'	SDI	ITI	BRI
			Middle shelf Zone 1 (31-50 m)				
7 *	41	99	391	4.11	34	89	17
8 *	44	121	456	4.14	41	79	15
21 *	44	129	473	4.26	45	85	12
22 *	45	78	193	3.92	32	86	11
30 *	46	95	288	3.96	35	81	14
36 *	45	97	359	3.37	26	79	19
55 *	40	140	820	4.25	40	81	15
59 *	40	117	481	4.17	40	88	12
	Mean	**110**	**433**	**4.02**	**37**	**84**	**14**
			Middle shelf Zone 2, Non-ZID (51-90 m)				
1	56	93	545	3.25	17	71	18
3	60	103	533	3.54	25	74	22
5	59	82	459	3.37	21	75	15
9	59	75	376	3.43	23	75	19
10 *	62	72	399	2.93	14	72	17
12	58	116	497	4.00	37	78	16
13 *	59	83	277	3.62	30	78	10
37 *	56	100	312	3.96	39	86	15
68	52	105	592	3.61	26	75	18
69	52	121	556	3.61	29	72	19
70	52	101	542	3.24	18	75	18
71	52	118	585	3.68	30	80	18
72	55	78	429	3.00	17	72	17
73	55	104	573	3.50	23	71	23
74	57	103	475	3.53	26	77	19
75	60	92	447	3.39	22	74	20
77	60	77	325	3.39	23	75	14
78	63	89	319	3.60	30	77	20
79	65	94	518	3.33	21	73	16
80	65	68	359	3.13	14	76	16
81	65	93	402	3.30	19	73	16
82	65	84	370	3.49	23	75	21
84	54	103	632	3.22	19	70	17
85	57	98	378	3.73	28	73	21
86	57	96	391	3.67	30	71	18
87	60	99	521	3.55	26	73	20
C	56	100	392	3.81	33	80	14
C2 *	56	40	142	3.28	16	63	40
CON	59	107	434	4.01	34	77	14
	Mean	**93**	**441**	**3.49**	**25**	**75**	**18**
			Middle shelf Zone 2, Within-ZID (51-90 m)				
0	56	89	462	3.25	17	67	23
4	56	92	453	3.51	23	77	21
76	58	96	452	3.60	25	74	22
ZB	56	88	521	3.19	18	70	23
	Mean	**91**	**472**	**3.39**	**21**	**72**	**22**

Table 2-8 continues.

Table 2-8 continued.

Station	Depth (m)	Total No. of Species	Total Abundance	H'	SDI	ITI	BRI
			Middle shelf Zone 3 (91-120 m)				
17 *	91	93	413	3.70	26	77	16
18 *	91	96	399	3.73	26	82	13
20 *	100	90	357	3.84	29	86	17
23 *	100	98	488	3.72	25	81	19
29 *	100	77	257	3.73	30	92	15
33 *	100	87	271	4.05	35	78	21
38 *	100	96	382	4.01	34	82	22
56 *	100	99	351	4.06	37	84	25
60 *	100	72	232	3.80	30	93	18
83 *	100	94	373	3.84	28	86	15
	Mean	**90**	**352**	**3.85**	**30**	**84**	**18**
			Outer shelf (121-200 m)				
24 *	200	43	114	3.43	20	64	23
25 *	200	50	96	3.59	28	79	22
27 *	200	64	227	3.50	21	74	19
39 *	200	56	292	3.16	13	72	25
57 *	200	31	50	3.26	20	57	31
61 *	200	40	86	3.38	20	64	21
63 *	200	44	102	3.40	21	71	27
65 *	200	43	182	2.59	13	69	26
C4 *	187	23	62	2.50	8	56	39
	Mean	**44**	**135**	**3.20**	**18**	**67**	**26**
			Upper slope/Canyon (201-500 m)				
40 *	303	34	91	3.17	13	N/A	N/A
41 *	303	31	79	2.97	12	N/A	N/A
42 *	303	30	91	2.96	12	N/A	N/A
44 *	241	20	46	2.67	9	N/A	N/A
58 *	300	26	49	2.88	15	N/A	N/A
62 *	300	23	34	2.95	15	N/A	N/A
64 *	300	26	48	2.90	15	N/A	N/A
C5 *	296	29	78	2.72	11	N/A	N/A
	Mean	**27**	**65**	**2.90**	**13**	**N/A**	**N/A**
			Regional values [mean (range)] †				
Bight'08 Middle shelf		99 (30-153)	393 (79-1159)	3.83 (2.82-4.32)	31 (13-48)	NC	15 (2-26)
Bight'08 Outer shelf		62 (27-127)	190 (43-532)	3.52 (2.93-4.19)	24 (12-41)	NC	15 (-2-33)
Bight'08 Upper slope		26 (9-69)	70 (13-258)	2.72 (1.71-3.83)	11 (4-28)	N/A	N/A
			District historical summer values (2004-2014 Fiscal Years) [mean (range)]				
Middle shelf Zone 1		113 (6-156)	451 (11-818)	4.00 (1.42-4.46)	35 (4-51)	83 (67-95)	17 (8-23)
Middle shelf Zone 2, Within-ZID		90 (33-138)	538 (211-1491)	3.39 (0.36-4.00)	22 (1-35)	45 (1-83)	30 (13-52)
Middle shelf Zone 2, Non-ZID		101 (29-143)	444 (145-829)	3.80 (2.29-4.42)	30 (5-52)	75 (1-96)	20 (10-57)
Middle shelf Zone 3		104 (67-146)	543 (177-882)	3.78 (3.04-4.23)	27 (14-42)	82 (65-91)	18 (13-26)
Outer shelf		48 (23-80)	145 (41-367)	3.33 (2.58-3.95)	20 (9-32)	74 (42-100)	22 (14-36)
Upper slope/Canyon		28 (14-49)	67 (19-165)	2.91 (2.31-3.43)	13 (7-22)	69 (33-100)	24 (13-42)

† Source: Ranasinghe *et al*. (2012).

Abbreviations: ZID = Zone of Initial Dilution, N/A = Not Applicable, NC = Not Calculated.

Table 2–9. Summary of infaunal community measures for each semi-annual station sampled during the Winter 2015 benthic survey, including regional and District historical values.

Station	Depth (m)	Total No. of Species	Total Abundance	H'	SDI	ITI	BRI
Middle shelf Zone 2, Non-ZID (51-90 m)							
1	56	59	152	3.64	26	83	18
3	60	72	278	3.51	23	78	19
5	59	61	247	3.52	22	85	20
9	59	72	231	3.52	24	75	16
12	58	76	281	3.56	27	77	13
68	52	94	325	4.00	35	93	13
69	52	74	247	3.79	26	88	18
70	52	84	343	3.71	26	88	17
71	52	69	239	3.63	23	90	13
72	55	55	206	3.17	17	76	17
73	55	77	292	3.61	25	74	22
74	57	60	263	3.28	19	76	16
75	60	68	280	3.50	19	83	17
77	60	65	232	3.54	23	78	17
78	63	71	199	3.65	25	80	18
79	65	74	343	3.36	21	78	13
80	65	78	335	3.63	25	81	14
81	65	74	263	3.40	23	75	16
82	65	70	252	3.68	25	79	14
84	54	75	294	3.76	28	79	19
85	57	71	280	3.46	22	78	20
86	57	62	229	3.37	18	86	20
87	60	84	270	3.69	31	78	18
C	56	95	313	4.01	35	85	19
CON	59	67	202	3.61	24	82	13
	Mean	**72**	**264**	**3.58**	**24**	**81**	**17**
Middle shelf Zone 2, Within-ZID (51-90 m)							
0	56	81	374	3.41	19	73	23
4	56	72	251	3.49	23	79	19
76	58	84	314	3.49	25	76	20
ZB	56	71	274	3.39	18	79	20
	Mean	**77**	**303**	**3.45**	**21**	**77**	**21**
Regional values [mean (range)] †							
Bight'08 Middle shelf		99 (30-153)	393 (79-1159)	3.83 (2.82-4.32)	31 (13-48)	NC	15 (2-26)
District historical winter values (2004-2014 Fiscal Years) [mean (range)]							
Middle shelf Zone 2, Non-ZID		94 (45-142)	370 (157-634)	3.78 (2.87-4.32)	29 (9-48)	76 (47-95)	19 (10-46)
Middle shelf Zone 2, Within-ZID		85 (35-128)	424 (142-1230)	3.39 (0.89-4.04)	22 (1-37)	46 (3-84)	29 (16-45)

† Source: Ranasinghe *et al*. (2012).

Abbreviations: ZID = Zone of Initial Dilution, NC = Not Calculated.

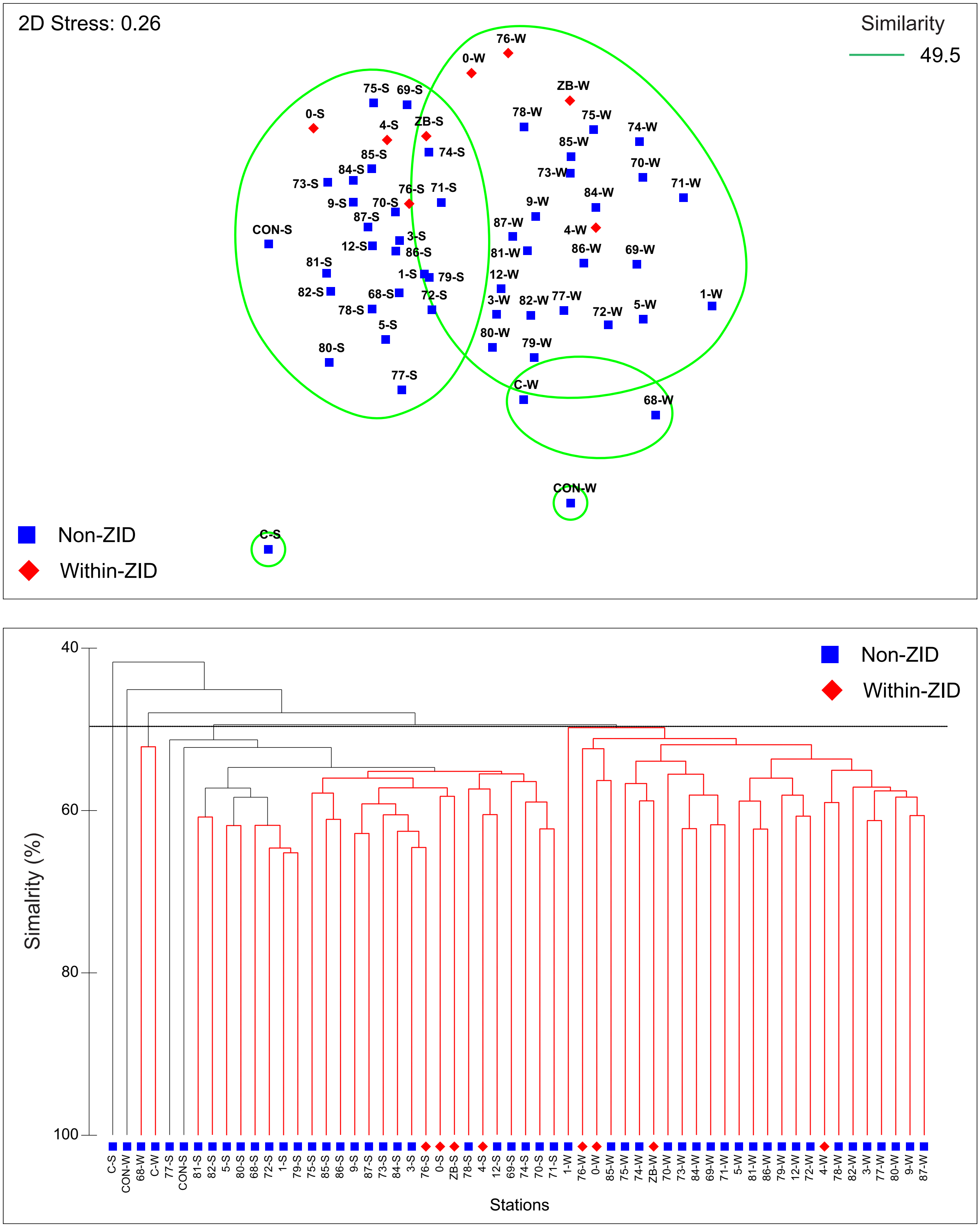


Figure 2–5. Non-metric multidimensional scaling (MDS) plot (top panel) and dendrogram (bottom panel) of the infauna collected at within- and non-ZID stations for the Summer 2014 (S) and Winter 2015 (W) benthic surveys.
Stations connected by red lines in the dendrogram are not significantly differentiated based on the SIMPROF test. The 5 main clusters formed at a 49.5% similarity level on the dendrogram are superimposed on the MDS plot.

Table 2–10. Summary of epibenthic macroinvertebrate community measures for each semi-annual and annual (*) station sampled during the Summer 2014 and Winter 2015 trawl surveys, as well as District historical values.

Season	Station	Nominal Depth (m)	Total No. of Species	Total Abundance	Biomass (kg)	H'	SDI
Summer				**Middle shelf Zone 1 (31-50 m)**			
	T2 *	35	10	74	0.13	1.8	4
	T24 *	36	18	182	0.89	1.8	3
	T6 *	36	11	105	0.21	1.8	4
	T18 *	36	12	129	0.33	1.1	2
		Mean	**13**	**123**	**0.39**	**1.6**	**3**
				Middle shelf Zone 2, Non-outfall (51-90 m)			
	T23	58	12	392	0.80	0.9	2
	T12	57	8	150	0.45	0.8	1
	T17	60	9	2431	4.70	0.1	1
	T11	60	14	2498	3.54	0.3	1
		Mean	**11**	**1368**	**2.37**	**0.5**	**1**
				Middle shelf Zone 2, Outfall (51-90 m)			
	T22	60	15	182	0.67	1.9	4
	T1	55	13	114	0.80	1.4	2
		Mean	**14**	**148**	**0.73**	**1.7**	**3**
				Outer shelf (121-200 m)			
	T10 *	137	15	194	11.91	1.2	2
	T25 *	137	11	81	0.57	1.4	3
	T14 *	137	12	124	1.91	1.4	2
	T19 *	137	11	188	2.01	1.2	2
		Mean	**12**	**147**	**4.10**	**1.3**	**2**
Winter				**Middle shelf Zone 2, Non-outfall (51-90 m)**			
	T23	58	12	1378	11.16	0.3	1
	T12	57	9	27	0.61	1.8	4
	T17	60	6	2221	1.90	0.2	1
	T11	60	9	2011	1.71	0.2	1
		Mean	**9**	**1409**	**3.84**	**0.6**	**2**
				Middle shelf Zone 2, Outfall (51-90 m)			
	T22	60	13	405	2.45	1.1	2
	T1	55	10	59	0.19	1.6	3
		Mean	**12**	**232**	**1.32**	**1.4**	**3**
				District historical values (2004-2014 Fiscal Years) [mean (range)] †			
Middle shelf Zone 1			15 (4-26)	413 (33-2592)	1.12 (0.06-4.16)	1.5 (0.1-2.2)	3 (1-6)
Middle shelf Zone 2, Non-outfall			16 (5-45)	388 (18-2567)	3.24 (0.12-26.33)	1.5 (0.4-2.8)	3 (1-10)
Middle shelf Zone 2, Outfall			15 (9-24)	881 (55-6860)	3.66 (0.08-9.89)	1.4 (0.2-2.1)	3 (1-5)
Outer shelf			12 (5-22)	271 (37-999)	6.04 (0.10-26.39)	1.1 (0.1-2.3)	2 (1-6)

† Summary statistics are based on data from all trawl surveys conducted between the 2004-2014 FY.

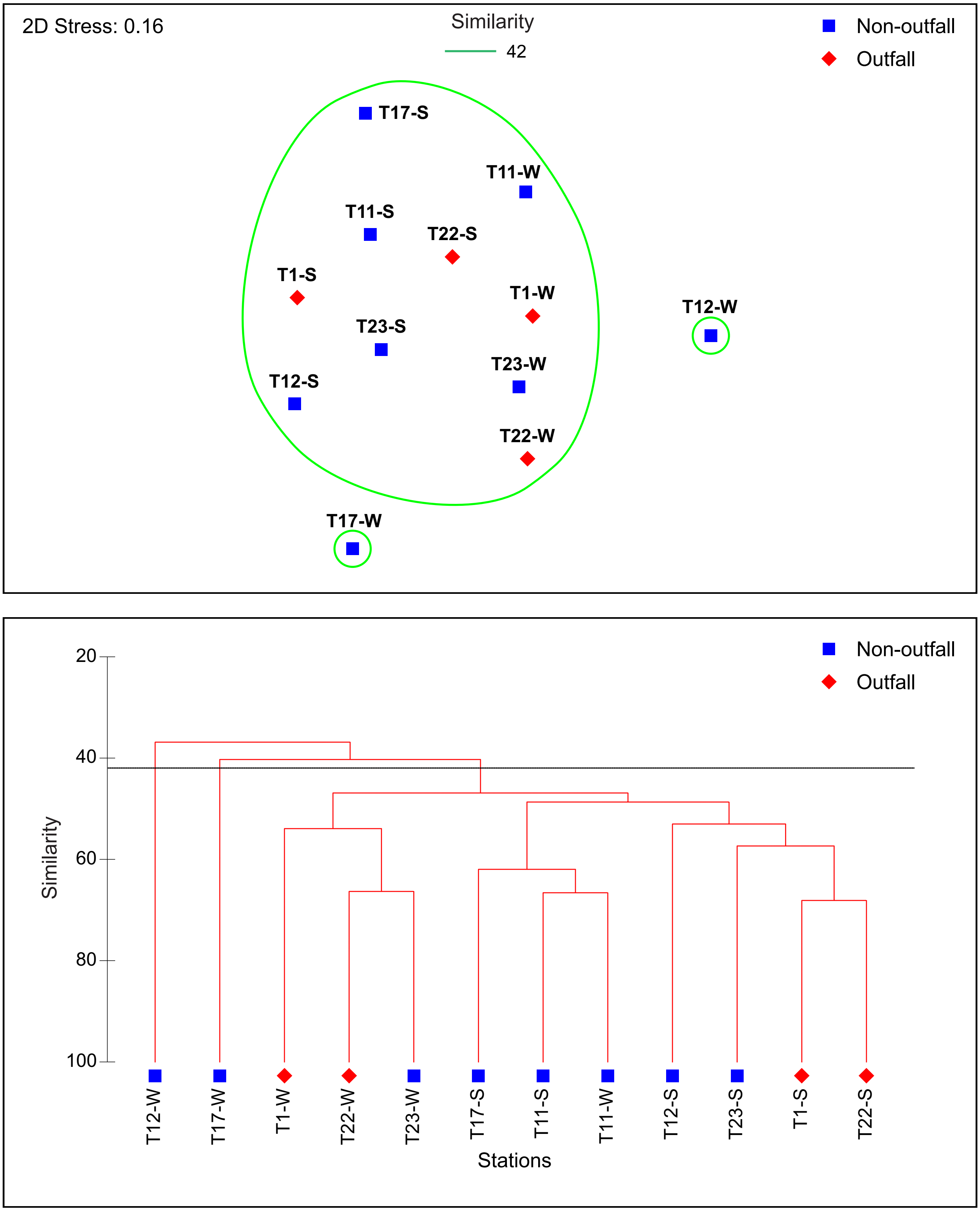


Figure 2–6. Non-metric multidimensional scaling (MDS) plot (top panel) and dendrogram (bottom panel) of the epibenthic macroinvertebrates collected at outfall and non-outfall stations for the Summer 2014 (S) and Winter 2015 (W) trawl surveys.
Stations connected by red lines in the dendrogram are not significantly differentiated based on the SIMPROF test. The 3 main clusters formed at a 42% similarity level on the dendrogram are superimposed on the MDS plot.

Table 2–11. Summary of demersal fish community measures for each semi-annual and annual (*) station sampled during the Summer 2014 and Winter 2015 trawl surveys, as well as the District historical values.

Season	Station	Nominal Depth (m)	Total No. of Species	Total Abundance	Biomass (kg)	H'	SDI	FRI
Summer				**Middle shelf Zone 1 (31-50 m)**				
	T2 *	35	12	127	4.95	1.9	5	22
	T24 *	36	12	177	4.52	2.0	5	26
	T6 *	36	10	221	3.19	1.7	4	20
	T18 *	36	12	281	5.46	1.6	3	24
		Mean	**12**	**202**	**4.53**	**1.8**	**4**	**23**
				Middle shelf Zone 2, Non-outfall (51-90 m)				
	T23	58	14	235	14.32	1.5	3	28
	T12	57	20	574	14.12	1.8	3	28
	T17	60	11	276	10.68	1.9	4	23
	T11	60	13	419	6.83	1.8	4	21
		Mean	**15**	**376**	**11.49**	**1.8**	**4**	**25**
				Middle shelf Zone 2, Outfall (51-90 m)				
	T22	60	15	247	11.18	1.7	3	26
	T1	55	15	445	21.00	1.9	3	32
		Mean	**15**	**346**	**16.09**	**1.8**	**3**	**29**
				Outer shelf (121-200 m)				
	T10 *	137	21	511	17.99	1.7	2	13
	T25 *	137	13	674	18.72	1.0	1	12
	T14 *	137	18	552	16.67	1.6	4	14
	T19 *	137	19	690	22.74	1.5	3	15
		Mean	**18**	**607**	**19.03**	**1.5**	**3**	**14**
Winter				**Middle shelf Zone 2, Non-outfall (51-90 m)**				
	T23	58	13	301	11.41	1.5	3	20
	T12	57	14	282	12.87	1.9	4	20
	T17	60	12	202	8.84	1.6	3	22
	T11	60	14	267	9.29	1.5	2	24
		Mean	**13**	**263**	**10.60**	**1.6**	**3**	**22**
				Middle shelf Zone 2, Outfall (51-90 m)				
	T22	60	13	396	10.62	1.5	2	21
	T1	55	13	285	6.74	1.6	3	18
		Mean	**13**	**341**	**8.68**	**1.6**	**3**	**20**
				District historical values (2004-2014 FY) [mean (range)] †				
Middle shelf Zone 1			14 (8-17)	456 (148-1132)	9.64 (3.82-20.73)	1.7 (1-2.2)	3 (2-6)	22 (18-26)
Middle shelf Zone 2, Non-outfall			18 (11-28)	1394 (155-15772)	31.91 (4.98-163.87)	1.8 (0.2-2.3)	4 (1-6)	24 (14-39)
Middle shelf Zone 2, Outfall			17 (12-24)	1196 (218-4186)	51.25 (8.59-168.92)	1.8 (1-2.1)	4 (1-5)	24 (18-37)
Outer shelf			18 (13-26)	1053 (313-3874)	29.18 (5.12-125.46)	1.5 (0.7-1.9)	3 (1-5)	15 (2-34)

† Summary statistics are based on data from all trawl surveys conducted between the 2004-2014 FY.

fish communities were similar between the outfall and non-outfall stations (Figure 2-7). These results indicate that the outfall discharge had no adverse effect on the demersal fish community structure within the monitoring area. We conclude that the demersal fish communities within the monitoring area were not degraded by the outfall discharge, and thus, compliance was met.

FISH BIOACCUMULATION AND HEALTH

Demersal Fish Tissue Chemistry

In 2014-15, muscle and liver tissue contaminant concentrations in the target species (Hornyhead Turbot and English Sole) were generally similar between outfall and non-outfall stations, and all muscle tissue contaminant values were well below federal and state human consumption guidelines (Table 2-12). The mean total PCB (tPCB) concentration in English Sole liver at the non-outfall station slightly exceeded the state advisory tissue level. All other liver contaminant values were below both state and federal levels (Table 2-12). Elevated tPCB values in fish livers are not unexpected as high interannual and interspecies variability of certain contaminants, including tPCB, have been documented in the District's monitoring area since July 2004 (OCSD 2014). Furthermore, PCB is a bioaccummulative legacy contaminant found in marine sediments throughout the SCB due to historical POTW discharges that occurred until the early 1970s (Schiff 2000). Overall, there is no outfall-related trend of increased contaminant levels in fish muscle or liver tissue. These results demonstrate that the outfall is not an epicenter of disease due to the bioaccumulation of contaminants in fish tissue.

Sport Fish Muscle Chemistry

All fish muscle tissue contaminant levels at both zones were well below federal and state human consumption guidelines (Table 2-13). These results, in tandem with the demersal fish tissue chemistry results, indicate there is little risk from consuming fish from the monitored areas and compliance was achieved.

Fish Health

Fishes appeared normal in both color and odor in 2014-15, thus compliance was met. Furthermore, less than 1% of all fishes collected showed evidence of irregularities. The most common irregularity was the presence of the eye parasite *Phrixocephalus cincinnatus* on the Pacific Sanddab (*Citharichthys sordidus*), which occurred in 1% of the examined fish. These results are comparable to background levels found within the Southern California Bight (Perkins and Gartman 1997) and do not indicate a degraded biota.

CONCLUSIONS

In summary, California Ocean Plan criteria for water quality were met. Bacterial standards were achieved at offshore stations. Sediment quality was not degraded by excessive loading of measured chemical contaminants or by physical changes to the sediment from the discharge of wastewater solids. This was corroborated by the absence of sediment toxicity

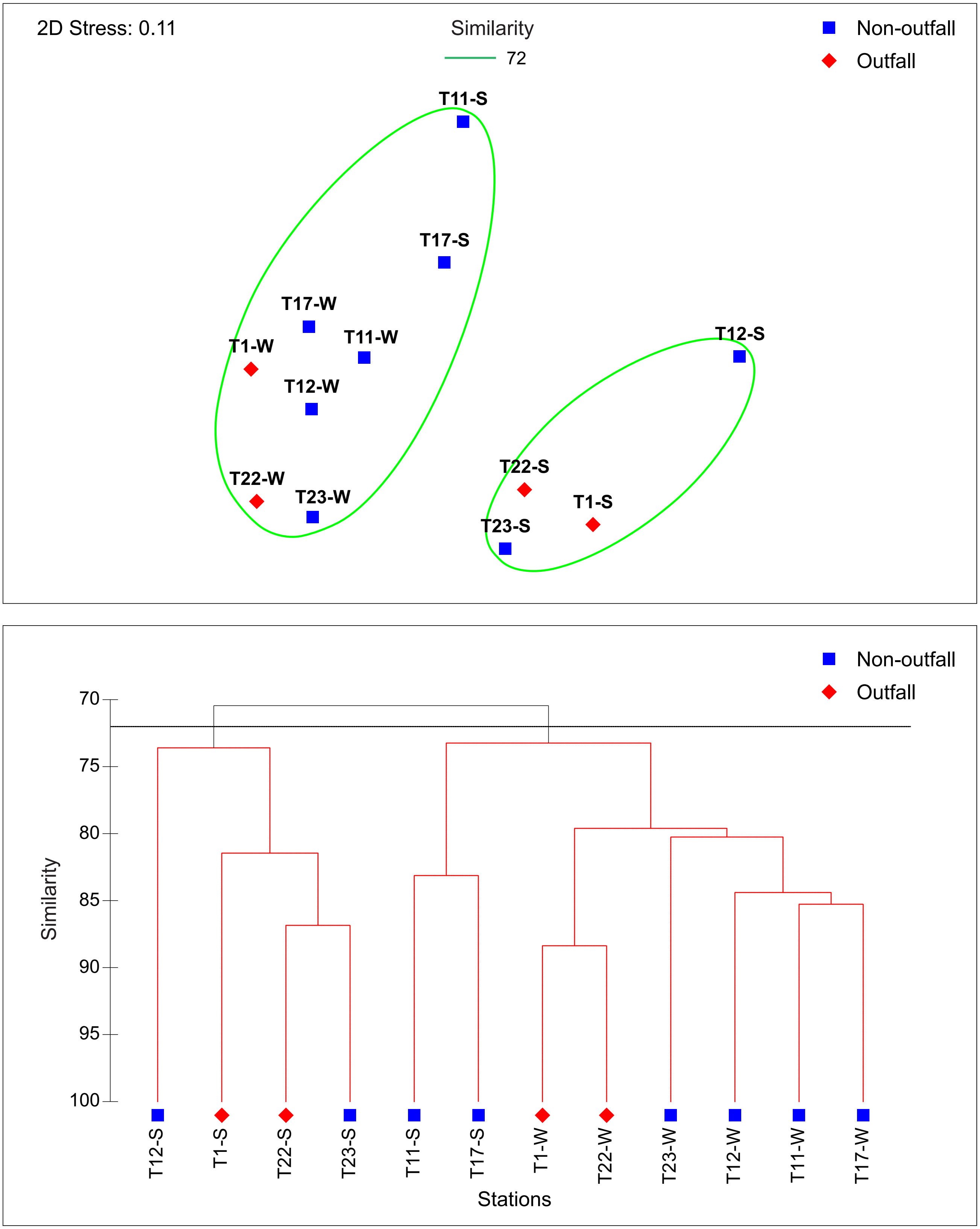


Figure 2–7. Non-metric multidimensional scaling (MDS) plot (top panel) and dendrogram (bottom panel) of the demersal fishes collected at outfall and non-outfall stations for the Summer 2014 (S) and Winter 2015 (W) trawl surveys.
Stations connected by red lines in the dendrogram are not significantly differentiated based on the SIMPROF test. The 2 main clusters formed at a 72% similarity level on the dendrogram are superimposed on the MDS plot.

Table 2–12. Summary statistics of tissue contaminant analyses of trawl fishes collected in January 2015 at outfall and non-outfall stations.

Species (Common name)	Tissue	Station	n	Standard Length (mm)	Percent Lipid	Mercury (mg/kg)	Total DDT (µg/kg)	Total PCB (µg/kg)	Total Chlordane (µg/kg)	Dieldrin (µg/kg)
Pleuronichthys verticalis (Hornyhead Turbot)	Muscle	T11 (Non-outfall)	10	163	ND	0.07 (0.03-0.11)	10.39 (5.61-14.40)	8.37 (0-18.36)	0.33 (0-1.45)	ND
		T1 (Outfall)	10	172	ND	0.11 (0.02-0.27)	6.28 (0-12.80)	4.99 (0.60-12.57)	0.07 (0-0.71)	1.27 (0-12.7)
	Liver	T11 (Non-outfall)	10	163	3.53	0.27 (0.13-0.44)	448.29 * (0-661)	16.51 * (0-77.70)	ND *	ND *
		T1 (Outfall)	10	172	6.4	0.25 (0.14-0.40)	NR	NR	NR	NR
Parophrys vetulus (English Sole)	Muscle	T11 (Non-outfall)	9	182	0.22	0.06 (0.03-0.08)	69.28 (13.92-242.77)	26.11 (4.33-61.20)	ND	0.49 (0-4.45)
		T1 (Outfall)	2	183	0.31	0.05 (0.04-0.06)	44.26 (13.30-75.22)	29.50 (10.47-48.52)	ND	ND
	Liver	T11 (Non-outfall)	9	182	12.76	0.07 (0.03-0.13)	1194.41 (242.50-5454.40)	125.14 (0-478.20)	ND	ND
		T1 (Outfall)	2	183	21.5	0.04 (0.03-0.04)	NR	NR	NR	NR
CA Advisory Tissue Level (ATL)						0.44	2100	120	560	46
Federal Action Level for edible tissue						1	5000	2000	300	300

Abbreviations: ND = Not Detected, NR = No Result (see Appendix C for explanation).

* Values based on 7 samples, as the other 3 had no result.

Table 2–13. Summary statistics of muscle tissue contaminant analyses of rig-caught fishes collected in January 2015 at Zone 1 (outfall) and Zone 3 (non-outfall).

Zone	Species (Common name)	n	Standard Length (mm)	Lipids (%)	Mercury (mg/kg)	Arsenic (mg/kg)	Selenium (mg/kg)	Total DDT (µg/kg)	Total PCB (µg/kg)	Total Chlordane (µg/kg)	Dieldrin (µg/kg)
1	*Sebastes caurinus* (Copper Rockfish)	5	274	0.56	0.10 (0.05-0.14)	1.52 (1.18-1.90)	0.86 (0.83-0.92)	7.57 (5.44-9.45)	4.30 (2.58-6.02)	ND	ND
	Sebastes miniatus (Vermilion Rockfish)	5	307	1.17	0.07 (0.05-0.08)	3.06 (2.38-3.68)	0.83 (0.79-0.88)	28.05 (15.0-58.3)	6.21 (1.23-17.2)	ND	ND
3	*Sebastes caurinus* (Copper Rockfish)	5	369	0.22	0.12 (0.07-0.19)	1.86 (1.62-2.04)	0.78 (0.67-0.90)	20.64 (6.05-33.2)	3.20 (0.26-5.97)	ND	ND
	Sebastes miniatus (Vermilion Rockfish)	5	260	0.33	0.08 (0.05-0.12)	2.53 (1.84-3.29)	0.69 (0.68-0.71)	15.13 (6.91-22.5)	1.40 (0-2.46)	ND	ND
CA Advisory Tissue Level (ATL)				N/A	0.44	N/A	15	2100	120	560	46
Federal Action Level for edible tissue				N/A	1	N/A	N/A	5000	2000	300	300

Abbreviations: ND = Not Detected, N/A = Not Applicable.

in controlled laboratory tests and the presence of normal infaunal communities throughout the monitoring area. Fish and trawl invertebrate communities in the monitoring area were healthy and diverse, and federal and state fish consumption guidelines were met. Altogether, these results indicate that the receiving environment was not degraded by the discharge of the treated wastewater, all permit compliance criteria were met, and environmental and human health was protected.

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STRATEGIC PROCESS STUDIES AND REGIONAL MONITORING

Chapter 3

Chapter 3
STRATEGIC PROCESS STUDIES AND REGIONAL MONITORING

INTRODUCTION

The Orange County Sanitation District (District) operates under the auspices of a National Pollutant Discharge Elimination System (NPDES) permit issued jointly by the United States Environmental Protection Agency (EPA) and the State of California Regional Water Quality Control Board (RWQCB) (Order No. R8-2012-0035, NPDES Permit No. CA0110604) in June 2012. The permit requires the District to conduct an ocean monitoring program (OMP) that documents the effectiveness of the District's source control and wastewater treatment operations in protecting coastal ocean resources and beneficial uses. Part of the codified OMP is a requirement to conduct Strategic Process Studies (SPS) and to participate in regional monitoring programs. In addition, the District performs special studies, which are generally less involved than SPS and have no regulatory requirement for prior approval or level of effort.

SPS are designed to address unanswered questions raised by the Core monitoring program results or they may focus on issues of interest to the District, such as the effect of contaminants of emerging concern (CECs) on local fish populations. Some SPS are enumerated in the NPDES permit. Other SPS are proposed and must be approved by state and/or federal regulators to ensure proper focus and level of effort. For the 2014-15 program year, no SPS were conducted.

Regional monitoring studies are those not focused solely on the District's monitoring area, but which sample on larger areas of the Southern California Bight. These may include the "Bight" studies coordinated by the Southern California Coastal Water Research Project (SCCWRP) or studies conducted in coordination with other public agencies and/or non-governmental organizations in the region. Examples include the Central Region Kelp Survey Consortium and the Central Bight Water Quality Study.

This chapter provides study overviews of recently completed and ongoing special studies and regional monitoring efforts. Unlike the other chapters in this report, these summaries are the most recent information available up to the publication of this report. In most cases, this information is also used in other chapters of this report to corroborate and supplement Core monitoring results. This chapter provides study summaries only and the projects described are not intended as comprehensive reports. Links to final study reports, if available, are listed under each section below.

REGIONAL MONITORING

Regional Nearshore (Surfzone) Bacterial Sampling

The District is a partner with the Orange County Health Care Agency (OCHCA), the South Orange County Wastewater Authority (SOCWA), and the Orange County Public Works (OCPW) in the Ocean Water Protection Program, a regional bacterial sampling program that samples 126 stations along 42 miles (67.5 km) of coastline (Seal Beach to San Clemente State Beach) and 70 miles (112.6 km) of harbor and bay frontage. In 2014, over 7,700 samples were collected regionally for 3 fecal indicator bacteria (FIB; total coliform, fecal coliform, and enterococci).

OCHCA reviews bacteriological data to determine whether a station meets beach bathing water quality standards. Beach closures, postings, or health advisories are based on these results. The 2012/2013/2014 Triennial Ocean, Harbor, and Bay Water Quality Report provides a summary of bacteriological water quality for the county (www.ocbeachinfo.com). The report also describes year-to-year variability and trends representing the 15-year period (2000–2014) that Ocean Water-Contact Sports Standards (i.e., Assembly Bill 411) for bacteriological water quality have been in place.

A few of the county-wide report findings include:

- The number of reported sewage spills was at an all-time low, with 12 consecutive years of decreasing spills.
- The yearly average number (12) of beach closures due to sewage spills from 2012 to 2014 was 53% below the 16-year average (23).
- The average number (25.3) of Beach Mile Days closures due to sewage spills was also below the 16-year average (28.7).
- Total Beach Mile Days posted due to bacteriological standards violations during the AB411 period (April 1 to October 31) was at near record lows (35.4) and was 81% below the 15-year average of 182.5 days (2000 through 2014).

Data from 18 of the 38 Regional stations sampled during 2014-15 by the District (Table B-11) were analyzed separately for comparison with the District's historical surfzone results. Table B-12 presents summary statistics for the remaining stations; a discussion of these data can be found on the OCHCA website (www.ocbeachinfo.com). Results for the 18 District stations were similar to those of previous years (OCSD 2014, 2015). FIB counts at these stations varied by season, location, and by bacteria type. A general spatial pattern was associated with the mouth of the Santa Ana River. Seasonal geomeans and the percent of samples exceeding geomean and single sample standards all peaked near the river mouth and then tapered off upcoast and downcoast. Collectively, exceedance of the state single sample standard (AB411) was low, with less than 1% by total coliforms, slightly over 2% by fecal coliforms, and 5% by enterococci.

Central Bight Regional Water Quality Program

The District is a member of a regional cooperative sampling effort known as the Central Bight Regional Water Quality Monitoring Program (Central Bight) with the City of Oxnard, City of Los Angeles, the County Sanitation Districts of Los Angeles, and the City of San Diego. Each quarter, the participating agencies sample a station grid that covers the coastal waters from Ventura County to Crystal Cove State Beach and from Point Loma to the United States–Mexico Border. The participants employ similarly equipped CTDs and comparable field sampling methods. When combined with the District's Core water quality program data, the Central Bight monitoring provides regional data that enhances the evaluation of water quality changes due to natural or anthropogenic discharges (e.g., stormwater) and provides a regional context for comparisons with the District's monitoring results. The Central Bight data also provides a link to other larger-scale regional programs, such as the California Cooperative Oceanic Fisheries Investigations (CalCOFI) and serve as the basis for the Bight'13 Nutrients sampling. Currently, the Central Bight group is working to develop closer ties to the CalCOFI program and District staff are working with the regional Southern California Coastal Ocean Observing System (SCCOOS) to develop quality assurance guidelines for submitting Central Bight data to SCCOOS that complies with the national Integrated Ocean Observing System (IOOS) guidelines.

Bight'13 Regional Monitoring

Since 1994, the District has participated in 5 regional monitoring studies of environmental conditions within the Southern California Bight (SCB): 1994 Southern California Bight Pilot Project (SCBPP), Bight'98, Bight'03, Bight'08, and Bight'13. The District has played a considerable role in all aspects of these regional projects, including program design, sampling, quality assurance, data analysis, and report writing. Results from these efforts provide information that is used by individual dischargers, resource managers, and the public to improve region-wide understanding of environmental conditions and to provide a regional perspective for comparisons with data collected from individual point sources. During the summer of 2013, District staff conducted field operations, ranging in area from Orange County south to Camp Pendleton in northern San Diego County and west to the southern end of Santa Catalina Island, as part of the Bight'13 sampling effort. Currently District staff is involved in final data submissions, data review, and report production for the Bight'13 project. Final reports for the Bight'13 project will be available in December 2017. Project documents, data, and reports on the previous studies are available on SCCWRP's website (http://sccwrp.org).

Regional Kelp Survey Consortium – Central Region

The District is a member of the Central Region Kelp Survey Consortium (CRKSC), which was formed in 2003 to map Giant Kelp (*Macrocystis pyrifera*) beds off Ventura, Los Angeles, and Orange Counties via aerial photography. The program is modeled after the San Diego Regional Water Quality Control Board, Region Nine Kelp Survey Consortium, which began in 1983. Both consortiums sample quarterly to count the number of observable kelp beds and calculate maximum kelp canopy coverage. Combined, the CRKSC and San Diego aerial surveys provide synoptic coverage of kelp beds along approximately 81% of the 270 miles (435 km) of the southern California mainland coast from northern Ventura County to the United States–Mexico Border. Survey results are published and presented annually by MBC Applied Environmental Sciences to both consortium groups, regulators, and the public. Reports are available on the SCCWRP's website (http://kelp.sccwrp.org/reports.html)

2014 Central Region Results

The number of kelp beds displaying canopy remained the same in the Central Region (24 of 26), however, the overall canopy cover decreased by nearly 24% from 2.2 mi^2 (5.6 km^2) in 2013 to 1.7 mi^2 (4.3 km^2) in 2014. Four kelp beds had increased surface coverage (3-59%), whereas 21 beds had decreased surface coverage (1-73%) and 1 bed had no change. However, total coverage in 2014 was still above the long-term (1965-2014) regional average of 1.6 mi^2 (4.1 km^2) (MBC 2015). Consistent with previous results, most of the Central Region kelp beds reached their maximum extent in early summer.

There was no evidence of any adverse effects on Giant Kelp resources from any of the region's dischargers. Rather, the Giant Kelp surveys of 2014 continued to demonstrate that most kelp bed dynamics in the Central region are influenced by the large-scale oceanographic environment, while micro-variations in local topography and currents can cause anomalies in kelp bed performances.

Ocean Acidification Mooring

Increased acidification of coastal waters is an issue that has become increasingly important along the west coast as reflected in its incorporation into the State of California Ocean Protection Council's (OPC) most recent 5-year strategic plan (OPC 2012). The acidity/alkalinity (pH) of receiving waters is an important biologic parameter as it affects the solubility of calcium carbonate, a necessary building material for organisms with calcareous shells. Aragonite concentration is a conventional metric used to evaluate potential impacts to marine organisms with saturation values ≥1 considered necessary for calcium formation. Preindustrial surface pH has been estimated to be 8.16 and a pH value of 7.75 has been associated with an aragonite saturation of 1 (Orr *et al*. 2005, Feely *et al*. 2008, Bernie 2009, Bijma *et al*. 2009, Pelejero *et al*. 2010). Since 1985, 11% of pH samples collected by the District fell below 7.75, with a range of <1% (1989 and 1991) to 33% (1998) (Figure 3-1).

Findings from the Bight'08 project showed that nutrients discharged from ocean outfalls off heavily urbanized regions were equivalent to natural nutrient sources (Howard *et al*. 2012) and research has linked nutrients with increased coastal acidification (NOAA 2012). Additionally, Howard *et al*. (2012) showed that algal bloom intensity significantly increased over the last decade and algal bloom 'hotspots' were shown to be co-located with major anthropogenic sources and extended water residence times. These findings led to the inclusion of enhanced nutrient and pH monitoring in the SCB as part of the Bight'13 Nutrients program (SCCWRP 2013).

Primary productivity and nutrient cycling (including oxygen demanding processes like nitrification) can have direct and indirect effects on the ecological condition of coastal waters. The California Ocean Plan (COP) establishes criteria for the amount of influence that anthropogenic wastewater dischargers are permitted to have on the ecological condition of coastal waters. These include criteria for nutrients ("shall not cause objectionable growth or degrade indigenous biota"), dissolved oxygen ("shall not be depressed by more than 10% of

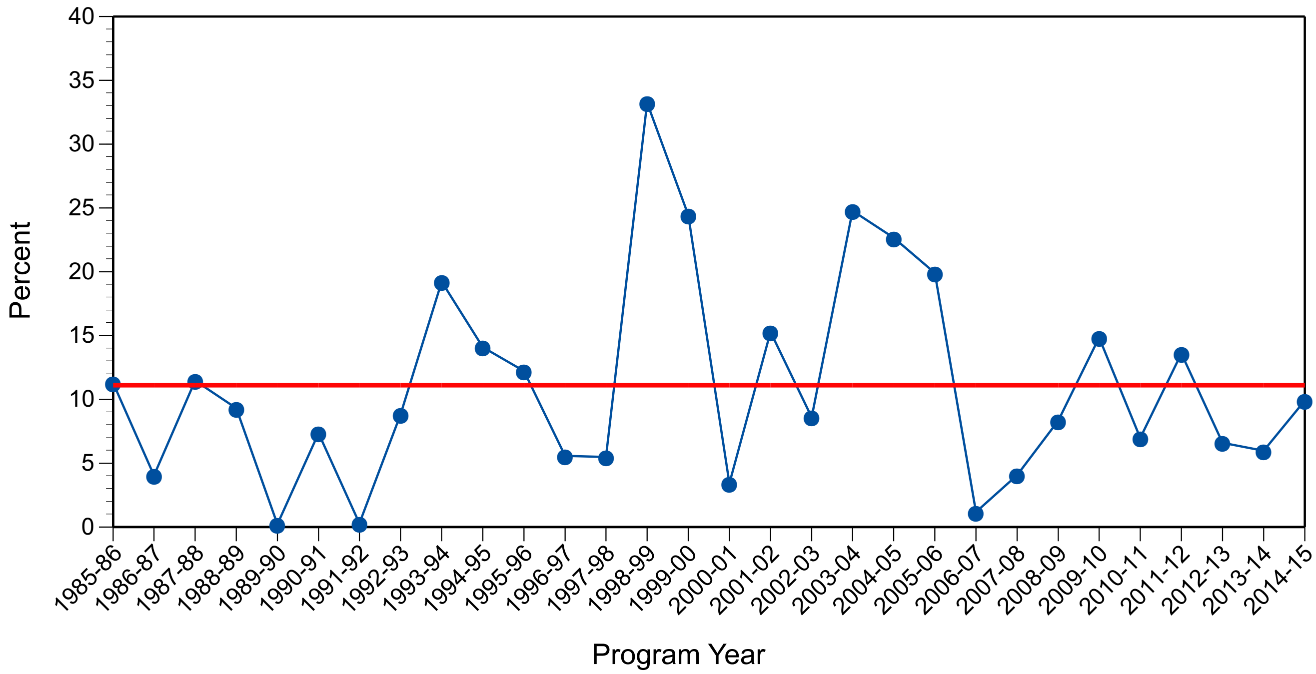

Figure 3–1. Percent of pH values measured below 7.75 (aragonite saturation ≈ 1) by the District by program year.
Red horizontal line represents the period-of-record mean of 11%.

that which would occur naturally"), and pH ("shall not be changed more than 0.2 pH units"). However, how anthropogenic nutrients influence each of these is not well understood and existing pH sensors are not sensitive or stable enough to measure small changes in pH.

To address these issues, 4 Bight'13 participants (City of Los Angeles, County Sanitation Districts of Los Angeles, City of San Diego, and the District) worked collectively to design moored instrumentation platforms to measure pH, dissolved oxygen, and chlorophyll-*a* fluorescence. The District built and recently deployed (October 2015) an Ocean Acidification (OA) Mooring that measures temperature, salinity, dissolved oxygen, pH, and chlorophyll-*a* fluorescence at selected depths as well as currents throughout the water column. A more sensitive and stable pH sensor developed by the Monterey Bay Aquarium Research Institute (MBARI) in conjunction with Scripps Institution of Oceanography (SIO) is also being used on the mooring. Temperature is measured every 5 m of the water column from the surface to 70 m. With the exception of chlorophyll-*a* (sampled only at 35 m) the other physical factors are measured at the surface, 5 m, 35 m, and 60 m. The mooring is located downcoast and just offshore of the District's outfall. Data is stored internally and selected data is telemetered hourly to shore.

SPECIAL STUDIES

Cessation of Disinfection

In 2002, the District began effluent disinfection with chlorine bleach followed by de-chlorination with sodium bisulfite. At that time, the District provided 50% secondary treatment, requiring the use of large quantities of bleach due to the high amount of solids in the effluent. Beginning in 2006 the invertebrate community in the immediate area near the outfall pipe began changing in structure and had decreased community health index scores. The trend began slowly, but increased rapidly from 2008 to 2010. In 2009, stations as far as 0.6 miles (1 km) from the outfall pipe began showing change with a trend of decreased impact with increased distance from the outfall. This suggested the effluent discharge was the cause. Staff addressed this issue by conducting 10 individual studies over a 3-year period to determine the cause. Results showed that the District's use of large amounts of chlorine bleach for disinfection were creating toxic disinfection by-products that were the likely cause of the decline in the invertebrate communities.

The District achieved consistent full secondary treatment of the wastewater in March 2011. This required approximately 10% of the 2002 bleach usage to meet operational goals. Ocean monitoring results from January 2012 found evidence of invertebrate community improvement at the affected permit-compliance stations near the outfall. By July 2012, all previously affected stations near the outfall had normal or near-normal communities. This recovery is likely due to the high quality of the secondary treated wastewater being produced, requiring a greatly reduced amount of chlorine in the treatment process. However, the disinfection by-products that caused the decline were still being produced by the use of chlorine bleach, though at a much reduced volume. Further, an examination of the beach and nearshore bacterial monitoring data showed no evidence that effluent disinfection had any effect on bacterial levels in human recreational areas. District staff recommended that the use of chlorination for effluent disinfection be discontinued based on the demonstrated potential for environmental harm and permit-compliance issues and evidence indicating that effluent disinfection does not provide increased human health protection on local beaches or other recreational zones.

In anticipation of completion of all secondary treatment projects prior to 2012, the District initiated an evaluation of its disinfection practices by an Independent Advisory Panel (IAP) of experts hosted by the National Water Research Institute (NWRI). The IAP most recently met on March 26, 2014. They reviewed and discussed the data and circumstances surrounding the use of disinfection by the District to protect public health and meet water quality standards. The IAP concluded, among numerous observations and recommendations, that:

- The District's investigations indicate that the main source of FIB and potential pathogens are from birds, the Santa Ana River and Talbert Marsh, and groundwater and not from the diluted effluent plume.
- Based on the District's water quality FIB data, collected during high-use periods, all health department standards have been met.
- Continuing to chlorinate full secondary treated effluent provides little to no public health benefit.
- If the use of chlorine is eliminated, the Panel recommends that the District continue to extensively monitor the condition of the benthic environment near the outfall discharge until it is determined that conditions have stabilized.

District staff presented the findings to the Orange County Coastal Coalition (OCCC) and the cities of Newport Beach and Huntington Beach. They all endorsed the District's proposal to eliminate the use of continuous disinfection for effluent disinfection. Based on the observations and recommendations of the IAP and with public support, the District ceased disinfection of the final effluent in March 2015.

To demonstrate continued compliance with NPDES permit requirements and public health protection, enhanced beach and ocean water quality monitoring was initiated by the District. This included adding one extra sampling day per week to 19 of the 38 Regional water quality surfzone stations (Table A-1) resulting in a new total of twice per week, and adding a 10-m contour (7 stations) to our offshore water quality grid which the District sampled 5 times per quarter. The additional samples collected along the 10-m contour provided additional data nearer the beach to demonstrate that the effluent plume did not migrate into bathing waters. The enhanced monitoring was conducted from March through November 2015, after which the RWQCB determined that the enhanced monitoring was no longer necessary based on the monitoring results (see Chapter 2).

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METHODS

Appendix A

INTRODUCTION

This appendix contains a summary of the field sampling, laboratory testing, and data analysis methods used in the District's Ocean Monitoring Program (OMP). The methods also include calculations of water quality compliance with California Ocean Plan (COP) criteria.

WATER QUALITY MONITORING

Field Methods

Offshore Zone

Permit-specified water quality monitoring was conducted 3 times per quarter at 28 stations (Figure A-1, Tables A-1 and A-2). Eight stations located inshore of the 3-mile line of the coast are designated as areas used for water contact sports by the Regional Water Quality Control Board (RWQCB) (i.e., waters designated as REC-1), and were sampled an additional 3 days per quarter for fecal indicator bacteria (FIB; total coliform, fecal coliform, and enterococci). The additional surveys were conducted in order to calculate a 30-day geometric mean.

Each survey included measurements of pressure (from which depth is calculated), temperature, conductivity (from which salinity is calculated), dissolved oxygen (DO), pH, water clarity (light transmissivity, beam attenuation coefficient [beam-c], and photosynthetically active radiation [PAR]), chlorophyll-*a* fluorescence, and colored dissolved organic matter (CDOM). Measurements were conducted using a Sea-Bird Electronics SBE9/SBE 11 Deck Unit (SBE9/11) CTD (conductivity-temperature-depth) profiling system deployed from the M/V *Nerissa*. Profiling was conducted at each station from 1 m below the surface to 2 m above the bottom or to a maximum depth of 75 m, when water depths exceeded 75 m. SEASOFT (2014a) software was used for data acquisition, data display, and sensor calibration. PAR was measured in conjunction with chlorophyll-*a* because of the positive linkage between light intensity and photosynthesis per unit chlorophyll (Hardy 1993). Wind condition, sea state, and visual observations of floatable materials or grease that might be of sewage origin were also conducted. Discrete water samples were collected using a Sea-Bird Electronics Carousel Water Sampler (SBE32/SBE33) equipped with Niskin bottles for ammonium (NH3-N) and FIB at specified stations and depths. All discrete samples were kept on wet ice in coolers and transported to the District's laboratory within 6 hours. A summary of the sampling methods are presented in Table A-3.

Central Bight Regional Water Quality

An expanded grid of water quality stations was sampled quarterly as part of the District's Central Bight Regional Water Quality monitoring. These 38 stations were sampled in conjunction with the 28 Core water quality stations (see Figure 2-1) along with the County Sanitation Districts of Los Angeles, the City of Los Angeles, and the City of Oxnard. The total sampling area extends from the Ventura River in the north to Crystal Cove State Beach

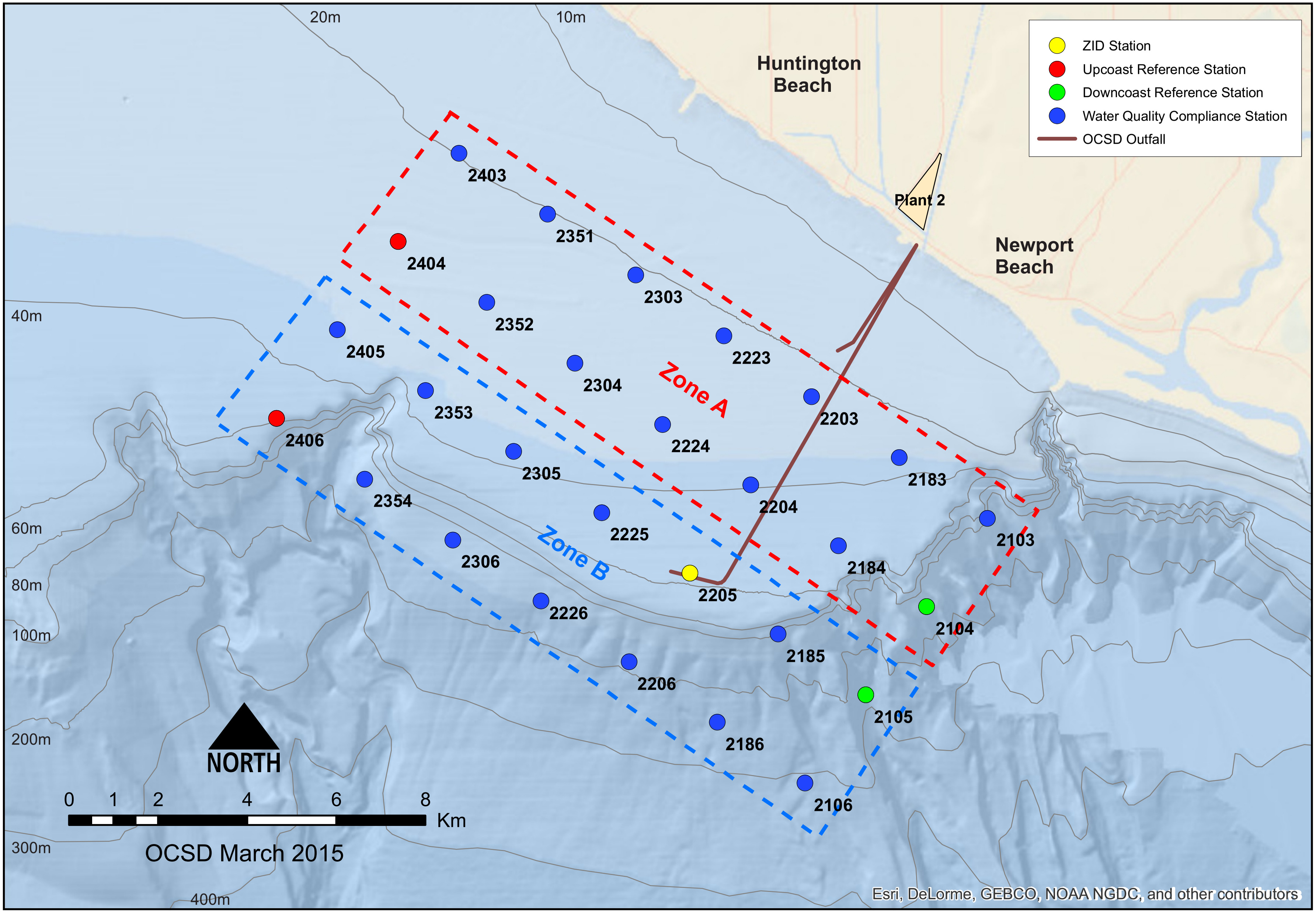

Figure A–1. **Water quality monitoring stations and zones used for compliance determinations.**

Table A–1. The District's ocean monitoring program station positions and nominal depths.

Station	Latitude	Longitude	Depth	Station	Latitude	Longitude	Depth
Offshore Water Quality							
1901 [a]	33° 33.682' N	117° 49.654' W	10	2204 [c]	33° 35.423' N	117° 59.546' W	39
1902 [a]	33° 33.165' N	117° 49.944' W	60	2205 [c]	33° 34.534' N	118° 00.282' W	57
1903 [a]	33° 32.762' N	117° 50.182' W	100	2206 [c]	33° 33.644' N	118° 01.018' W	185
1904 [a]	33° 31.787' N	117° 50.734' W	405	2221 [a, e]	33° 38.099' N	117° 58.908' W	10
1905 [a]	33° 30.810' N	117° 51.285' W	510	2222 [a]	33° 37.522' N	117° 59.374' W	15
1906 [a]	33° 29.829' N	117° 51.842' W	550	2223 [d]	33° 36.924' N	117° 59.871' W	22
2001 [a]	33° 35.335' N	117° 51.564' W	10	2224 [c]	33° 36.035' N	118° 00.608' W	31
2002 [a]	33° 34.755' N	117° 51.844' W	60	2225 [c]	33° 35.146' N	118° 01.346' W	47
2003 [a]	33° 34.565' N	117° 52.123' W	100	2226 [c]	33° 34.257' N	118° 02.083' W	135
2004 [a]	33° 33.589' N	117° 52.657' W	345	2301 [a, e]	33° 38.572' N	118° 00.064' W	10
2005 [a]	33° 32.613' N	117° 53.225' W	410	2302 [a]	33° 38.053' N	118° 00.495' W	15
2006 [a]	33° 31.647' N	117° 53.793' W	470	2303 [d]	33° 37.537' N	118° 00.936' W	21
2021 [a]	33° 35.771' N	117° 52.099' W	10	2304 [c]	33° 36.649' N	118° 01.674' W	29
2022 [a]	33° 35.283' N	117° 52.379' W	53	2305 [c]	33° 35.760' N	118° 02.412' W	38
2023 [a]	33° 34.796' N	117° 52.658' W	165	2306 [c]	33° 34.871' N	118° 03.149' W	114
2024 [a]	33° 33.811' N	117° 53.179' W	300	2349 [a, e]	33° 39.190' N	118° 01.135' W	10
2025 [a]	33° 32.851' N	117° 53.741' W	390	2350 [a]	33° 38.667' N	118° 01.566' W	14
2026 [a]	33° 31.900' N	117° 54.301' W	432	2351 [d]	33° 38.151' N	118° 02.001' W	21
2101 [a, e]	33° 36.183' N	117° 55.749' W	10	2352 [b]	33° 37.262' N	118° 02.739' W	29
2102 [a]	33° 35.631' N	117° 56.206' W	26	2353 [b]	33° 36.373' N	118° 03.477' W	37
2103 [d]	33° 35.089' N	117° 56.678' W	110	2354 [b]	33° 35.484' N	118° 04.214' W	123
2104 [d]	33° 34.199' N	117° 57.414' W	143	2401 [a, e]	33° 39.920' N	118° 02.103' W	10
2105 [c]	33° 33.309' N	117° 58.150' W	280	2402 [a]	33° 39.342' N	118° 02.593' W	16
2106 [c]	33° 32.420' N	117° 58.885' W	309	2403 [d]	33° 38.765' N	118° 03.072' W	21
2181 [a, e]	33° 36.877' N	117° 56.752' W	10	**2404** [b]	33° 37.875' N	118° 03.808' W	29
2182 [a]	33° 36.272' N	117° 57.264' W	15	2405 [b]	33° 36.986' N	118° 04.544' W	37
2183 [d]	33° 35.701' N	117° 57.744' W	36	**2406** [b]	33° 36.096' N	118° 05.280' W	60
2184 [c]	33° 34.811' N	117° 58.480' W	51	2451 [a]	33° 41.475' N	118° 03.944' W	10
2185 [c]	33° 33.922' N	117° 59.215' W	114	2452 [a]	33° 40.739' N	118° 04.584' W	17
2186 [c]	33° 33.032' N	117° 59.951' W	247	2453 [a]	33° 39.987' N	118° 05.204' W	22
2201 [a, e]	33° 37.493' N	117° 57.831' W	10	2454 [a]	33° 39.098' N	118° 05.946' W	30
2202 [a]	33° 36.901' N	117° 58.314' W	16	2455 [a]	33° 38.210' N	118° 06.675' W	36
2203 [d]	33° 36.313' N	117° 58.810' W	25	2456 [a]	33° 37.318' N	118° 07.411' W	42

[a] Central Bight Water Quality Regional Grid station only - CTD profiling only.
[b] Core Water Quality Station - CTD profiling only.
[c] Core Water Quality Station - CTD profiling and ammonium samples.
[d] Core Water Quality Station - CTD profiling plus ammonium and bacteria (REC-1) samples.
[e] Disinfection Cessation Station - CTD profiling plus ammonium and bacteria samples.
Stations denoted in bold represent the potential California Ocean Plan water quality compliance reference stations.

Table A-1 Continues.

Table A-1 Continued.

Station	Latitude	Longitude	Depth	Station	Latitude	Longitude	Depth
Regional Nearshore (Surfzone) Water Quality							
OSB02 [a]	33° 44.420' N	118° 06.937' W	Ankle deep	6N [a]	33° 38.331' N	117° 58.573' W	Ankle deep
OSB03	33° 44.355' N	118° 06.449' W	Ankle deep	3N [a]	33° 38.018' N	117° 58.032' W	Ankle deep
OSB05	33° 44.296' N	118° 06.378' W	Ankle deep	TM	33° 37.994' N	117° 57.645' W	Ankle deep
OSB04	33° 44.209' N	118° 06.121' W	Ankle deep	0 [a]	33° 37.764' N	117° 57.598' W	Ankle deep
OSB01	33° 43.603' N	118° 05.041' W	Ankle deep	SAR-N	33° 37.870' N	117° 57.434' W	Ankle deep
OSUB1	33° 42.986' N	118° 04.341' W	Ankle deep	3S [a]	33° 37.619' N	117° 57.264' W	Ankle deep
39N [a]	33° 42.114' N	118° 03.321' W	Ankle deep	6S [a]	33° 37.337' N	117° 56.704' W	Ankle deep
33N [a]	33° 41.281' N	118° 02.495' W	Ankle deep	9S [a]	33° 37.033' N	117° 56.283' W	Ankle deep
BCO-1	33° 40.994' N	118° 02.138' W	Ankle deep	15S [a]	33° 36.342' N	117° 55.459' W	Ankle deep
27N [a]	33° 40.587' N	118° 01.712' W	Ankle deep	21S [a]	33° 36.059' N	117° 54.213' W	Ankle deep
HB1 [b]	33° 40.065' N	118° 01.937' W	Ankle deep	27S [a]	33° 35.646' N	117° 52.910' W	Ankle deep
HB2 [b]	33° 40.022' N	118° 01.937' W	Ankle deep	29S [a]	33° 35.559' N	117° 52.508' W	Ankle deep
HB3 [b]	33° 39.952' N	118° 00.933' W	Ankle deep	BGC [b]	33° 35.389' N	117° 52.121' W	Ankle deep
21N [a]	33° 39.843' N	118° 00.785' W	Ankle deep	PPC [b]	33° 34.933' N	117° 51.416' W	Ankle deep
HB4 [b]	33° 39.680' N	118° 00.613' W	Ankle deep	WFC [b]	33° 34.900' N	117° 51.334' W	Ankle deep
HB5 [b]	33° 39.414' N	118° 00.310' W	Ankle deep	39S [a]	33° 34.700' N	117° 51.946' W	Ankle deep
15N [a]	33° 39.114' N	117° 59.846' W	Ankle deep	ONB39 [b]	33° 34.444' N	117° 50.410' W	Ankle deep
12N [a]	33° 38.854' N	117° 59.413' W	Ankle deep	MDC [b]	33° 33.838' N	117° 49.702' W	Ankle deep
9N [a]	33° 38.565' N	117° 58.924' W	Ankle deep	El Moro [b]	33° 33.593' N	117° 49.292' W	Ankle deep

[a] Bacteria sample was collected at least twice for both regional monitoring and the disinfection cessation study.

[b] When flowing, 2 additional bacteria samples were collected: 1) 25 yards upcoast and 2) 25 yards downcoast of freshwater-ocean interface. When flow was not observed at the interface, a single sample was collected 25 yards downcoast.

Bacteria sample was collected at least once per week at all other stations.

Station	Latitude	Longitude	Depth	Station	Latitude	Longitude	Depth
Trawl							
T0 [a]	33° 37.117' N	117° 59.283' W	18	T17 [b]	33° 35.160' N	118° 02.658' W	60
T1 [b]	33° 34.641' N	118° 00.567' W	55	T18	33° 36.960' N	118° 05.268' W	36
T2	33° 35.688' N	117° 59.561' W	35	T19	33° 35.394' N	118° 05.424' W	137
T6	33° 35.946' N	118° 02.785' W	36	T22 [b]	33° 34.326' N	117° 59.856' W	60
T10	33° 33.771' N	118° 00.250' W	137	T23 [b]	33° 34.336' N	117° 59.051' W	58
T11 [b]	33° 36.055' N	118° 05.199' W	60	T24	33° 35.648' N	118° 01.274' W	36
T12 [b]	33° 34.868' N	118° 01.670' W	57	T25	33° 34.245' N	118° 01.967' W	137
T14	33° 34.672' N	118° 03.200' W	137				

[a] Sampled for historical purposes.
[b] Semi-annual station.
All other stations were sampled annually.

Table A-1 Continues.

Table A-1 Continued.

Station	Latitude	Longitude	Depth	Station	Latitude	Longitude	Depth
Rig-fishing							
RF1	**Zone 1 (outfall):** Inshore of the 60 m depth contour bounded by the coordinates 33° 36.272' N / 117° 57.264' W and 33° 37.522' N / 117° 59.374' W along the 15 m contour and 33° 34.698' N / 118° 01.713' W along the 80 m contour, and 33° 33.475' N / 117° 59.583' W along the 180 m contour.						
RF3	**Zone 3 (non-outfall):** Bounded by the coordinates. 33° 35.879' N / 118° 08.015' W, 33° 35.333' N / 118° 07.476' W, 33° 34.272' N / 118° 08.557' W, 33° 34.820' N / 118° 09.086' W.						
Sediment Geochemistry, Sediment Toxicity, and Benthic Infauna							
0 [a, b]	33° 34.573' N	118° 00.598' W	56	58	33° 33.365' N	118° 05.347' W	300
1 [a, b]	33° 34.657' N	118° 00.968' W	56	59	33° 36.070' N	118° 03.701' W	40
3 [a]	33° 34.434' N	118° 00.660' W	60	60	33° 35.532' N	118° 04.017' W	100
4 [a, b]	33° 34.498' N	117° 59.761' W	56	61	33° 35.011' N	118° 04.326' W	200
5 [a]	33° 34.749' N	118° 01.612' W	59	62	33° 34.069' N	118° 04.568' W	300
7	33° 35.325' N	118° 00.367' W	41	63	33° 34.173' N	118° 03.407' W	200
8	33° 35.164' N	117° 59.555' W	44	64	33° 33.484' N	118° 03.663' W	300
9 [a]	33° 34.363' N	117° 59.510' W	59	65	33° 33.859' N	117° 57.230' W	200
10	33° 34.902' N	118° 02.081' W	62	68 [a]	33° 34.848' N	118° 00.694' W	52
12 [a]	33° 34.385' N	117° 59.054' W	58	69 [a]	33° 34.794' N	118° 00.465' W	52
13	33° 35.307' N	118° 02.944' W	59	70 [a]	33° 34.736' N	118° 00.183' W	52
17	33° 33.961' N	118° 00.187' W	91	71 [a]	33° 34.687' N	117° 59.939' W	52
18	33° 34.064' N	118° 00.750' W	91	72 [a, b]	33° 34.674' N	118° 01.146' W	55
20	33° 34.599' N	118° 02.229' W	100	73 [a, b]	33° 34.596' N	118° 00.709' W	55
21	33° 35.313' N	118° 01.891' W	44	74 [a]	33° 34.616' N	118° 00.230' W	57
22	33° 35.204' N	117° 59.028' W	45	75 [a]	33° 34.559' N	117° 59.974' W	60
23	33° 33.968' N	117° 59.147' W	100	76 [a, b]	33° 34.459' N	118° 00.297' W	58
24	33° 33.563' N	118° 01.140' W	200	77 [a, b]	33° 34.373' N	117° 59.730' W	60
25	33° 33.924' N	118° 02.176' W	200	78 [a]	33° 34.329' N	118° 00.036' W	63
27	33° 33.326' N	117° 59.708' W	200	79 [a]	33° 34.383' N	118° 00.876' W	65
29	33° 35.033' N	118° 03.113' W	100	80 [a]	33° 34.324' N	118° 00.662' W	65
30	33° 35.493' N	118° 02.899' W	46	81 [a]	33° 34.263' N	118° 00.362' W	65
33	33° 34.349' N	117° 57.866' W	100	82 [a]	33° 34.207' N	118° 00.077' W	65
36	33° 35.308' N	117° 57.495' W	45	83	33° 34.239' N	118° 01.414' W	100
37	33° 34.832' N	117° 57.369' W	56	84 [a]	33° 34.648' N	118° 00.543' W	54
38	33° 34.634' N	117° 57.317' W	100	85 [a]	33° 34.532' N	118° 00.679' W	57
39	33° 33.283' N	117° 58.531' W	200	86 [a]	33° 34.560' N	118° 00.802' W	57
40	33° 32.496' N	117° 59.775' W	303	87 [a]	33° 34.401' N	118° 00.380' W	60
41	33° 32.690' N	118° 01.149' W	303	C [a]	33° 35.799' N	118° 03.855' W	56
42	33° 33.098' N	118° 02.598' W	303	C2	33° 36.125' N	117° 56.014' W	56
44	33° 34.586' N	118° 05.422' W	241	C4	33° 35.056' N	117° 55.833' W	187
55	33° 36.739' N	118° 05.413' W	40	C5	33° 33.920' N	117° 55.620' W	296
56	33° 35.665' N	118° 05.417' W	100	Control 1 [a, b]	33° 36.037' N	118° 05.387' W	59
57	33° 34.970' N	118° 05.418' W	200	ZB [a, b]	33° 34.545' N	118° 00.274' W	56

[a] Semi-annual station.

[b] Sediment toxicity station (winter only).

All other stations were sampled annually.

Table A–2. Sampling dates during 2014-15.

Quarter	Date	Cruise #	# of days	Purpose
Water Quality				
Summer	07/16/2014	OC-2014-034	1	Core 28 Station Grid (Day 1) - Ammonium Only
	08/05/2014	OC-2014-037	1	Bight'13 pH
	08/06/2014	OC-2014-038	1	Core 28 Station Grid (Day 2)
	08/07/2014	OC-2014-039	1	Central Bight Grid
	08/12/2014	OC-2014-040	1	REC-1 (Day 1)
	08/13/2014	OC-2014-041	1	REC-1 (Day 2)
	08/14/2014	OC-2014-042	1	REC-1 (Day 3)
	08/25-09/02/2014	OC-2014-043	3	Bight'13 Nutrients Process
	09/03/2014	OC-2014-046	1	Core 28 Station Grid (Day 3)
Fall	10/02/2014	OC-2014-048	1	Core 28 Station Grid (Day 1)
	10/22/2014	OC-2014-050	1	REC-1 (Day 1)
	11/04/2014	OC-2014-053	1	Bight'13 pH
	11/05/2014	OC-2014-054	1	Core 28 Station Grid (Day 2)
	11/06/2014	OC-2014-055	1	Central Bight Grid
	11/12/2014	OC-2014-056	1	REC-1 (Day 2)
	11/13/2014	OC-2014-057	1	REC-1 (Day 3)
	12/10/2014	OC-2014-061	1	Core 28 Station Grid (Day 3) - Ammonium Only
Winter	01/20/2015	OC-2015-004	1	Core 28 Station Grid (Day 1)
	02/03/2015	OC-2015-005	1	Core 28 Station Grid (Day 2)
	02/04/2015	OC-2015-006	1	Central Bight Grid
	02/05/2015	OC-2015-007	1	REC-1 (Day 1)
	02/11/2015	OC-2015-008	1	Bight'13 pH
	02/09/2015	OC-2015-009	1	REC-1 (Day 2)
	02/10/2015	OC-2015-010	1	REC-1 (Day 3)
	03/26/2015	OC-2015-013	1	Core 28 Station Grid (Day 3) - Ammonium Only
	03/18-03/23/2015	OC-2015-014	2	Bight'13 Nutrients Process
Spring	04/21/2015	OC-2015-017	1	Core 28 Station Grid (Day 1) - Ammonium Only
	04/22/2015	OC-2015-018	1	REC-1 (Day 1) + Disinfection Cessation
	04/23/2015	OC-2015-019	1	REC-1 (Day 2) + Disinfection Cessation
	05/06/2015	OC-2015-020	1	Core 28 Station Grid (Day 2) - Ammonium Only
	05/07/2015	OC-2015-021	1	Central Bight Grid
	05/05/2015	OC-2015-022	1	REC-1 (Day 3) + Disinfection Cessation
	05/18/2015	OC-2015-023	1	REC-1 (Day 4) + Disinfection Cessation
	05/19/2015	OC-2015-024	1	REC-1 (Day 5) + Disinfection Cessation
	05/27/2015	OC-2015-025	1	Bight'13 pH
	06/17/2015	OC-2015-030	1	Core 28 Station Grid (Day 3) - Ammonium Only

Table A-2 Continues.

in the south. Data were collected using CTDs within a fixed-grid pattern comprising 216 stations during a targeted 3 to 4 day period. Parameters measured included pressure, water temperature, conductivity, DO, pH, chlorophyll-*a*, CDOM, and water clarity. Profiling was conducted from the surface depth to 2 m from the bottom or to a maximum depth of 100 m. Sampling and analytical methods were the same as those presented in Table A-3.

Table A-2 Continued.

Quarter	Date	Cruise #	# of days	Purpose
Sediment and Infauna				
Summer	07/08-07/09/2014	OC-2014-032	2	Core Semi-annual Benthic
	07/10-07/15/2014	OC-2014-033	3	Core Annual Benthic
Winter	01/06-01/08/2015	OC-2015-001	2	Core Semi-annual Benthic
	03/26/2015	OC-2015-016	1	Toxicity Samples only
Trawls				
Summer	07/22-07/23/2014	OC-2014-035	2	Core Semi-annual
	07/17-07/23/2014	OC-2014-036	3	Core Annual
Winter	01/21-01/26/2015	OC-2015-002	3	Core Semi-annual
Rig Fishing				
Fall	10/27/2014	OC-2014-051	1	Pilot Study
Winter	01/27-01/29/2015	OC-2015-003	2	Core Annual
Current Meters and Moorings				
Sumer	08/18/2014	OC-2014-047	1	TRBM/ADCP Recovery (M18, M19, & M21)
	09/04/2014	OC-2014-045	1	Thermistor Mooring Recovery (M18 & M21)
Winter	02/24/2015	OC-2015-011	1	Thermistor Mooring Deployment (M18 & M21)
	02/25/2015	OC-2015-012	1	TRBM/ADCP Deployment (M18, M19, & M21)
Spring	06/04/2015	OC-2015-026	1	TRBM/ADCP Recovery/Redeployment (M18)
	06/18/2015	OC-2015-027	1	TRBM/ADCP Recovery/Redeployment (M21)

<u>Nearshore Zone</u>

Regional nearshore (surfzone) FIB samples were collected 1–2 days per week at a total of 38 stations (Figure 2-1, Table A-1). When creek/storm drain stations flowed to the ocean, 3 bacteriological samples were collected at the source, 25 yards downcoast, and 25 yards upcoast. When flow was absent, a single sample was collected 25 yards downcoast.

Samples were collected in ankle-deep water, with the mouth of the sterile bottle facing an incoming wave but away from both the sampler and ocean bottom. After the sample was taken, the bottle was tightly capped and promptly stored on ice in the dark. The occurrence and size of any grease particles at the high tide line were also recorded. Laboratory analysis of FIB samples began within 6 hours of collection.

Laboratory Methods

Laboratory analyses of NH3-N and bacteriology samples followed methods listed in Table A-3. Quality assurance/quality control (QA/QC) procedures included analysis of laboratory blanks and duplicates. All data underwent at least 3 separate reviews prior to being included in the final database used for statistical analysis, comparison to standards, and data summaries.

Data Analyses

Raw CTD data were processed using both SEASOFT (2014b) and third party (IGODS 2012) software. The steps included retaining downcast data and removing potential outliers, i.e. data that exceeded specific criteria limits. Flagged data were removed if they were considered to be due to instrument failures, electrical noise (e.g., large data spikes), or physical interruptions of sensors (e.g., by bubbles) rather than by actual oceanographic events. After

Table A–3. Water quality sample collection and analysis methods by parameter during 2014-15.

Parameter	Sampling Method	Method Reference	Preservation	Container	Holding Time	Sampling Interval	Field Replicates
Nearshore (Surfzone)							
Total Coliforms Fecal Coliforms Enterococci	grab	Standard Methods 9222 B ** Standard Methods 9222 D ** EPA Method 1600 ***	Ice (<6°C)	125 mL HDPE (Sterile container)	8 hrs. (field + lab)	Ankle deep water	at least 10% of samples
Offshore							
Temperature [1]	*in-situ* probe	SOP 1500.1 - CTD Operations	not applicable	not applicable	not applicable	every 1 m *	at least 10% of stations
Salinity (conductivity) [2]	*in-situ* probe	SOP 1500.1 - CTD Operations	not applicable	not applicable	not applicable	every 1 m *	at least 10% of stations
pH [3]	*in-situ* probe	SOP 1500.1 - CTD Operations	not applicable	not applicable	not applicable	every 1 m *	at least 10% of stations
Dissolved Oxygen [4]	*in-situ* probe	SOP 1500.1 - CTD Operations	not applicable	not applicable	not applicable	every 1 m *	at least 10% of stations
Transmissivity [5]	*in-situ* probe	SOP 1500.1 - CTD Operations	not applicable	not applicable	not applicable	every 1 m *	at least 10% of stations
Photosynthetically Active Radiation (PAR) [6]	*in-situ* probe	SOP 1500.1 - CTD Operations	not applicable	not applicable	not applicable	every 1 m *	at least 10% of stations
Chlorophyll-*a* fluorescence [6]	*in-situ* probe	SOP 1500.1 - CTD Operations	not applicable	not applicable	not applicable	every 1 m *	at least 10% of stations
Color Dissolved Organic Matter (CDOM) [6]	*in-situ* probe	SOP 1500.1 - CTD Operations	not applicable	not applicable	not applicable	every 1 m *	at least 10% of stations
Ammonium (NH3-N)	Niskin	SOP 4500-NH_3.G, Rev. J **	Ice (<6°C)	125 mL HDPE	28 days	Surface, 10m, 20m, 30m, 40m, 50m, 60m, Bottom	at least 10% of samples
Total Coliforms and *Escherichia coli* [7]	Niskin	Standard Methods 9223 C **	Ice (<6°C)	125 mL HDPE (Sterile container)	8 hrs. (field + lab)	Surface, 10m, 20m, 30m, 40m, 50m, 60m, Bottom	at least 10% of samples
Enterococci	Niskin	Standard Methods 9230 D	Ice (<6°C)	125 mL HDPE (Sterile container)	8 hrs. (field + lab)	Surface, 10m, 20m, 30m, 40m, 50m, 60m, Bottom	at least 10% of samples
Surface Observations	visual observations	Permit specs.	not applicable	not applicable	not applicable	surface	not applicable

1 Calibrated to reference cells (0.0005°C accuracy) annually.

2 Calibrated to IAPSO Standard and Guildline 8400B Autosal annually.

3 Referenced and calibrated to NIST buffers of pH 7, 8, and 9 prior to every survey.

4 Referenced and calibrated each survey by comparison with the lab DO probe, which is calibrated daily.

5 Referenced and calibrated to known transmittance in air.

6 Factory calibrated annually.

7 Fecal coliform count calculation: (*Escherichia coli* MPN/100 mL x 1.1)

* Sampled continuously at 24 scans/second but data processed to 1 m intervals.

** APHA (2012).

*** Available online at www.epa.gov.

outlier removal, averaged 1 m depth values were prepared from the downcast data; if there were any missing 1 m depths, then the upcast data were used as a replacement. CTD and discrete data were then combined to create a single data file that contained all sampled stations for each survey day.

Compliance Determinations

Water quality compliance was assessed based on: (1) specific numeric criteria for DO, pH, and FIB; and (2) narrative (non-numeric) criteria for transmissivity, floating particulates, oil and grease, water discoloration, beach grease, and excess nutrients. Station locations were defined as either Zone A (2 innermost, alongshore transects) or Zone B (2 outermost, alongshore transects) as shown in Figure A-1. Compliance evaluations for DO, pH, and transmissivity were based on statistical comparisons to the corresponding Zone A or Zone B reference station located upcurrent of the outfall (OCSD 1999). FIB compliance used corresponding COP bacterial standards at each REC-1 station. The remaining compliance determinations were completed based on presence/absence and level of potential effect at each station.

<u>Dissolved Oxygen, pH, and Transmissivity</u>

For each survey, the depth of the pycnocline layer, if present, was calculated for each station using temperature and salinity data. The pycnocline is defined as the depth layer where stability is greater than 0.05 kg/m^3 (Officer 1976). Data for each station and numeric compliance parameter (transmissivity, DO, and pH) were binned by water column stratum: above, within, or below the pycnocline. When a pycnocline was absent, data were binned into the top, middle, or bottom third of the water column for each station. Mean values for each parameter were calculated by stratum and station. The number of observations usually differed from station to station and survey to survey due to different water and pycnocline depths. The selection of appropriate reference stations (i.e., upcoast or downcoast) for each survey day were determined based on available current measurements and the presence or absence of typical plume "signals" (e.g., elevated NH3-N, FIB, and CDOM). If the choice of a reference station is indeterminate, then the data is analyzed twice using both upcoast and downcoast reference stations. Once reference stations were determined, the data were analyzed using in-house MATLAB (2007) routines to calculate out-of-range occurrences (OROs) for each sampling date and parameter. These OROs were based on comparing the mean data by stratum and station with the corresponding reference station data to determine whether the following COP criteria were exceeded:

- Dissolved oxygen: cannot be depressed >10% below the mean;
- pH: cannot be greater than ±0.2 pH units of the mean; and
- Natural light (defined as transmissivity): shall not be significantly reduced, where statistically different from the mean is defined as the lower 95% confidence limit.

In accordance with permit specifications, the outfall station (2205) was not included in the comparisons because it is within the zone of initial dilution (ZID).

To determine whether an ORO was out-of-compliance (OOC), distributional maps were created that identified the reference stations for each sampling date and location of each ORO, including which stratum was out of range. Each ORO was then evaluated to determine if it represented a logical OOC event. These evaluations were based on: (A) evaluation of the wastewater plume location relative to depth using a combination of temperature, density, salinity, CDOM, and when available, FIB and NH3-N; (B) evaluation of features in the water column relative to naturally occurring events (i.e., high chlorophyll-*a* due to phytoplankton); and (C) unique characteristics of some stations that may not be comparable with permit-specified reference stations (2104/2105 or 2404/2406) due to differences in water depth and/or variable oceanographic conditions. For example, Zone A stations (2103, 2203, 2303, and 2403) are located at shallower depths than reference Station 2104. Waves and currents can cause greater mixing and resuspension of bottom sediments at shallower stations under certain conditions (e.g., winter storm surges). This can result in naturally decreased water clarity (transmissivity) that is unrelated to the wastewater discharge. An ORO can be in-compliance if, for example, a downcurrent station is different from the reference, but no intermediate (e.g., nearfield) stations exhibited OROs.

Once the total number of OOC events was summed by parameter, the percentage of OROs and OOCs were calculated according to the total number of observations. In a typical year, Zone A has a total of 504 possible comparisons if 14 stations (not including the reference station) and 3 strata over 12 survey dates per year are used. For Zone B, 432 comparisons are possible from 12 stations (not including the reference station), 3 strata, and 12 sampling dates. The total combined number of ORO and OOC events was then determined by summing the Zone A and Zone B results. If not all of the strata are present or additional surveys are conducted, the total number of comparisons in the analysis may be more or less than the total number of comparisons possible (936).

Fecal Indicator Bacteria (FIB)

FIB counts at individual REC-1 stations were averaged per survey and compliance for each FIB was determined using the following COP criteria (SWRCB 2010):

30-day Geometric Mean

- Total coliform density shall not exceed 1,000 per 100 mL.
- Fecal coliform density shall not exceed 200 per 100 mL.
- Enterococci density shall not exceed 35 per 100 mL.

Single Sample Maximum

- Total coliform density shall not exceed 10,000 per 100 mL.
- Fecal coliform density shall not exceed 400 per 100 mL.
- Enterococci density shall not exceed 104 per 100 mL.
- Total coliform density shall not exceed 1,000 per 100 mL when the fecal coliform/total coliform ratio exceeds 0.1.

Additionally, the District's permit includes the following USEPA Primary Recreation Criteria for *Enterococcus* (EPA 1994a).

- 30-day geometric mean: Density less than 35 per 100 mL.
- Single sample: Density less than 104 per 100 mL for designated bathing beaches.
- Single sample: Density less than 158 per 100 mL for moderate use.
- Single sample: Density less than 276 per 100 mL for light use.
- Single sample: Density less than 501 per 100 mL for infrequent use.

For purposes of this report, compliance with the EPA criteria was based on infrequent use.

Determinations of fecal coliform compliance were accomplished by multiplying *E. coli* data by 1.1 to obtain a calculated fecal coliform value.

There are no compliance criteria for FIB at the nearshore stations. Nevertheless, FIB data were given to the Orange County Health Agency (who follows State Department of Health Service AB411 standards) for the Ocean Water Protection Program (http://ocbeachinfo.com/), and are briefly discussed in Chapter 2.

Nutrients and Aesthetics

Compliance for floating particulates, oil and grease, and water discoloration were determined based on presence/absence at the ocean surface for each station. Compliance with the excess nutrient criterion was based on evaluation of NH3-N compared to COP objectives for chronic (4 mg/L) and acute (6 mg/L) toxicity to marine organisms. Compliance was also evaluated by looking at potential spatial relationships between NH3-N distribution and phytoplankton (using chlorophyll-*a* fluorescence).

SEDIMENT GEOCHEMISTRY MONITORING

Field Methods

Sediment samples were collected for geochemistry analyses from 29 semi-annual stations in July 2014 (summer) and in January 2015 (winter) as well as from 39 annual stations in July 2014 (Figure 2-2, Tables A-1, A-2, and A-4). In addition, 3 L of sediment was collected from 9 stations in March 2015 for sediment toxicity testing (Tables A-1 and A-2). Each station was assigned to 1 of 6 station groups: (1) Middle shelf Zone 1 (31–50 m); (2) Middle shelf Zone 2, within-ZID (51–90 m); (3) Middle shelf Zone 2, non-ZID (51–90 m); (4) Middle shelf Zone 3 (91–120 m); (5) Outer shelf (121–200 m); and (6) Upper slope/Canyon (201–500 m). In the Compliance Determinations Chapter, the Middle shelf Zone 2, within- and non-ZID station groups are simply referred to as within-ZID and non-ZID stations, respectively.

A single sample was collected at each station using a paired 0.1 m^2 Van Veen grab sampler deployed from the M/V *Nerissa*. All sediment samples were qualitatively and quantitatively assessed for acceptability prior to processing. Samples were deemed as acceptable if they had a minimum depth of 5 cm. However, if 3 consecutive sediment grabs each yielded a depth of <5 cm at a station, then the depth threshold was lowered to ≤4 cm. The top 2 cm of the sample was transferred into containers and resealable plastic bags using a stainless steel scoop. The sampler and scoop were rinsed thoroughly with filtered seawater prior to sample collection. All sediment samples were transported on wet ice to the laboratory. Sample storage and holding times followed specifications in the District's Environmental Laboratory and Ocean Monitoring Standard Operating Procedures (ELOM SOP) (OCSD 2015; Table A-5). Sediment grain size, total organic carbon (TOC), total nitrogen, and total phosphorus samples were subsequently transferred to local and interstate laboratories for analysis (see Appendix C). All sample transfers were conducted and documented using required chain of custody protocols through the Laboratory Information Management Systems (LIMS) software.

Table A–4. Sediment geochemistry and infaunal sampling summary for 2014-15.

Stations	Sampling Frequency	Parameters
0, 1, 3, 4, 5, 9 12, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 84, 85, 86, 87, C,CON, ZB	Semi-annual (summer and winter)	Infauna Metals Mercury Grain Size Total DDT Total Nitrogen Total Phosphorus Sediment Toxicity [1] Dissolved Sulfides Total Organic Carbon Total Linear Alkylbenzenes [2] Total Chlorinated Pesticides Total Polychlorinated Biphenyls Total Polycyclic Aromatic Hydrocarbons
7, 8, 10, 13, 17, 18, 20, 21, 22, 23, 24, 25, 27, 29, 30, 33, 36, 37, 38, 39, 40, 41, 42, 44, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 83, C2, C4, C5	Annual (summer only)	Infauna Metals Mercury Grain Size Total DDT Total Nitrogen Total Phosphorus Dissolved Sulfides Total Organic Carbon Total Linear Alkylbenzenes Total Chlorinated Pesticides Total Polychlorinated Biphenyls Total Polycyclic Aromatic Hydrocarbons

[1] Conducted on selected winter samples only.

[2] Analyzed in summer samples only.

Laboratory Methods

Sediment chemistry and grain size samples were processed and analyzed using the methods listed in Table A-5. The measured sediment chemistry parameters are listed in Table A-6. Method blanks, analytical quality control samples (duplicates, matrix spikes, and blank spikes), and standard reference materials were prepared and analyzed with each sample batch. Total linear alkylbenzenes (total LAB), total polychlorinated biphenyls (total PCB), and total polycyclic aromatic hydrocarbons (total PAH) were calculated by summing the measured value of each respective constituent listed in Table A-6. Total dichlorodipheynltrichloroethane (total DDT) represents the summed values of 4,4'-DDMU and the 2,4- and 4,4'-isomers of DDD, DDE, and DDT, and total chlorinated pesticides (total Pest) represents the summed values of 13 chlordane derivative compounds plus dieldrin.

Sediment toxicity, following EPA-recommended methods (EPA 1994b), was conducted using the 10-day *Eohaustorius estuarius* amphipod survival test. Amphipods were exposed to test and home (control) sediments, and the percent survival in each was determined.

Table A–5. Sediment collection and analysis summary during 2014-15.

Parameter	Container	Preservation	Holding Time	Method
Dissolved Sulfides	HDPE container	Freeze	6 months	ELOM SOP 4500-S G Rev. B
Grain Size	Plastic bag	4° C	6 months	Plumb (1981)
Mercury	Amber glass jar	Freeze	6 months	ELOM SOP 245.1B Rev. F
Metals	Amber glass jar	Freeze	6 months	ELOM SOP 200.8B_SED Rev E
Sediment Toxicity	HDPE container	4° C	2 months	ELOM SOP 8810
Total Chlorinated Pesticides	Glass jar	Freeze	6 months	ELOM SOP 8000-SPP
Total DDT	Glass jar	Freeze	6 months	ELOM SOP 8000-SPP
Total Linear Alkylbenzenes	Glass jar	Freeze	12 months	ELOM SOP 8000-LAB
Total Nitrogen	Glass jar	Freeze	6 months	EPA 351.2M and 353.2M *
Total Organic Carbon	Glass jar	Freeze	6 months	EPA 9060 *
Total Phosphorus	Glass jar	Freeze	6 months	EPA 6010B *
Total Polychlorinated Biphenyls	Glass jar	Freeze	6 months	ELOM SOP 8000-SPP
Total Polycyclic Aromatic Hydrocarbons	Glass jar	Freeze	6 months	ELOM SOP 8000-SPP

* Available online at www.epa.gov.

Data Analyses

All analytes that were undetected (i.e., value below the method detection limit) are reported as ND (not detected) in Tables 2-3 to 2-6. Further, an ND value was treated as zero for calculating a mean analyte concentration; however, if a station group contained all NDs for a particular analyte, then the mean analyte concentration is reported as ND. Sediment contaminant concentrations were evaluated against sediment quality guidelines known as Effects Range-Median (ERM) (Long *et al*. 1998). The ERM guidelines were developed for the National Oceanic and Atmospheric Administration (NOAA) National Status and Trends Program (NOAA 1993) as non-regulatory benchmarks to aid in the interpretation of sediment chemistry data and to complement toxicity, bioaccumulation, and benthic community assessments (Long and MacDonald 1998). The ERM is the 50th percentile sediment concentration above which a toxic effect frequently occurs (Long *et al*. 1995), and as such an ERM exceedance is considered a significant potential for adverse biological effects. Data analysis consisted of summary statistics and qualitative comparisons only.

Toxicity threshold criteria applied in this report were consistent with those of the Water Quality Control Plan for Enclosed Bays and Estuaries – Part 1 Sediment Quality (Bay *et al*. 2009, SWRCB 2009). Stations with statistically different ($p<0.05$) survival rates when compared to the control, determined by a two sample t-test, were categorized as nontoxic when survival was 90–100% of the control, lowly toxic when survival was 82–89% of the control, and moderately toxic when survival was 59-81% of the control. Stations with not statistically different ($p>0.05$) survival rates when compared to the control were categorized as nontoxic when survival was 82–100% of the control and lowly toxic when survival was 59–81% of the control. Any station exhibiting survival less than 59% of the control was categorized as highly toxic.

Table A–6. Parameters measured in sediment samples during 2014-15.

	Metals		
Antimony	Cadmium	Lead	Selenium
Arsenic	Chromium	Mercury	Silver
Barium	Copper	Nickel	Zinc
Beryllium			
	Chlorinated Pesticides		
	Chlordane Derivatives and Dieldrin		
Aldrin	Endosulfan-alpha	*gamma*-BHC	Hexachlorobenzene
cis-Chlordane	Endosulfan-beta	Heptachlor	Mirex
trans-Chlordane	Endosulfan-sulfate	Heptachlor epoxide	*trans*-Nonachlor
Dieldrin	Endrin		
	DDT Derivatives		
2,4’-DDD (o,p’-DDD)	2,4’-DDE (o,p’-DDE)	2,4’-DDT (o,p’-DDT)	4,4’-DDMU
4,4’-DDD (p,p’-DDD)	4,4’-DDE (p,p’-DDE)	4,4’-DDT (p,p’-DDT)	
	Polychlorinated Biphenyl (PCB) Congeners		
PCB 18	PCB 81	PCB 126	PCB 170
PCB 28	PCB 87	PCB 128	PCB 177
PCB 37	PCB 99	PCB 138	PCB 180
PCB 44	PCB 101	PCB 149	PCB 183
PCB 49	PCB 105	PCB 151	PCB 187
PCB 52	PCB 110	PCB 153/168	PCB 189
PCB 66	PCB 114	PCB 156	PCB 194
PCB 70	PCB 118	PCB 157	PCB 201
PCB 74	PCB 119	PCB 167	PCB 206
PCB 77	PCB 123	PCB 169	
	Polycyclic Aromatic Hydrocarbon (PAH) Compounds		
Acenaphthene	Benzo[g,h,i]perylene	Fluorene	2-Methylnaphthalene
Acenaphthylene	Benzo[k]fluoranthene	Indeno[1,2,3-c,d]pyrene	2,6-Dimethylnaphthalene
Anthracene	Biphenyl	Naphthalene	1,6,7-Trimethylnaphthalene
Benz[a]anthracene	Chrysene	Perylene	2,3,6-Trimethylnaphthalene
Benzo[a]pyrene	Dibenz[a,h]anthracene	Phenanthrene	1-Methylphenanthrene
Benzo[b]fluoranthene	Dibenzothiophene	Pyrene	
Benzo[e]pyrene	Fluoranthene	1-Methylnaphthalene	
	Linear Alkylbenzenes [1]		
2-Phenyldecane	5-Phenyldodecane	7-Phenyltetradecane	3-Phenylundecane
3-Phenyldecane	6-Phenyldodecane	2-Phenyltridecane	4-Phenylundecane
4-Phenyldecane	2-Phenyltetradecane	3-Phenyltridecane	5-Phenylundecane
5-Phenyldecane	3-Phenyltetradecane	4-Phenyltridecane	6-Phenylundecane
2-Phenyldodecane	4-Phenyltetradecane	5-Phenyltridecane	
3-Phenyldodecane	5-Phenyltetradecane	7+6-Phenyltridecane	
4-Phenyldodecane	6-Phenyltetradecane	2-Phenylundecane	
	Other Parameters		
Dissolved Sulfides	Total Nitrogen	Total Organic Carbon	Total Phosphorus
Grain Size			

[1] Analyzed in summer samples only.

BENTHIC INFAUNA MONITORING

Field Methods

The infaunal community was monitored by collecting 1 sediment sample, concurrently with sediment geochemistry samples, from 29 semi-annual stations in July 2014 (summer) and in January 2015 (winter) as well as from 39 annual stations in July 2014 (Figure 2-2, Tables A-1, A-2, and A-4). The purpose of the semi-annual surveys was to determine long-term trends and potential effects along the 60 m depth contour, while the annual survey was conducted primarily to assess the spatial extent of the influence of the effluent discharge. Each station was assigned to 1 of 6 depth categories as described above in the sediment geochemistry field methods section. The Middle shelf Zone 2, within- and non-ZID stations are simply referred to as within-ZID and non-ZID stations, respectively, in Chapter 2.

All infauna sediment samples were qualitatively and quantitatively assessed for acceptability prior to processing as described above in the sediment geochemistry field methods section. Each acceptable sample was gently washed with filtered seawater through a 1.0 mm sieve. Retained organisms were rinsed into 1 L plastic containers and anesthetized with 7% magnesium sulfate for approximately 30 minutes. To fix the animals, full strength buffered formaldehyde was then added to achieve a 10%, by volume, solution and returned to the laboratory.

Laboratory Methods

After 3–10 days in formalin, samples were rinsed with water and transferred to 70% ethanol for long-term preservation. Samples were sent to Marine Taxonomic Services, Inc. (San Marcos, CA) to be sorted to 5 major taxonomic groups, Polychaeta, (worms), Mollusca (snails, clams, etc.), Arthropoda (shrimps, crabs, etc.), Echinodermata (sea stars, sea urchins, etc.), and miscellaneous phyla (Cnidaria, Nemertea, etc.). Removal of organisms from the sediment samples was monitored to ensure that at least 95% of all organisms were successfully separated from the sediment matrix (see Appendix C). Upon completion of sample sorting, the major taxonomic groups were distributed for identification and enumeration (Table A-7). Taxonomic differences were resolved and the database was edited accordingly (see Appendix C). Species names used in this report follow those given in Cadien and Lovell (2014).

Table A–7. Benthic infauna sample distribution for 2014-15.

Quarter	Survey	Taxonomic Groups									
		Annelida		Arthropoda		Mollusca		Echinodermata		Misc. Phyla	
		OCSD	Contractor	OCSD	Contractor	OCSD	Contractor	OCSD	Contractor	OCSD	Contractor
Summer 2014	Semi-annual	24	5	29	0	0	29	15	14	15	14
Summer 2014	Annual	33	6	39	0	0	39	20	19	20	19
Winter 2015	Semi-annual	25	4	29	0	0	29	0	29	0	29

Data Analyses

Infaunal community data were analyzed to determine if populations outside the ZID were affected by the outfall discharge. Six community measures were used to assess infaunal community health and function: (1) total number of species (richness), (2) total number of individuals (abundance), (3) Shannon-Wiener Diversity (H′), (4) Swartz's 75% Dominance Index (SDI), (5) Infaunal Trophic Index (ITI), and (6) Benthic Response Index (BRI). H′ was calculated using $\log_e$ (Zar 1999). SDI was calculated as the minimum number of species with combined abundance equal to 75% of the individuals in the sample (Swartz 1978). SDI is inversely proportional to numerical dominance, thus a low index value indicates high dominance (i.e., a community dominated by a few species). The ITI was developed by Word (1978, 1990) to provide a measure of infaunal community "health" based on a species' mode of feeding (e.g., primarily suspension vs. deposit feeder). ITI values greater than 60 are considered indicative of a "normal" community, while 30–60 represent a "changed" community, and values less than 30 indicate a "degraded" community. The BRI measures the pollution tolerance of species on an abundance-weighted average basis (Smith *et al*. 2001). This measure is scaled inversely to ITI with low values (<25) representing reference conditions and high values (>72) representing defaunation or the exclusion of most species. The intermediate value range of 25–34 indicates a marginal deviation from reference conditions, 35–44 indicates a loss of biodiversity, and 45–72 indicates a loss of community function. The ITI and BRI were not calculated for stations >200 m in depth following recommendations provided by Word (1978) and Ranasinghe *et al*. (2012), respectively. The BRI was used to determine compliance with NPDES permit conditions, as it is a commonly used southern California benchmark for infaunal community structure and was developed with the input of regulators (Ranasinghe *et al*. 2007, 2012).

The presence or absence of certain indicator species (pollution sensitive and pollution tolerant) was also determined for each station. The presence of pollution sensitive species, i.e., *Amphiodia urtica* (brittlestar) and amphipod crustaceans in the genera *Ampelisca* and *Rhepoxynius*, typically indicates the existence of a healthy environment, while the occurrence of large numbers of pollution tolerant species, i.e., *Capitella capitata* Cmplx (polychaete), may indicate stressed or organically enriched environments. Patterns of these species were used to assess the spatial and temporal influence of the wastewater discharge in the receiving environment.

PRIMER v6 (2001) multivariate statistical software was used to examine the spatial patterns of infaunal invertebrate communities at the Middle shelf Zone 2 stations. The other stations were excluded from the analyses, as Clarke and Warwick (2001) advocated that clustering is less useful and may be misleading where there is a strong environmental forcing, such as depth. Analyses included (1) ordination clustering of the data using non-metric multidimensional scaling (nMDS), (2) hierarchical clustering with group-average linking based on Bray-Curtis similarity indices, and (3) similarity profile (SIMPROF) permutation tests of the clusters. Prior to the calculation of the Bray-Curtis indices, the data were 4th-root transformed in order to down-weight the highly abundant species and to incorporate the less common species (Clarke and Warwick 2001).

TRAWL COMMUNITIES MONITORING

Field Methods

Demersal fishes and epibenthic macroinvertebrates (EMIs) were collected in the summer (July) of 2014 and the winter (January) of 2015. Sampling was conducted at 15 stations: Inner shelf (18 m) Station T0; Middle shelf Zone 1 (36 m) Stations T2, T24, T6, and T18; Middle shelf Zone 2 (60 m) Stations T23, T22, T1, T12, T17, and T11; and Outer shelf (137 m) Stations T10, T25, T14, and T19 (Figure 2-3, Tables A-1 and A-2). Only Middle shelf, Zone 2 stations were sampled in both summer and winter; the remaining stations were sampled in summer only. Station T0 was sampled to maintain the long-term abundance records of fishes and EMIs at this site. Data for this historical station are not discussed in this report, however.

One trawl was conducted from the M/V *Nerissa* at each station using a 7.6 m (25 ft) wide, Marinovich, semi-balloon otter trawl (2.54 cm mesh) with a 0.64 cm mesh cod-end liner, an 8.9 m chain-rigged foot rope, and 23 m long trawl bridles following regionally adopted methodology (Mearns and Allen 1978). The trawl wire scope varied from a ratio of approximately 5:1 at the shallowest stations to approximately 3:1 at the deepest station. To minimize catch variability due to weather and current conditions, which may affect the bottom-time duration of the trawl, trawls generally were taken along a constant depth at each station, and usually in the same direction.

Established trawl QA/QC methods for southern California were used (see Appendix C). Station locations and trawling speeds and paths were determined using Global Positioning System (GPS) navigation. Trawl depths were determined using an attached Sea-Bird Electronics SBE 39 pressure sensor on 1 of the trawl boards.

Upon retrieval of the trawl net, the contents (fishes and EMIs) were emptied into a large flow-through water tank and then sorted by species into separate containers. Fish bioaccumulation specimens were counted, recorded, and removed for processing (see below). The remaining fish specimens were processed as follows: (1) a minimum of 15 randomly selected specimens of each species were weighed to the nearest gram and measured individually to the nearest millimeter (standard length); and (2) if a haul sample contained substantially more than 15 individuals of a species, then the excess specimens were enumerated in 1 cm size classes and a bulk weight was recorded. All fish specimens were examined for abnormalities such as external tumors, lesions, parasites, and skeletal deformities. EMIs were sorted to species, counted, and batch weighed. In the event of a large haul of a single invertebrate species (n>100), 100 individuals were counted and batch weighed; the remaining animals were batch weighed and enumerated later by back calculating using the weight of the first 100. Fish and EMI specimens that required further taxonomic scrutiny were retained for final identification at a later date.

Laboratory Methods

Specimens for the voucher collection and any animals that could not be identified in the field were preserved in 10% buffered formalin for subsequent laboratory analysis. A representative voucher collection of fishes and EMIs is maintained in the District's Taxonomy Lab for reference and verification. Species and common names used in this report follow those given in Page *et al*. (2013) and Cadien and Lovell (2014).

Data Analyses

Number of species, abundance, biomass, H′, and SDI were calculated for both fishes and EMIs at each station. *Pleuroncodes planipes* (pelagic red crab) was collected in the winter survey; however, this species was not included in the calculations as it was mistakenly neither recorded on all field sheets nor enumerated upon collection. Fish biointegrity in the District's monitoring area was assessed using the fish response index (FRI). The FRI is a multivariate weighted-average index produced from an ordination analysis of calibrated species abundance data (Allen *et al*. 2001, 2006). FRI scores less than 45 are classified as reference (normal) and those greater than 45 are non-reference (abnormal or disturbed).

PRIMER (2001) multivariate statistical software was used to examine the spatial patterns of the fish and EMI assemblages at the Middle shelf Zone 2 stations. The other stations were excluded from the analyses, as Clarke and Warwick (2001) advised that clustering is less useful and may be misleading where there is a strong environmental forcing, such as depth. Analyses included (1) ordination clustering of the data using nMDS, (2) hierarchical clustering with group-average linking based on Bray-Curtis similarity indices, and (3) SIMPROF permutation tests of the clusters. Prior to the calculation of the Bray-Curtis indices, the data were fourth-root transformed in order to down-weight the highly abundant species and incorporate the importance of the less common species (Clarke and Warwick 2001).

Middle shelf Zone 2 stations were grouped into the following categories to assess spatial, outfall-related patterns: "outfall" (Stations T22 and T1) and "non-outfall" (Stations T23, T12, T17, and T11).

FISH TISSUE CONTAMINANTS MONITORING

Two demersal fish species, English Sole (*Parophrys vetulus*) and Hornyhead Turbot (*Pleuronichthys verticalis*), were targeted for analysis of muscle and liver tissue chemistry. Muscle tissue was analyzed because contaminants may bioaccumulate in this tissue and can be transferred to higher trophic levels. Liver tissue was analyzed because it typically has higher lipid content than muscle tissue and thus bioaccumulates relatively higher concentrations of lipid-soluble contaminants that have been linked to pathological conditions as well as immunological or reproductive impairment (Arkoosh *et al*. 1998).

Demersal fishes in the families Scorpaenidae (e.g., Vermilion Rockfish and California Scorpionfish) and Serranidae (e.g., Kelp Bass and Sand Bass) were targeted, as they are frequently caught and consumed by recreational anglers. As such, contaminants in the muscle tissue of these fishes were analyzed to gauge human health risk.

Field Methods

The sampling objective for bioaccumulation analysis was to collect 10 individuals each of English Sole and Hornyhead Turbot at outfall (T1) and non-outfall (T11) stations during the

January 2015 trawl survey. Likewise, 10 individuals in total of scorpaenid and serranid fishes were targeted at each outfall (Zone 1) and non-outfall (Zone 3) areas using hook-and-line fishing gear ("rig fishing") in January 2015 (Figure 2-3, Tables A-1 and A-2). Zone 3 rather than Zone 2 was fished this monitoring year, as the fishing quota was not met at Zone 2 in the previous 2 survey periods.

Each fish was weighed to the nearest gram and its standard length measured to the nearest millimeter; placed in pre-labelled, plastic, re-sealable bags; and stored on wet ice in insulated coolers. All samples were subsequently transported under chain of custody protocols to the District's laboratory. Sample storage and holding times (Table A-8) followed specifications in the District's ELOM SOP (OCSD 2015).

Table A–8. Fish tissue handling and analysis summary during 2014-15.

Parameter	Container	Preservation	Holding Time	Method
Arsenic and Selenium	Ziplock bag	Freeze	6 months	NS&T (NOAA 1993); EPA 200.8 *
Chlorinated Pesticides	Ziplock bag	Freeze	6 months	NS&T (NOAA 1993); EPA 8270 *
DDTs	Ziplock bag	Freeze	6 months	NS&T (NOAA 1993); EPA 8270 *
Lipids	Ziplock bag	Freeze	N/A	EPA 9071 *
Mercury	Ziplock bag	Freeze	6 months	EPA 245.6 *
Polychlorinated Biphenyls	Ziplock bag	Freeze	6 months	NS&T (NOAA 1993); EPA 8270 *

N/A = Not Applicable.
* Available online at www.epa.gov.

Laboratory Methods

Individual fish were dissected in the laboratory under clean conditions. Muscle and liver tissues were analyzed for various parameters listed in Table A-9 using methods shown in Table A-8. Method blanks, analytical quality control samples (duplicates, matrix spikes, and blank spikes), and standard reference materials were prepared and analyzed with each sample batch. All reported concentrations are on a wet weight basis.

Total dichlorodipheynltrichloroethane (tDDT) represents the summed values of 2,4- and 4,4'-isomers of DDD, DDE, and DDT and 4,4'-DDMU, total polychlorinated biphenyls (tPCB) represents the summed values of 44 congeners, and total chlordane represents the sum of 7 derivative compounds (*cis*- and *trans*-chlordane, *cis*- and *trans*-nonachlor, heptachlor, heptachlor epoxide, and oxychlordane). Organic contaminant data were not lipid normalized.

Data Analyses

All analytes that were undetected (i.e., value below the method detection limit) are reported as ND (not detected) in Tables 2-12 and 2-13. Further, an ND value was treated as zero for calculating a mean analyte concentration; however, if fish tissue samples had all NDs for a particular analyte, then the mean analyte concentration is reported as ND. Data analysis consisted of summary statistics (i.e., means and ranges) and qualitative comparisons only.

The U.S. Food and Drug Administration (FDA) action levels for tDDT, tPCBs, methylmercury, dieldrin and total chlordane (FDA 2011), as well as the State of California Office of

Table A–9. Parameters measured in fish tissue samples during 2014-15.

Metals		
Arsenic [1]	Mercury	Selenium [1]
Chlorinated Pesticides		
Chlordane Derivatives and Dieldrin		
cis-Chlordane	Dieldrin	*cis*-Nonachlor
trans-Chlordane	Heptachlor	*trans*-Nonachlor
Oxychlordane	Heptachlor epoxide	
DDT Derivatives		
2,4'-DDD (o,p'-DDD)	4,4'-DDE (p,p'-DDE)	4,4'-DDMU
4,4'-DDD (p,p'-DDD)	2,4'-DDT (o,p'-DDT)	
2,4'-DDE (o,p'-DDE)	4,4'-DDT (p,p'-DDT)	
Polychlorinated Biphenyl (PCB) Congeners		
PCB 18	PCB 101	PCB 156
PCB 28	PCB 105	PCB 157
PCB 37	PCB 110	PCB 167
PCB 44	PCB 114	PCB 169
PCB 49	PCB 118	PCB 170
PCB 52	PCB 119	PCB 177
PCB 66	PCB 123	PCB 180
PCB 70	PCB 126	PCB 183
PCB 74	PCB 128	PCB 187
PCB 77	PCB 138	PCB 189
PCB 81	PCB 149	PCB 194
PCB 87	PCB 151	PCB 201
PCB 99	PCB 153/168	PCB 206
Other Parameter		
Lipids		

[1] Analyzed only in rig-fish specimens.

Environmental Health Hazard Assessment (OEHHA) advisory tissue levels (ATLs) for selected fish contaminants (Klasing and Brodberg 2008), were used to assess human health risk.

FISH HEALTH MONITORING

Field Methods

Assessment of the overall health of the fish population is also required by the NPDES permit. Consequently, all fish samples were visually inspected for large non-mobile external parasites, lesions, tumors, and other signs of disease (e.g., skeletal deformities). In addition, any atypical odor and coloration of fish samples were noted.

Data Analyses

Data analysis consisted of summary statistics and qualitative comparisons only.

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SUPPORTING DATA

Appendix B

Table B–1. Depth-averaged total coliform bacteria counts (MPN/100 mL) collected in offshore waters and used for comparison with California Ocean Plan Water-Contact (REC-1) compliance criteria, July 2014 through June 2015.

Station	Date					Meets 30-day Geometric Mean of ≤1000/100 mL	Meets Single Sample Standard of ≤10,000/100 mL	Meets Single Sample Standard of ≤1000/100 mL *
	8/6/2014	**8/12/2014**	**8/13/2014**	**8/14/2014**	**9/3/2014**			
2103	<10	<10	<10	<10	10	YES	YES	YES
2104	<10	10	<10	<10	<10	YES	YES	YES
2183	<10	<10	<10	<10	11	YES	YES	YES
2203	<10	<10	<10	<10	<10	YES	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES	YES
	10/21/2014	**10/22/2014**	**11/5/2014**	**11/12/2014**	**11/13/2014**			
2103	39	29	40	<10	17	YES	YES	YES
2104	24	20	32	20	<10	YES	YES	YES
2183	21	16	222	14	11	YES	YES	YES
2203	<10	12	117	<10	12	YES	YES	YES
2223	<10	<10	606	12	<10	YES	YES	YES
2303	<10	<10	475	10	<10	YES	YES	YES
2351	<10	<10	168	<10	<10	YES	YES	YES
2403	<10	<10	88	10	10	YES	YES	YES
	1/20/2015	**2/3/2015**	**2/5/2015**	**2/9/2015**	**2/10/2015**			
2103	10	<10	<10	<10	10	YES	YES	YES
2104	21	<10	<10	36	46	YES	YES	YES
2183	10	<10	<10	<10	19	YES	YES	YES
2203	<10	<10	<10	11	<10	YES	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES	YES
	4/22/2015	**4/23/2015**	**5/5/2015**	**5/18/2015**	**5/19/2015**			
2103	<10	<10	<10	10	11	YES	YES	YES
2104	<10	<10	16	<10	<10	YES	YES	YES
2183	<10	<10	11	11	14	YES	YES	YES
2203	<10	<10	<10	<10	<10	YES	YES	YES
2223	10	<10	<10	<10	<10	YES	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES	YES

* Standard is based on when the single sample maximum fecal coliform/total coliform ratio >0.1.

Table B–2. Depth-averaged fecal coliform bacteria counts (MPN/100 mL) collected in offshore waters and used for comparison with California Ocean Plan Water-Contact (REC-1) compliance criteria, July 2014 through June 2015.

Station	Date					Meets 30-day Geometric Mean ≤200/100 mL	Meets single sample standard of ≤400/100 mL
	8/6/2014	**8/12/2014**	**8/13/2014**	**8/14/2014**	**9/3/2014**		
2103	<10	<10	<10	<10	<10	YES	YES
2104	<10	10	<10	<10	<10	YES	YES
2183	<10	<10	<10	<10	<10	YES	YES
2203	<10	<10	<10	<10	<10	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES
	10/21/2014	**10/22/2014**	**11/5/2014**	**11/12/2014**	**11/13/2014**		
2103	12	<10	10	<10	<10	YES	YES
2104	<10	16	<10	<10	<10	YES	YES
2183	10	<10	<10	<10	<10	YES	YES
2203	<10	<10	11	<10	<10	YES	YES
2223	<10	<10	15	<10	<10	YES	YES
2303	<10	<10	12	<10	<10	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES
	1/20/2015	**2/3/2015**	**2/5/2015**	**2/9/2015**	**2/10/2015**		
2103	<10	<10	<10	<10	<10	YES	YES
2104	<10	<10	<10	12	24	YES	YES
2183	<10	<10	<10	<10	<10	YES	YES
2203	<10	<10	<10	<10	<10	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES
	4/22/2015	**4/23/2015**	**5/5/2015**	**5/18/2015**	**5/19/2015**		
2103	<10	<10	<10	<10	<10	YES	YES
2104	<10	<10	11	<10	<10	YES	YES
2183	<10	<10	<10	<10	11	YES	YES
2203	<10	<10	<10	<10	<10	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES

Table B–3. Depth-averaged enterococci bacteria counts (MPN/100 mL) collected in offshore waters and used for comparison with California Ocean Plan Water-Contact (REC-1) compliance criteria and EPA Primary Recreation Criteria in Federal Waters, July 2014 through June 2015.

Station	Date					Meets COP 30-day Geometric Mean of ≤35/100 mL	Meets COP single sample standard of ≤104/100 mL	Meets EPA single sample standard of ≤501/100 mL*
	8/6/2014	**8/12/2014**	**8/13/2014**	**8/14/2014**	**9/3/2014**			
2103	<10	<10	<10	<10	<10	YES	YES	YES
2104	<10	<10	<10	<10	<10	YES	YES	YES
2183	<10	<10	<10	<10	<10	YES	YES	YES
2203	<10	<10	<10	<10	<10	YES	YES	YES
2223	10	<10	<10	<10	<10	YES	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES	YES
2351	<10	<10	<10	11	<10	YES	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES	YES
	10/21/2014	**10/22/2014**	**11/5/2014**	**11/12/2014**	**11/13/2014**			
2103	<10	<10	<10	<10	<10	YES	YES	YES
2104	<10	<10	<10	<10	<10	YES	YES	YES
2183	<10	<10	<10	<10	<10	YES	YES	YES
2203	<10	<10	<10	<10	<10	YES	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES	YES
	1/20/2015	**2/3/2015**	**2/5/2015**	**2/9/2015**	**2/10/2015**			
2103	10	<10	<10	<10	<10	YES	YES	YES
2104	<10	<10	<10	<10	11	YES	YES	YES
2183	<10	<10	<10	<10	<10	YES	YES	YES
2203	<10	<10	<10	<10	<10	YES	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES	YES
	4/22/2015	**4/23/2015**	**5/5/2015**	**5/18/2015**	**5/19/2015**			
2103	<10	<10	<10	<10	<10	YES	YES	YES
2104	<10	<10	<10	<10	<10	YES	YES	YES
2183	<10	<10	<10	<10	<10	YES	YES	YES
2203	<10	<10	<10	<10	<10	YES	YES	YES
2223	10	<10	<10	<10	<10	YES	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES	YES

* Standard is based on area of infrequent use.

Table B–4. Summary of floatable material by station group observed during the 28-station grid water quality surveys, July 2014 through June 2015.

Surface Observation	Station Group							Totals
	Upcoast Offshore	Upcoast Nearshore	Nearfield Offshore	Within ZID	Nearfield Nearshore	Downcoast Offshore	Downcoast Nearshore	
	2225, 2226 2305, 2306 2353, 2354 2405, 2406	2223, 2224 2303, 2304 2351, 2352 2403, 2404	2206	2205	2203, 2204	2105, 2106 2185, 2186	2103, 2104 2183, 2184	
Oil and Grease	0	0	0	0	0	0	0	0
Trash/Debris (black tar, ash from brush fires) [1]	1	2	0	1	0	0	2	6
Biological Material (kelp)	3	3	1	0	0	2	2	11
Totals	4	5	1	1	0	2	4	17

[1] Concluded to be not of sewage origin.

Table B–5. Summary of floatable material by station group observed during the REC-1 water quality surveys, July 2014 through June 2015.

Surface Observation	Station Groups				Totals
	Upcoast Nearshore	Within ZID	Nearfield Nearshore	Downcoast Nearshore	
	2223, 2224, 2303 2304, 2351, 2352 2403, 2404	2205	2203, 2204	2103, 2104 2183, 2184	
Oil and Grease	0	0	0	0	0
Trash/Debris (black tar, ash from brush fires) [1]	2	1	0	2	5
Biological Material (kelp)	3	0	0	2	5
Totals	5	1	0	4	10

[1] Concluded to be not of sewage origin.

Table B–6. Summary statistics of quarterly water quality parameters by depth strata and season during 2014-15.

Depth	Summer 2014				Fall 2014				Winter 2015				Spring 2015				Annual			
(m)	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev
Temperature (°C)																				
1-15	15.51	20.68	23.62	1.85	17.51	19.65	21.59	1.04	15.81	17.01	18.97	0.59	11.51	15.70	19.12	1.99	11.51	18.27	23.62	2.49
16-30	13.29	16.61	21.90	1.81	15.44	18.16	21.16	1.11	12.63	16.02	17.77	0.88	10.56	13.07	18.07	1.69	10.56	15.95	21.90	2.33
31-45	11.80	13.76	16.54	0.95	14.29	15.92	18.89	0.85	11.41	14.62	16.69	1.59	10.24	11.07	13.72	0.72	10.24	13.85	18.89	2.08
46-60	11.34	12.51	14.19	0.72	12.46	14.29	15.61	0.53	10.74	13.26	15.66	1.42	10.00	10.41	11.20	0.16	10.00	12.61	15.66	1.66
61-75	11.00	11.75	13.33	0.51	11.86	13.14	14.20	0.47	10.24	11.99	13.60	0.97	9.78	10.19	10.55	0.13	9.78	11.77	14.20	1.21
All	11.00	16.31	23.62	3.68	11.86	17.17	21.59	2.49	10.24	15.27	18.97	2.00	9.78	12.86	19.12	2.60	9.78	15.40	23.62	3.20
Density (kg/m^3)																				
1-15	22.75	23.47	24.63	0.44	23.23	23.71	24.17	0.23	23.65	24.23	24.50	0.17	23.76	24.52	25.39	0.43	22.75	23.98	25.39	0.54
16-30	23.16	24.39	25.08	0.40	23.38	24.03	24.54	0.23	24.01	24.46	25.10	0.17	24.01	25.07	25.66	0.37	23.16	24.49	25.66	0.48
31-45	24.40	24.96	25.38	0.19	23.87	24.49	24.83	0.16	24.35	24.75	25.41	0.29	24.91	25.53	25.81	0.18	23.87	24.93	25.81	0.44
46-60	24.86	25.23	25.52	0.17	24.52	24.85	25.22	0.12	24.55	25.02	25.65	0.31	25.49	25.73	25.93	0.07	24.52	25.21	25.93	0.38
61-75	25.07	25.42	25.66	0.14	24.90	25.11	25.39	0.09	24.93	25.31	25.86	0.26	25.69	25.85	26.04	0.06	24.90	25.42	26.04	0.31
All	22.75	24.43	25.66	0.80	23.23	24.24	25.39	0.53	23.65	24.61	25.86	0.43	23.76	25.15	26.04	0.59	22.75	24.61	26.04	0.69
Salinity (psu)																				
1-15	33.31	33.55	33.72	0.09	33.35	33.51	33.61	0.06	33.16	33.33	33.42	0.06	33.24	33.33	33.40	0.03	33.16	33.43	33.72	0.12
16-30	33.34	33.43	33.64	0.05	33.27	33.44	33.59	0.06	33.18	33.34	33.43	0.07	33.25	33.33	33.46	0.04	33.18	33.38	33.64	0.08
31-45	33.19	33.36	33.42	0.04	33.15	33.34	33.50	0.06	32.97	33.32	33.43	0.06	33.26	33.41	33.60	0.06	32.97	33.36	33.60	0.07
46-60	33.25	33.37	33.49	0.06	33.17	33.34	33.45	0.06	32.98	33.30	33.49	0.07	33.39	33.52	33.70	0.06	32.98	33.38	33.70	0.11
61-75	33.27	33.44	33.57	0.06	33.23	33.38	33.45	0.05	33.26	33.36	33.65	0.10	33.48	33.63	33.78	0.05	33.23	33.45	33.78	0.13
All	33.19	33.45	33.72	0.10	33.15	33.42	33.61	0.09	32.97	33.33	33.65	0.07	33.24	33.40	33.78	0.11	32.97	33.40	33.78	0.10

Table B-6 continues.

Table B-6 continued.

Depth	Summer 2014				Fall 2014				Winter 2015				Spring 2015				Annual			
(m)	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev
Dissolved Oxygen (mg/L)																				
1-15	5.88	7.39	8.91	0.47	6.82	7.38	8.07	0.17	6.91	7.84	8.93	0.33	5.91	7.84	9.41	0.60	5.88	7.61	9.41	0.48
16-30	6.94	8.29	9.62	0.36	6.97	7.60	8.19	0.28	6.38	7.79	8.50	0.38	5.23	6.75	8.40	0.82	5.23	7.61	9.62	0.75
31-45	5.90	7.69	8.86	0.62	6.96	7.65	8.30	0.31	5.85	7.33	8.78	0.67	4.63	5.53	7.79	0.50	4.63	7.05	8.86	1.04
46-60	5.32	6.66	7.92	0.74	6.41	7.33	8.40	0.35	5.31	7.01	8.44	0.83	4.22	4.98	5.62	0.26	4.22	6.49	8.44	1.08
61-75	4.80	5.81	7.36	0.65	6.04	6.83	7.92	0.37	4.68	6.57	8.05	0.92	4.03	4.59	5.23	0.23	4.03	5.95	8.05	1.06
All	4.80	7.41	9.62	0.93	6.04	7.42	8.40	0.37	4.68	7.49	8.93	0.72	4.03	6.40	9.41	1.34	4.03	7.18	9.62	1.02
pH (log scale)																				
1-15	8.12	8.17	8.22	0.03	8.13	8.20	8.30	0.06	8.01	8.07	8.17	0.03	7.85	8.12	8.24	0.06	7.85	8.14	8.30	0.07
16-30	8.12	8.18	8.24	0.03	8.11	8.19	8.28	0.05	7.88	8.04	8.10	0.04	7.77	8.01	8.16	0.10	7.77	8.11	8.28	0.10
31-45	8.02	8.15	8.23	0.04	8.07	8.17	8.27	0.05	7.77	7.98	8.08	0.10	7.72	7.87	8.10	0.09	7.72	8.04	8.27	0.14
46-60	7.99	8.07	8.19	0.04	8.03	8.12	8.24	0.05	7.72	7.91	8.07	0.11	7.68	7.80	7.92	0.06	7.68	7.98	8.24	0.14
61-75	7.93	8.00	8.09	0.03	7.97	8.07	8.17	0.05	7.65	7.85	7.98	0.11	7.63	7.76	7.86	0.06	7.63	7.92	8.17	0.14
All	7.93	8.14	8.24	0.07	7.97	8.17	8.30	0.07	7.65	8.00	8.17	0.10	7.63	7.96	8.24	0.15	7.63	8.07	8.30	0.14
Chlorophyll-*a* (µg/L)																				
1-15	0.30	1.17	5.53	0.56	0.45	3.02	15.92	2.70	0.39	2.76	22.06	2.60	0.12	3.10	15.35	2.48	0.12	2.51	22.06	2.40
16-30	0.90	2.93	11.87	1.75	0.79	3.59	9.46	1.82	0.57	4.63	13.87	2.52	0.36	1.86	10.11	1.16	0.36	3.25	13.87	2.13
31-45	1.80	5.57	10.60	1.62	1.05	3.13	6.15	0.98	0.96	4.35	11.74	1.66	0.28	1.12	4.76	0.80	0.28	3.55	11.74	2.10
46-60	1.21	3.31	6.49	1.03	0.91	2.40	5.61	0.86	0.75	2.54	8.01	1.31	0.19	0.47	1.10	0.16	0.19	2.18	8.01	1.41
61-75	0.60	1.72	3.98	0.52	0.60	1.21	2.52	0.38	0.41	1.11	2.77	0.39	0.12	0.25	0.45	0.06	0.12	1.08	3.98	0.65
All	0.30	2.76	11.87	1.97	0.45	2.91	15.92	1.99	0.39	3.34	22.06	2.43	0.12	1.75	15.35	1.87	0.12	2.69	22.06	2.16

Table B-6 continues.

Table B-6 continued.

Depth	Summer 2014				Fall 2014				Winter 2015				Spring 2015				Annual			
(m)	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev
Light Transmissivity (%)																				
1-15	73.35	86.56	89.80	2.22	62.40	85.83	88.73	3.05	77.26	85.61	88.76	2.18	61.87	79.06	88.39	6.51	61.87	84.28	89.80	4.93
16-30	69.16	86.03	88.36	2.02	60.42	86.20	88.72	2.66	76.71	85.37	88.67	2.05	60.20	83.47	88.47	4.14	60.20	85.26	88.72	3.05
31-45	78.10	85.26	88.18	1.63	76.68	86.82	88.65	1.49	80.59	85.63	88.68	1.31	61.73	85.07	88.84	3.32	61.73	85.69	88.84	2.20
46-60	78.43	86.72	88.93	1.50	82.34	87.29	89.00	1.22	82.11	86.77	88.79	1.08	75.32	86.37	89.13	2.83	75.32	86.78	89.13	1.83
61-75	82.60	87.65	89.27	1.45	83.88	88.11	89.17	0.94	85.03	88.06	89.06	0.72	74.41	86.88	89.39	2.75	74.41	87.68	89.39	1.74
All	69.16	86.33	89.80	2.02	60.42	86.55	89.17	2.46	76.71	85.97	89.06	1.96	60.20	83.15	89.39	5.51	60.20	85.50	89.80	3.60
Photosynthetically Active Radiation (PAR, %)																				
1-15	5.50	29.79	100.00	17.64	1.90	23.64	100.00	17.26	3.40	24.71	100.00	20.25	0.70	21.13	100.00	15.84	0.70	24.83	100.00	18.10
16-30	1.50	8.95	25.30	4.65	0.30	6.45	17.60	3.96	0.60	7.02	17.50	4.01	0.10	3.62	16.10	4.04	0.10	6.51	25.30	4.59
31-45	0.30	1.93	6.10	1.10	0.10	1.85	6.20	1.32	0.10	1.98	8.20	1.77	0.00	0.67	4.50	0.80	0.00	1.61	8.20	1.41
46-60	0.10	0.41	1.40	0.23	0.00	0.50	2.10	0.42	0.00	0.51	3.10	0.51	0.00	0.13	0.80	0.15	0.00	0.39	3.10	0.39
61-75	0.00	0.12	0.40	0.07	0.00	0.16	0.70	0.16	0.00	0.16	0.80	0.17	0.00	0.02	0.20	0.04	0.00	0.12	0.80	0.13
All	0.00	12.14	100.00	16.00	0.00	9.55	100.00	13.92	0.00	9.99	100.00	15.34	0.00	7.65	100.00	12.85	0.00	9.83	100.00	14.67
Ammonium (mg/L)																				
1-15	<0.02	<0.02	<0.02	0.00	<0.02	<0.02	0.03	0.00	<0.02	<0.02	<0.02	0.00	<0.02	<0.02	0.02	0.00	<0.02	<0.02	0.03	0.00
16-30	<0.02	<0.02	0.05	0.00	<0.02	<0.02	0.06	0.01	<0.02	<0.02	0.11	0.01	<0.02	<0.02	0.07	0.01	<0.02	<0.02	0.11	0.01
31-45	<0.02	0.03	0.18	0.04	<0.02	0.02	0.06	0.01	<0.02	<0.02	0.07	0.01	<0.02	0.02	0.08	0.01	<0.02	0.02	0.18	0.02
46-60	<0.02	0.02	0.12	0.02	<0.02	0.02	0.11	0.02	<0.02	0.02	0.27	0.04	<0.02	<0.02	0.06	0.01	<0.02	0.02	0.27	0.02
61-75	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
All	<0.02	<0.02	0.18	0.02	<0.02	<0.02	0.11	0.01	<0.02	<0.02	0.27	0.02	<0.02	<0.02	0.08	0.01	<0.02	<0.02	0.27	0.01

NS = Not Sampled.

Table B–7. Abundance of epibenthic macroinvertebrates by station and species for the Summer 2014 and Winter 2015 trawl surveys.

Stratum	Middle shelf Zone 1				Middle shelf Zone 2												Outer shelf					
Station	T2	T24	T6	T18	T23		T22		T1		T12		T17		T11		T10	T25	T14	T19		
Nominal Depth (m)	35	36	36	36	58		60		55		57		60		60		137	137	137	137		
Season	S	S	S	S	S	W	S	W	S	W	S	W	S	W	S	W	S	S	S	S	Total	%
Ophiura luetkenii	11	1	24	8	17	13	79	5	1	1	8	10	2412		2325	1950	4			1	6870	53.1
Lytechinus pictus		3	1	90	290	2	7	2	67		120		1	2108	109		38	50	65	10	2963	22.9
Sicyonia penicillata	1					1303		266		9		3		104		6		1			1693	13.1
Thesea sp B	31	64	35	1	28	18	12	30	22	20	2	6	4	3	20	33	1			4	334	2.6
Hamatoscalpellum californicum	9	65	18	17	1	1	23	15	8	20	12				29	6			3	4	231	1.8
Acanthoptilum sp	8				48	33	20	74	2	1	3	2	1	2	2		2	2			200	1.5
Sicyonia ingentis						1		1							1	2	2	9	34	137	187	1.4
Strongylocentrotus fragilis							1		1								131	5		11	149	1.2
Ophiothrix spiculata		19	9		1	1	17	5		1		2			2	7					64	0.5
Acanthodoris brunnea		2	3				7		4						1		1	7	10	6	41	0.3
Luidia foliolata		3		1	1		6		1	2			9	1	2	2	3			3	34	0.3
Pleurobranchaea californica		2	6	1			1	1			2		1				4		4	5	27	0.2
Astropecten californicus	2				1	2	3		2	3			1	3	1	2		1			21	0.2
Orthopagurus minimus		5	4		2	2	2									3					18	0.1
Loxorhynchus crispatus	4	5	2									1									12	0.1
Luidia asthenosoma						1	1		1						1		1		1	6	12	0.1
Octopus rubescens									1		1		1				3	2			8	0.1
Parastichopus californicus		1					2		2			1							1		7	0.1
Philine auriformis			1	5													1				7	0.1
Platymera gaudichaudii		1											1		3				2		7	0.1
Dendronotus venustus	5														1						6	<0.1
Heterogorgia tortuosa								2		1	2										5	<0.1
Erileptus spinosus	1	2		1																	4	<0.1
Flabellina iodinea	2	2																			4	<0.1
Luidia sp				2														2			4	<0.1
Podochela lobifrons			2	1														1			4	<0.1

Table B-7 continues.

Table B-7 continued.

Stratum	Middle shelf Zone 1				Middle shelf Zone 2												Outer shelf					
Station	T2	T24	T6	T18	T23		T22		T1		T12		T17		T11		T10	T25	T14	T19		
Nominal Depth (m)	35	36	36	36	58		60		55		57		60		60		137	137	137	137		
Season	S	S	S	S	S	W	S	W	S	W	S	W	S	W	S	W	S	S	S	S	**Total**	**%**
Astropecten sp								2									1				3	<0.1
Diaulula sandiegensis		3																			3	<0.1
Latulambrus occidentalis		2		1																	3	<0.1
Tritonia festiva									2						1						3	<0.1
Amphichondrius granulatus																	1			1	2	<0.1
Calinaticina oldroydii												1							1		2	<0.1
Amphiura arcystata												1									1	<0.1
Asteroidea					1																1	<0.1
Baptodoris mimetica		1																			1	<0.1
Calliostoma turbinum																	1				1	<0.1
Cancer productus										1											1	<0.1
Ericerodes hemphillii								1													1	<0.1
Metacarcinus gracilis																			1		1	<0.1
Neocrangon zacae																		1			1	<0.1
Paguristes bakeri								1													1	<0.1
Parapagurodes makarovi					1																1	<0.1
Pyromaia tuberculata				1																	1	<0.1
Randallia ornata		1																			1	<0.1
Rossia pacifica																			1		1	<0.1
Simnia sp						1															1	<0.1
Styela gibbsii							1														1	<0.1
Stylatula elongata					1																1	<0.1
Tubulanus albocinctus																			1		1	<0.1
Total Abundance	74	182	105	129	392	1378	182	405	114	59	150	27	2431	2221	2498	2011	194	81	124	188	**12945**	100
Total No. of Species	10	18	11	12	12	12	15	13	13	10	8	9	9	6	14	9	15	11	12	11	**49**	

Table B–8. Biomass (kg) of epibenthic macroinvertebrates by station and species for the Summer 2014 and Winter 2015 trawl surveys.

Stratum	Middle shelf Zone 1				Middle shelf Zone 2												Outer shelf					
Station	T2	T24	T6	T18	T23		T22		T1		T12		T17		T11		T10	T25	T14	T19		
Nominal Depth (m)	35	36	36	36	58		60		55		57		60		60		137	137	137	137		
Season	S	S	S	S	S	W	S	W	S	W	S	W	S	W	S	W	S	S	S	S	Total	%
Sicyonia penicillata	0.04					11.05		2.30		0.08		0.04		1.15		0.06		0.03			14.74	31.4
Strongylocentrotus fragilis							0.01		0.01								11.36	0.25		0.75	12.38	26.4
Ophiura luetkenii	0.01	0.01	0.03	0.01	0.01	0.01	0.05	0.01	0.01	0.01	0.01	0.01	4.10		2.79	1.55	0.01			0.01	8.63	18.4
Parastichopus californicus		0.50					0.49		0.57			0.45							1.25		3.26	6.9
Lytechinus pictus		0.01	0.01	0.21	0.67	0.01	0.01	0.01	0.06		0.34		0.01	0.72	0.22		0.10	0.08	0.11	0.01	2.56	5.5
Sicyonia ingentis						0.01		0.01							0.01	0.01	0.02	0.04	0.11	1.06	1.27	2.7
Platymera gaudichaudii		0.17											0.23		0.42				0.20		1.02	2.2
Luidia foliolata		0.03		0.02	0.01		0.01		0.01	0.01			0.23	0.01	0.01	0.03	0.13			0.05	0.55	1.2
Pleurobranchaea californica		0.01	0.07	0.01			0.01	0.01			0.06		0.01				0.10		0.10	0.09	0.46	1
Octopus rubescens									0.03		0.01		0.10				0.11	0.10			0.35	0.7
Thesea sp B	0.01	0.05	0.02	0.01	0.01	0.01	0.01	0.03	0.04	0.02	0.01	0.01	0.01	0.01	0.02	0.03	0.01			0.01	0.31	0.7
Acanthoptilum sp	0.01				0.03	0.01	0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01		0.01	0.01			0.17	0.4
Hamatoscalpellum californicum	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01				0.01	0.01			0.01	0.01	0.15	0.3
Astropecten californicus	0.01				0.01	0.01	0.01		0.02	0.02			0.01	0.00	0.01	0.01		0.01			0.13	0.3
Ophiothrix spiculata		0.01	0.01		0.01	0.01	0.02	0.01		0.01		0.01			0.01	0.01					0.11	0.2
Acanthodoris brunnea		0.01	0.01				0.01		0.01						0.01		0.01	0.01	0.01	0.01	0.09	0.2
Calinaticina oldroydii												0.07							0.02		0.08	0.2
Metacarcinus gracilis																			0.08		0.08	0.2
Luidia asthenosoma						0.01	0.01		0.01						0.01		0.01		0.01	0.01	0.07	0.1
Orthopagurus minimus		0.01	0.01		0.01	0.01	0.01									0.01					0.06	0.1
Loxorhynchus crispatus	0.01	0.01	0.01									0.01									0.04	0.1
Erileptus spinosus	0.01	0.01		0.01																	0.03	0.1
Heterogorgia tortuosa								0.01		0.01	0.01										0.03	0.1
Philine auriformis			0.01	0.01													0.01				0.03	0.1
Podochela lobifrons			0.01	0.01														0.01			0.03	0.1

Table B-8 continues.

Table B-8 continued.

Stratum	Middle shelf Zone 1				Middle shelf Zone 2												Outer shelf					
Station	T2	T24	T6	T18	T23		T22		T1		T12		T17		T11		T10	T25	T14	T19		
Nominal Depth (m)	35	36	36	36	58		60		55		57		60		60		137	137	137	137		
Season	S	S	S	S	S	W	S	W	S	W	S	W	S	W	S	W	S	S	S	S	**Total**	**%**
Amphichondrius granulatus																	0.01			0.01	0.02	<0.1
Astropecten sp								0.01									0.01				0.02	<0.1
Dendronotus venustus	0.01														0.01						0.02	<0.1
Flabellina iodinea	0.01	0.01																			0.02	<0.1
Latulambrus occidentalis		0.01		0.01																	0.02	<0.1
Luidia sp				0.01														0.01			0.02	<0.1
Tritonia festiva									0.01						0.01						0.02	<0.1
Amphiura arcystata												0.01									0.01	<0.1
Asteroidea					0.01																0.01	<0.1
Baptodoris mimetica		0.01																			0.01	<0.1
Calliostoma turbinum																	0.01				0.01	<0.1
Cancer productus										0.01											0.01	<0.1
Diaulula sandiegensis		0.01																			0.01	<0.1
Ericerodes hemphillii								0.01													0.01	<0.1
Neocrangon zacae																		0.01			0.01	<0.1
Paguristes bakeri								0.01													0.01	<0.1
Parapagurodes makarovi					0.01																0.01	<0.1
Pyromaia tuberculata				0.01																	0.01	<0.1
Randallia ornata		0.01																			0.01	<0.1
Rossia pacifica																			0.01		0.01	<0.1
Simnia sp						0.01															0.01	<0.1
Styela gibbsii							0.01														0.01	<0.1
Stylatula elongata					0.01																0.01	<0.1
Tubulanus albocinctus																			0.01		0.01	<0.1
Total Biomass	0.13	0.89	0.21	0.33	0.80	11.16	0.67	2.45	0.80	0.19	0.45	0.61	4.70	1.90	3.54	1.71	11.91	0.57	1.91	2.01	**46.93**	100

Table B–9. **Abundance of demersal fishes by station and species for the Summer 2014 and Winter 2015 trawl surveys.**

Stratum	Middle shelf Zone 1				Middle shelf Zone 2												Outer shelf					
Station	T2	T24	T6	T18	T23		T22		T1		T12		T17		T11		T10	T25	T14	T19		
Nominal Depth (m)	35	36	36	36	58		60		55		57		60		60		137	137	137	137		
Season	S	S	S	S	S	W	S	W	S	W	S	W	S	W	S	W	S	S	S	S	**Total**	**%**
Citharichthys sordidus	2	8	34	61	142	165	114	111	142	49	145	85	97	99	49	140	252	508	311	397	2911	40.6
Synodus lucioceps	32	58	95	115	34	49	62	186	107	149	233	84	52	42	125	72	24	9	22	14	1564	21.8
Zaniolepis latipinnis	1			1	7	27	8	6	89	10	50	16	19	22	25	5	9	2	22	37	356	5
Icelinus quadriseriatus	5	11	27	17		3		17		19	59	7	39	1	139	2			1		347	4.8
Sebastes saxicola																	135	40	61	51	287	4
Microstomus pacificus					7		3		8		8						8	28	36	102	200	2.8
Parophrys vetulus	7	3		2	16	3	15		37		28	2	32	5	4	9	2	3	2	7	177	2.5
Symphurus atricaudus	11	13	9	1	4	25	7	36	17	17	2	12		11		7					172	2.4
Citharichthys xanthostigma	43	38	9		1		1			12		41	2	6	1	1					155	2.2
Pleuronichthys verticalis	7	4	4	1	3	14	9	11	12	11	6	4	7	8	10	9	3	2	1	1	127	1.8
Citharichthys stigmaeus	9	15	27	64												1					116	1.6
Hippoglossina stomata	4	16	10	6	4	6	5	13	3	6	2	11	2	2	2	1	7	5	2	3	110	1.5
Lycodes pacificus																	20	27	18	44	109	1.5
Zaniolepis frenata											1				1		16	40	40	10	108	1.5
Chitonotus pugetensis	3	3	5	9	5	5	9	4	6	5	11	6	17	3	4	2					97	1.4
Odontopyxis trispinosa	3	6	1		1	1	3	2	10	2	2	1	6		35	4				1	78	1.1
Pleuronichthys decurrens		2			7		4	6	9	2	2	7	3	2	23	7	2		1	1	78	1.1
Lyopsetta exilis																	8	5	25	11	49	0.7
Raja inornata				2		1	5	2	2		4	1					2		2	2	23	0.3
Xystreurys liolepis				2		1		1		2		5		1		7					19	0.3
Porichthys notatus					3	1	1				8						1				14	0.2
Sebastes semicinctus																	10	3		1	14	0.2
Chilara taylori											1				1		1		4	4	11	0.2
Zalembius rosaceus							1		1		5						4				11	0.2

Table B-9 Continues.

Table B-9 Continued.

Stratum	Middle shelf Zone 1				Middle shelf Zone 2												Outer shelf					
Station	T2	T24	T6	T18	T23		T22		T1		T12		T17		T11		T10	T25	T14	T19		
Nominal Depth (m)	35	36	36	36	58		60		55		57		60		60		137	137	137	137		
Season	S	S	S	S	S	W	S	W	S	W	S	W	S	W	S	W	S	S	S	S	**Total**	**%**
Agonopsis sterletus					1			1	1	1							1				5	0.1
Sebastes dallii											5										5	0.1
Sebastes elongatus																	1	2	2		5	0.1
Sebastes eos																	2		1	1	4	0.1
Sebastes levis																	3				3	<0.1
Argentina sialis																				2	2	<0.1
Sebastes miniatus									1		1										2	<0.1
Eopsetta jordani																			1		1	<0.1
Neoclinus blanchardi											1										1	<0.1
Sebastes goodei																				1	1	<0.1
Total Abundance	127	177	221	281	235	301	247	396	445	285	574	282	276	202	419	267	511	674	552	690	**7162**	100
Total No. of Species	12	12	10	12	14	13	15	13	15	13	20	14	11	12	13	14	21	13	18	19	**34**	

Table B–10. Biomass (kg) of demersal fishes by station and species for the Summer 2014 and Winter 2015 trawl surveys.

Stratum	Middle shelf Zone 1				Middle shelf Zone 2												Outer shelf				Total	%
Station	T2	T24	T6	T18	T23		T22		T1		T12		T17		T11		T10	T25	T14	T19		
Nominal Depth (m)	35	36	36	36	58		60		55		57		60		60		137	137	137	137		
Season	S	S	S	S	S	W	S	W	S	W	S	W	S	W	S	W	S	S	S	S		
Citharichthys sordidus	0.00	0.17	0.36	0.64	10.05	7.59	4.70	4.36	9.41	2.18	6.61	4.52	6.11	6.30	2.42	6.85	9.98	14.00	7.87	16.60	120.74	52
Synodus lucioceps	0.47	0.73	1.18	1.14	0.48	0.96	0.64	2.63	1.60	1.88	2.71	1.77	0.69	0.61	1.46	0.90	0.68	0.56	0.38	0.51	21.95	9.5
Parophrys vetulus	1.01	0.27		0.01	1.67	0.15	1.60		3.92		2.21	0.16	2.49	0.24	0.41	0.32	0.17	0.77	0.35	0.97	16.71	7.2
Citharichthys xanthostigma	2.51	2.05	0.49		0.03		0.07			0.85		3.68	0.11	0.70	0.11	0.09					10.70	4.6
Raja inornata				1.50		0.26	2.38	0.47	0.91		0.26	0.90					1.19		1.00	0.43	9.30	4
Pleuronichthys verticalis	0.51	0.39	0.36	0.10	0.17	1.02	0.63	1.03	1.04	0.42	0.31	0.26	0.47	0.29	0.26	0.43	0.19	0.15	0.40	0.06	8.48	3.7
Hippoglossina stomata	0.11	0.36	0.20	0.45	0.60	0.24	0.23	0.77	0.44	0.40	0.06	0.47	0.10	0.11	0.25	0.04	0.39	0.36	0.17	0.26	5.99	2.6
Sebastes saxicola																	2.90	0.64	1.47	0.75	5.76	2.5
Microstomus pacificus					0.34		0.20		0.87		0.44						0.61	1.08	1.29	0.92	5.74	2.5
Zaniolepis latipinnis	0.02			0.03	0.16	0.51	0.14	0.08	1.59	0.17	0.51	0.18	0.21	0.25	0.17	0.09	0.11	0.03	0.34	0.70	5.29	2.3
Pleuronichthys decurrens		0.04			0.41		0.29	0.42	0.43	0.08	0.09	0.40	0.12	0.08	1.01	0.26	0.14		0.09	0.04	3.88	1.7
Symphurus atricaudus	0.26	0.37	0.20	0.03	0.12	0.51	0.14	0.63	0.54	0.48	0.04	0.20		0.20		0.11					3.81	1.6
Lycodes pacificus																	0.52	0.49	0.62	0.91	2.54	1.1
Lyopsetta exilis																	0.34	0.17	0.94	0.33	1.78	0.8
Icelinus quadriseriatus	0.02	0.05	0.10	0.06		0.02		0.09		0.07	0.32	0.02	0.20	0.00	0.63	0.00			0.01		1.57	0.7
Xystreurys liolepis				0.78		0.09		0.09		0.15		0.24		0.02		0.15					1.52	0.7
Zaniolepis frenata											0.01				0.01		0.32	0.38	0.61	0.06	1.40	0.6
Citharichthys stigmaeus	0.02	0.06	0.26	0.68												0.01					1.03	0.4
Eopsetta jordani																			1.00		1.00	0.4
Chitonotus pugetensis	0.02	0.02	0.04	0.05	0.06	0.04	0.10	0.05	0.09	0.05	0.12	0.07	0.18	0.04	0.03	0.02					0.98	0.4
Porichthys notatus					0.24	0.01	0.03				0.18						0.06				0.51	0.2
Sebastes semicinctus																	0.28	0.07		0.01	0.35	0.1
Zalembius rosaceus							0.02		0.07		0.09						0.02				0.20	0.1
Chilara taylori											0.01				0.01		0.02		0.05	0.09	0.18	0.1
Odontopyxis trispinosa	0.01	0.01	0.00		0.00	0.00	0.01	0.01	0.03	0.01	0.00	0.00	0.02		0.08	0.01				0.01	0.18	0.1

Table B-10 continues.

Table B-10 continued.

Stratum	Middle shelf Zone 1				Middle shelf Zone 2												Outer shelf				Total	%
Station	T2	T24	T6	T18	T23		T22		T1		T12		T17		T11		T10	T25	T14	T19		
Nominal Depth (m)	35	36	36	36	58		60		55		57		60		60		137	137	137	137		
Season	S	S	S	S	S	W	S	W	S	W	S	W	S	W	S	W	S	S	S	S		
Sebastes dallii											0.11										0.11	<0.1
Sebastes goodei																				0.09	0.09	<0.1
Sebastes miniatus									0.07		0.01										0.08	<0.1
Sebastes eos																	0.02		0.04	0.02	0.08	<0.1
Sebastes elongatus																	0.01	0.02	0.04		0.07	<0.1
Agonopsis sterletus					0.01			0.01	0.01	0.01							0.01				0.06	<0.1
Sebastes levis																	0.04				0.04	<0.1
Neoclinus blanchardi											0.02										0.02	<0.1
Argentina sialis																				0.00	0.00	<0.1
Total Biomass	4.95	4.52	3.19	5.46	14.32	11.41	11.18	10.62	21.00	6.74	14.12	12.87	10.68	8.84	6.83	9.29	17.99	18.72	16.67	22.74	**232.11**	100

Table B–11. Summary statistics of historic District Core nearshore stations for total coliforms, fecal coliforms, and enterococci bacteria (CFU/100 mL) by station and season during 2014-2015.

Station	Summer 2014				Fall 2014				Winter 2015				Spring 2015				Annual			
	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev
Total Coliforms																				
39N	<17	26	170	2.37	<17	26	740	3.36	<17	17	50	1.56	<17	18	230	2.13	<17	20	740	2.32
33N	<17	45	4700	4.99	<17	48	660	4.13	<17	51	3000	5.62	<17	17	220	1.88	<17	32	4700	4
27N	<17	13	17	1.08	<17	35	300	3.5	<17	36	400	3.15	<17	17	83	1.74	<17	22	400	2.53
21N	<17	18	50	1.66	<17	29	67	2.03	<17	25	150	2.51	<17	16	150	1.72	<17	20	150	2.02
15N	<17	23	100	2.06	<17	42	400	3.12	<17	35	600	3.1	<17	15	83	1.57	<17	24	600	2.53
12N	<17	24	120	1.92	<17	52	960	4.43	<17	36	400	2.97	<17	17	100	1.68	<17	27	960	2.76
9N	<17	39	880	3.18	<17	42	>7300	4.23	<17	33	460	2.94	<17	17	150	1.74	<17	31	>7300	3.18
6N	<17	51	500	2.92	<17	64	>9800	5.07	<17	51	460	3.01	<17	20	170	1.92	<17	43	>9800	3.45
3N	<17	70	1100	3.79	<17	113	5900	5.62	<17	123	>7900	4.83	<17	38	440	3.09	<17	79	>7900	4.54
0	<17	24	600	2.92	<17	61	>20000	5.84	<17	97	8800	8.68	<17	23	120	2.14	<17	42	>20000	5.12
3S	<17	22	180	2.76	<17	54	>20000	11.37	<17	33	1800	3.49	<17	14	33	1.24	<17	25	>20000	4.07
6S	<17	16	120	1.85	<17	21	600	2.78	<17	26	420	2.74	<17	14	33	1.23	<17	18	600	2.13
9S	<17	14	17	1.13	<17	19	83	1.7	<17	26	83	1.87	<17	15	50	1.46	<17	17	83	1.66
15S	<17	15	50	1.46	<17	30	300	2.62	<17	22	100	1.96	<17	17	>120	1.89	<17	20	300	2.05
21S	<17	14	>40	1.46	<17	22	330	2.52	<17	32	>480	3.78	<17	14	33	1.22	<17	18	>480	2.32
27S	<17	17	130	1.96	<17	19	130	2.09	<17	17	83	1.66	<17	16	67	1.55	<17	17	130	1.76
29S	<17	20	67	1.8	<17	24	370	2.8	<17	25	1300	3.63	<17	14	33	1.22	<17	19	1300	2.32
39S	<17	27	1100	4.67	<17	17	200	2.07	<17	18	180	1.98	<17	14	67	1.4	<17	18	1100	2.35
All	<17	27	4700	1.14	<17	40	>20000	2.25	<17	39	>8800	1.71	<17	17	440	0.45	<17	27	>20000	1.00

Table B-11 Continues.

Table B-11 Continued.

Station	Summer 2014				Fall 2014				Winter 2015				Spring 2015				Annual			
	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev
Fecal Coliforms																				
39N	<17	20	120	1.91	<17	17	130	1.88	<17	19	120	1.88	<17	17	180	1.99	<17	18	180	1.91
33N	<17	33	3500	4.87	<17	27	200	2.66	<17	42	3900	5.65	<17	17	180	1.98	<17	26	3900	3.55
27N	<17	13	17	1.11	<17	24	200	2.28	<17	24	100	2.16	<17	16	83	1.61	<17	18	200	1.88
21N	<17	16	33	1.41	<17	21	33	1.5	<17	19	100	1.75	<17	15	50	1.46	<17	17	100	1.54
15N	<17	22	83	1.8	<17	30	180	2.6	<17	21	150	2.02	<17	18	1100	2.53	<17	21	1100	2.29
12N	<17	23	100	1.98	<17	39	780	3.8	<17	26	83	2.07	<17	15	50	1.39	<17	22	780	2.3
9N	<17	39	740	3.35	<17	29	580	2.81	<17	25	220	2.63	<17	15	67	1.46	<17	26	740	2.73
6N	<17	43	350	2.99	<17	36	980	3.38	<17	39	270	2.9	<17	16	83	1.55	<17	32	980	2.91
3N	<17	60	900	4.22	<17	94	6500	4.81	<17	69	980	3.92	<17	26	400	2.66	<17	57	6500	4.16
0	<17	25	600	2.91	<17	41	2500	4.18	<17	46	8000	6.09	<17	18	120	1.72	<17	30	8000	3.79
3S	<17	23	170	2.86	<17	35	2500	5.22	<17	20	250	2.39	<17	14	33	1.31	<17	20	2500	2.77
6S	<17	17	67	1.85	<17	19	50	1.7	<17	19	150	2.22	<17	13	17	1.06	<17	16	150	1.72
9S	<17	14	33	1.31	<17	16	50	1.44	<17	17	50	1.67	<17	14	50	1.39	<17	15	50	1.45
15S	<17	15	50	1.46	<17	21	250	2.42	<17	18	33	1.5	<17	16	67	1.61	<17	17	250	1.75
21S	<17	13	17	1.11	<17	18	100	1.8	<17	25	180	2.52	<17	13	33	1.22	<17	16	180	1.78
27S	<17	13	17	1.11	<17	16	150	1.99	<17	15	33	1.4	<17	15	120	1.66	<17	15	150	1.59
29S	<17	15	50	1.46	<17	20	83	2	<17	20	150	2.08	<17	13	17	1.06	<17	16	150	1.69
39S	<17	25	1000	4.29	<17	15	33	1.3	<17	14	33	1.29	<17	13	<17	1	<17	15	1000	1.99
All	<17	24	3500	1.20	<17	29	6500	1.17	<17	27	8000	1.35	<17	16	1100	0.46	<17	22	8000	0.82

Table B-11 Continues.

Table B-11 Continued.

Station	Summer 2014				Fall 2014				Winter 2015				Spring 2015				Annual			
	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev
Enterococci																				
39N	<2	10	92	4.06	<2	6	46	3.39	<2	4	46	2.54	<2	3	174	3.58	<2	5	174	3.56
33N	<2	16	>400	4.27	6	27	150	2.95	2	24	>400	6.64	<2	4	30	2.67	<2	12	>400	4.79
27N	<2	6	20	2.31	<2	10	76	3.95	<2	19	188	3.97	<2	5	>400	4.54	<2	8	>400	4.2
21N	<2	6	18	2.11	<2	14	196	4.37	<2	9	>400	5.3	<2	3	66	2.7	<2	6	>400	3.88
15N	<2	5	50	2.94	<2	16	370	5.07	2	12	98	3.4	<2	4	>400	3.69	<2	7	>400	4.12
12N	<2	6	60	3.44	<2	13	>400	6.07	<2	12	124	3.88	<2	3	40	2.63	<2	6	>400	4.12
9N	2	16	216	4.39	<2	10	312	5.42	<2	9	102	3.21	<2	3	100	2.52	<2	8	312	4.3
6N	<2	15	130	3.68	<2	12	>400	5.92	<2	13	268	4.14	<2	4	82	2.73	<2	10	>400	4.41
3N	<2	23	>400	5.34	2	31	>400	5.33	<2	33	284	3.91	<2	8	132	3.45	<2	21	>400	4.91
0	<2	6	230	5.04	<2	9	480	4.49	<2	17	238	4.67	<2	5	88	3.28	<2	8	480	4.6
3S	<2	3	208	4.94	<2	10	>400	7.69	<2	8	204	4.97	<2	2	8	1.66	<2	4	>400	4.69
6S	<2	3	74	4.01	<2	5	96	3.52	<2	7	148	3.78	<2	2	8	1.7	<2	3	148	3.25
9S	<2	3	42	3.7	<2	5	40	3.41	<2	6	54	3.42	<2	2	40	2.59	<2	4	54	3.29
15S	<2	3	118	3.29	<2	4	42	2.87	<2	7	94	4.05	<2	2	282	2.98	<2	3	282	3.44
21S	<2	5	>400	6.25	<2	5	56	2.96	<2	9	206	4.64	<2	2	8	1.72	<2	4	>400	3.78
27S	<2	3	68	3.56	<2	3	12	2.22	<2	3	24	2.67	<2	2	8	1.58	<2	2	68	2.38
29S	<2	4	38	3.07	<2	6	182	4.33	<2	5	186	4.45	<2	2	16	1.72	<2	4	186	3.31
39S	<2	3	22	2.46	<2	3	34	2.87	<2	3	84	3.03	<2	2	10	1.72	<2	2	84	2.39
All	<2	8	>400	1.10	<2	11	>480	1.43	<2	11	>400	1.00	<2	3	>400	0.85	<2	7	>480	0.75

Table B–12. Summary statistics of OCHCA nearshore stations for total coliforms, fecal coliforms, and enterococci bacteria (CFU/100 mL) by station and season during 2014-2015.

Station	Summer 2014				Fall 2014				Winter 2015				Spring 2015				Annual			
	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev
Total Coliforms																				
OSB02	>17	151	>20000	5.06	<17	247	>20000	9.08	<17	361	>20000	7.92	<17	86	>20000	5.62	<17	184	>20000	7.13
OSB03	33	189	>20000	5.62	<17	150	4700	5.1	50	174	1100	2.91	17	75	300	1.97	<17	141	>20000	3.94
OSB05	17	225	>20000	6.93	17	196	7100	5.27	<17	125	1200	3.95	<17	48	230	2.79	<17	132	>20000	5.06
OSB04	<17	63	>20000	7.11	<17	84	4800	5.4	<17	32	500	3.26	<17	21	170	2.41	<17	44	>20000	4.78
OSB01	<17	15	33	1.3	<17	37	1200	4.92	<17	22	100	1.97	<17	13	<17	1	<17	20	1200	2.57
OSUB1	<17	24	370	2.92	<17	39	1300	4.93	<17	25	67	1.98	<17	14	<20	1.12	<17	24	1300	2.91
BCO-1	<17	19	83	1.97	<17	30	460	3.15	<17	29	150	2.44	<17	15	33	1.33	<17	22	460	2.34
HB1D	<17	16	33	1.4	<17	37	130	2.78	<17	34	2900	5.34	<17	15	67	1.61	<17	23	2900	2.94
HB2U									800		800						800		800	
HB2									>40000		>40000						>40000		>40000	
HB2D	<17	15	50	1.44	<17	44	180	2.98	<17	28	230	2.68	<17	19	<100	1.86	<17	24	230	2.44
HB3D	<17	16	33	1.4	<17	45	270	2.59	<17	35	380	3.05	<17	16	83	1.7	<17	25	380	2.46
HB4D	<17	17	50	1.49	<17	41	2900	4.81	<17	25	420	2.7	<17	14	33	1.32	<17	22	2900	2.77
HB5U									500		500						500		500	
HB5									940		940						940		940	
HB5D	<17	18	83	1.84	<17	35	200	3.02	<17	41	370	3.31	<17	21	230	2.3	<17	27	370	2.7
SAR-N	<17	38	400	3.57	<17	182	>11000	13.63	<17	431	>20000	14.94	<17	71	350	3.58	<17	119	>20000	9.31
TM	<17	62	420	2.93	<17	63	4900	5.77	<17	80	1700	5.26	<17	26	250	2.99	<17	53	4900	4.28
BGCU	<17	32	320	3.04	67	289	>1900	2.72	<17	158	1800	3.27	<17	107	580	2.78	<17	113	>1900	3.8
BGC	>2200	5105	>9200	1.5	1000	5735	>40000	3.77	62	2580	9800	3.64	<20	4027	>21000	6.24	<20	4241	>40000	3.72
BGCD	>40	255	2200	2.99	<17	139	4100	7.12	<17	130	>3200	5.12	<17	92	2300	5.7	<17	144	4100	5.16
PPCU	<17	36	170	2.49	<17	88	300	3.54	83	138	230	2.06	220		220		<17	68	300	3.07
PPC	>4000	14195	>40000	3.04	>7600	24142	>40000	2.06	>6400	20000	>40000	3.65	>20000		>20000		>4000	18764	>40000	2.49
PPCD	<17	18	170	2.08	<17	21	300	2.7	<17	22	100	2.1	<17	17	33	1.57	<17	19	300	2.11
WFCU	<17	16	50	1.55	<17	21	150	2.55	<17	24	120	2.56	<17	24	>1300	4	<17	21	>1300	2.64
WFC	130	681	>2400	2.56	>200	1265	>40000	4.53	>110	751	>2000	2.75	<15	851	5400	5.11	<15	870	>40000	3.65
WFCD	<17	20	1400	3.68	<17	24	100	2.1	<17	22	180	2.26	<17	15	33	1.31	<17	20	1400	2.36
ONB39	<17	19	220	2.27	<17	87	>20000	9.43	<17	25	130	2.39	<17	21	230	2.37	<17	31	>20000	4.38
MDCU	<17	13	<17	1	<17	75	1100	6.87	<17	33	350	3.5	<17	13	<17	1	<17	35	1100	4.39
MDC	15	68	>250	8.56	800	8279	>40000	5.17	580	2775	>14000	2.68	>800	7071	>40000	15.9	15	2937	>40000	7.48
MDCD	<17	14	33	1.3	<17	27	600	3.16	<17	34	250	2.7	<17	13	17	1.08	<17	20	600	2.36
ELMOROU									<17		<17						<17		<17	
ELMORO									2100		2100						2100		2100	
ELMOROD	<17	14	33	1.31	<17	15	33	1.3	<17	19	120	2.13	<17	16	83	1.85	<17	16	120	1.66
All	<15	763	>40000	1.98	<17	1480	>40000	2.67	<17	2427	>40000	2.54	<15	1355	>40000	2.98	<15	2427	>40000	1.94

Table B-12 Continues.

Table B-12 continued.

Station	Summer 2014				Fall 2014				Winter 2015				Spring 2015				Annual			
	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev
Fecal Coliforms																				
OSB02	<17	86	>20000	5.06	<17	80	3700	3.7	<17	105	7000	6.5	<17	30	4800	4.53	<17	69	>20000	5.14
OSB03	50	181	>20000	4.68	<17	70	250	2.74	17	93	820	3.26	17	39	120	2.02	<17	85	>20000	3.53
OSB05	<17	182	>20000	7.72	17	98	660	2.97	<17	63	820	3.93	<17	31	200	2.59	<17	79	>20000	4.71
OSB04	<17	49	>20000	7.06	<17	36	300	3.25	<17	23	83	2.08	<17	15	33	1.45	<17	28	>20000	3.63
OSB01	<17	16	67	1.63	<17	21	220	2.43	<17	15	33	1.43	<17	13	<17	1	<17	16	220	1.74
OSUB1	<17	23	440	2.85	<17	25	250	2.53	<17	18	50	1.65	<17	13	<17	1	<17	19	440	2.18
BCO-1	<17	17	33	1.48	<17	31	170	2.33	<17	21	100	1.98	<17	17	50	1.65	<17	21	170	1.93
HB1D	<17	17	50	1.51	<17	29	180	2.74	<17	36	2100	4.13	<17	13	17	1.12	<17	22	2100	2.61
HB2U									170		170						170		170	
HB2									4500		4500						4500		4500	
HB2D	<17	16	50	1.43	<17	24	200	2.34	<17	26	130	2.31	<17	14	33	1.32	<17	19	200	1.96
HB3D	<17	14	17	1.14	<17	33	230	2.64	<17	31	130	2.43	<17	13	17	1.12	<17	21	230	2.17
HB4D	<17	16	67	1.62	<17	24	1400	3.83	<17	20	100	1.91	<17	14	33	1.32	<17	18	1400	2.22
HB5U									100		100						100		100	
HB5									150		150						150		150	
HB5D	<17	17	33	1.48	<17	25	130	2.26	<17	26	170	2.56	<17	17	67	1.65	<17	20	170	2.03
SAR-N	<17	42	350	3.43	<17	92	1000	4.17	<17	138	>20000	15.47	<17	40	270	2.9	<17	68	>20000	5.91
TM	<17	34	330	2.7	<17	39	480	3.49	<17	35	300	3.22	<17	26	170	2.12	<17	33	480	2.83
BGCU	<17	23	270	2.44	33	136	940	2.84	<17	84	700	3.82	<17	21	200	2.45	<17	49	940	3.7
BGC	<15	281	3400	6.57	31	1491	27000	9.31	15	420	7400	7.11	31	269	2400	3.8	<15	478	27000	7.15
BGCD	<17	102	1800	4.14	<17	90	4000	6.77	<17	63	880	3.44	<17	21	180	2.46	<17	60	4000	4.58
PPCU	<17	14	17	1.16	<17	28	130	3.05	17	34	67	2.64	<17		<17		<17	20	130	2.2
PPC	1100	4200	>40000	3.67	380	2579	>8800	3.49	62	165	440	4	420		420		62	1886	>40000	5.17
PPCD	<17	13	17	1.08	<17	16	67	1.62	<17	15	50	1.48	<17	13	<17	1	<17	14	67	1.39
WFCU	<17	13	<17	1	<17	18	100	1.91	<17	19	100	2.03	<17	13	17	1.08	<17	15	100	1.65
WFC	<15	94	620	3.42	15	101	2300	4.08	15	95	1300	5.25	<15	61	2200	5.7	<15	87	2300	4.39
WFCD	<17	18	1200	3.51	<17	16	67	1.62	<17	22	130	2.4	<17	13	<17	1	<17	17	1200	2.22
ONB39	<17	15	50	1.56	<17	29	1500	4.14	<17	14	33	1.32	<17	14	33	1.31	<17	17	1500	2.29
MDCU	<17	13	<17	1	<17	32	250	3.86	<17	35	300	3.27	<17	13	<17	1	<17	27	300	3.12
MDC	77	124	200	1.96	230	856	5200	3.19	62	407	6800	5.13	<15	19	31	2.05	<15	325	6800	5.61
MDCD	<17	13	<17	1	<17	20	120	2	<17	19	67	1.93	<17	13	17	1.08	<17	16	120	1.66
ELMOROU									<17		<17						<17		<17	
ELMORO									380		380						380		380	
ELMOROD	<17	13	<17	1	<17	15	67	1.56	<17	16	67	1.81	<17	17	580	2.87	<17	15	580	1.89
All	<15	202	>40000	1.95	<15	216	27000	1.60	<15	217	>20000	2.70	<15	43	4800	1.18	<15	261	>40000	1.64

Table B-12 Continues.

Table B-12 Continued.

Station	Summer 2014				Fall 2014				Winter 2015				Spring 2015				Annual			
	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev
Enterococci																				
OSB02	<2	26	>400	5.8	<2	26	>400	5.71	12	53	>400	3.21	<2	19	>400	5.59	<2	29	>400	5.16
OSB03	4	25	>400	4.43	2	12	104	3.42	4	18	306	3.41	<2	8	74	3.36	<2	15	>400	3.8
OSB05	<2	8	198	3.65	<2	12	108	4.33	4	19	>400	4.64	<2	4	50	3.16	<2	9	>400	4.25
OSB04	<2	5	156	3.4	<2	7	58	4.04	<2	5	70	2.74	<2	4	34	2.78	<2	5	156	3.19
OSB01	<2	3	22	2.36	<2	3	52	3.03	<2	5	28	3.24	<2	2	4	1.33	<2	3	52	2.66
OSUB1	<2	4	60	3.27	<2	4	80	3.45	<2	4	36	3.92	<2	2	2	1.09	<2	3	80	3.18
BCO-1	<2	5	42	2.82	<2	10	68	3.41	<2	13	114	3.69	<2	3	26	2.44	<2	7	114	3.48
HB1D	<2	8	102	3.47	<2	14	50	2.71	<2	28	>400	5.24	<2	4	20	2.36	<2	11	>400	4.05
HB2U									134		134						134		134	
HB2									>400		>400						>400		>400	
HB2D	<2	7	48	2.85	<2	24	348	4.83	<2	13	>400	5.66	<2	2	24	2.3	<2	9	>400	4.74
HB3D	<2	7	24	2.11	<2	17	80	3.64	<2	12	168	4.68	<2	3	26	2.39	<2	8	168	3.74
HB4D	<2	8	28	2.63	<2	11	68	3.62	<2	12	80	4.71	<2	3	26	2.83	<2	8	80	3.71
HB5U									108		108						108		108	
HB5									324		324						324		324	
HB5D	<2	6	34	2.7	<2	9	64	4.36	<2	9	88	4.64	<2	3	10	2.16	<2	6	88	3.58
SAR-N	<2	4	20	2.43	<2	23	>400	6.6	2	53	>400	6.32	2	9	38	2.27	<2	15	>400	5.5
TM	<2	8	226	3.94	<2	10	224	4.2	<2	11	96	4.06	2	6	94	3.73	<2	9	226	3.89
BGCU	<2	6	116	3.88	2	40	>400	4.86	<2	23	102	3.98	<2	10	188	4.69	<2	15	>400	5.1
BGC	134	215	>400	1.43	86	262	>400	1.92	88	209	>400	1.67	100	182	>400	1.64	86	216	>400	1.68
BGCD	8	53	>400	3.66	<2	27	>400	5.06	2	22	158	4.02	<2	10	76	3.91	<2	24	>400	4.51
PPCU	<2	13	108	5.57	2	10	64	4.73	8	10	12	1.33	12		12		<2	11	108	3.97
PPC	>400	500	>400	1	>400	500	>400	1	228	338	>400	1.74	>400		>400		228	473	>400	1.23
PPCD	<2	4	70	3.29	<2	3	76	3.49	<2	3	20	2.88	<2	2	14	1.86	<2	3	76	2.9
WFCU	<2	2	4	1.51	<2	3	42	3.06	<2	4	46	3.25	<2	2	2	1.11	<2	3	46	2.42
WFC	62	202	>400	1.91	22	89	>400	2.4	18	59	188	2.18	80	171	316	1.51	18	116	>400	2.33
WFCD	<2	3	120	3.67	<2	4	24	2.89	<2	7	38	3	<2	2	80	2.99	<2	4	120	3.26
ONB39	<2	2	70	2.85	<2	7	>400	5.35	<2	4	16	2.64	<2	2	34	2.38	<2	3	>400	3.53
MDCU	<2	2	2	1.23	<2	14	276	9.14	<2	7	40	3.03	<2	2	<2	1	<2	7	276	5.07
MDC	36	39	42	1.12	12	178	>400	4.18	60	155	>400	2.32	116	157	212	1.53	12	139	>400	2.89
MDCD	<2	2	4	1.32	<2	5	250	5.68	<2	7	72	4.61	<2	2	2	1.08	<2	3	250	3.72
ELMOROU									2		2						2		2	
ELMORO									>400		>400						>400		>400	
ELMOROD	<2	2	4	1.44	<2	3	60	2.98	<2	3	18	2.24	<2	2	2	1.13	<2	2	60	2.11
All	<2	42	>400	1.26	<2	47	>400	1.58	<2	79	>400	1.49	<2	40	>400	1.18	<2	80	>400	1.38

Blank cells in the table represent stations where no sample was collected or a single sample was collected.

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QUALITY ASSURANCE/QUALITY CONTROL

Appendix C

Appendix C
QUALITY ASSURANCE/QUALITY CONTROL

INTRODUCTION

This appendix details quality assurance/quality control (QA/QC) information for the collection and analyses of water quality, sediment geochemistry, tissue chemistry, benthic infauna, and trawl fish and invertebrate samples for the Orange County Sanitation District's (District) 2014-15 ocean monitoring program.

The Core monitoring program is designed to measure compliance with permit conditions and for temporal and spatial trend analysis. The program includes measurements of:

- Water quality;
- Sediment quality;
- Benthic infaunal community health;
- Fish and macroinvertebrate community health;
- Fish tissue contaminant concentrations (chemical body burden); and
- Fish health (including external parasites and diseases).

The Core monitoring program complies with the District's Quality Assurance Project Plan (QAPP) (OCSD 2014) requirements and applicable federal, state, local, and contract requirements. The objectives of the quality assurance program are as follows:

- Scientific data generated will be of sufficient quality to stand up to scientific and legal scrutiny.
- Data will be gathered or developed in accordance with procedures appropriate for the intended use of the data.
- Data will be of known and acceptable precision, accuracy, representativeness, completeness, and comparability as required by the program.

The various aspects of the program are conducted on a schedule that varies weekly, monthly, quarterly, semi-annually, and annually. Sampling and data analysis are designated by quarters 1 through 4, which are representative of the summer (July–September), fall (October–December), winter (January–March), and spring (April–June) seasons, respectively. Tables C-1 and C-2 show that all required samples, excluding those for trawl bioaccumulation, were collected in 2014-15. Not all required English Sole bioaccumulation samples were collected at outfall (n=9) and non-outfall (n=2) stations despite the fact that 5 trawls were conducted at each station.

Table C–1. Ocean monitoring program sample collection requirements and percent completion for water quality, July 2014–June 2015.

Quarter	Program Type	Parameter	Nominal # of Samples	# of Samples Collected	Nominal # of QA Duplicates *	# of Duplicates Collected	% Samples Collected
Summer	Water Quality	CTD Drops	146	146	15	15	100
		Ammonium	450	450	45	45	100
		Bacteria	175	175	N/A	N/A	100
Fall	Water Quality	CTD Drops	146	146	15	15	100
		Ammonium	450	450	45	45	100
		Bacteria	175	175	N/A	N/A	100
Winter	Water Quality	CTD Drops	146	146	15	15	100
		Ammonium	450	450	45	45	100
		Bacteria	175	175	N/A	N/A	100
Spring	Water Quality	CTD Drops	146	146	15	15	100
		Ammonium	450	450	45	45	100
		Bacteria	175	175	N/A	N/A	100

* QA samples were collected at 10% of nominal sampling requirement.
N/A = Not Applicable.

Table C–2. Ocean monitoring program sample collection requirements and percent completion for sediment geochemistry, infauna, sediment toxicity, trawl community, trawl fish tissue, and sport fish tissue, July 2014-June 2015.

Quarter	Program Type	Target fish	Nominal # of Samples	# of Samples Collected	% Samples Collected
Summer	Sediment Geochemistry	N/A	68	68	100
	Benthic infauna	N/A	68	68	100
	Trawl Community	N/A	14	14	100
Winter	Sediment Geochemistry	N/A	29	29	100
	Benthic infauna	N/A	29	29	100
	Sediment Toxicity	N/A	9	9	100
	Trawl Community	N/A	6	6	100
	Trawl Fish Tissue	Hornyhead Turbot	20	20	100
		English Sole	20	11	55
	Sport Fish Tissue (Zone 1)	Rockfish	10	10	100
	Sport Fish Tissue (Zone 3)	Rockfish	10	10	100

N/A = Not Applicable.

WATER QUALITY NARRATIVE

Ammonium

Introduction

All ammonium samples were iced upon collection, preserved with 1:1 sulfuric acid upon receipt by the Environmental Laboratory and Ocean Monitoring (ELOM) laboratory staff, and stored at 4±2 °C until analysis according to ELOM Standard Operating Procedures (SOPs) (OCSD 2015).

Analytical Method - Ammonium

The samples were analyzed for ammonium on a segmented flow analyzer using SOP 4500-NH_3 G. In the analysis, sodium phenolate and sodium hypochlorite reacted with ammonium to form indophenol blue in a concentration proportional to the ammonium concentration in the sample. The blue color was intensified with the addition of sodium nitroprusside and was measured at 660 nm.

QA/QC - Ammonium

A typical sample batch included a blank at a maximum of every 20 samples, a monthly external reference standard, and a spike in seawater collected from a control site at a maximum of every 20 samples. One spike and 1 spike replicate were added to the batch every 10 samples. The method detection limit (MDL) for ammonium samples is shown in Table C-3. All samples were analyzed within the required holding time. All 161 analyses met the QA/QC criteria for blanks, blank spikes, and external reference sample (Table C-4).

Table C–3. Method detection limits (MDLs) for ammonium and bacteria in receiving water, July 2014–June 2015.

Parameter	MDL
Ammonium	0.02 mg/L
Total coliform	10 MPN/100 mL
E. coli	10 MPN/100 mL
Enterococci	10 MPN/100 mL

Bacteria

Introduction

All bacteria samples were iced upon collection and stored at <10 °C until analysis following ELOM SOPs.

Analytical Method

Samples collected offshore were analyzed for bacteria using Enterolert™ for enterococci and Colilert-18™ for total coliforms and *Escherichia coli*. Fecal coliforms were estimated by multiplying the *Escherichia coli* result by a factor of 1.1. These methods utilize enzyme substrates that produce, upon hydrolyzation, a fluorescent signal when viewed under long-

Table C–4. Water quality ammonium QA/QC summary, July 2014–June 2015.

Quarter	Sample Set	Parameter	Description	Number of Compounds Tested	Number of Compounds Passed	Target Accuracy % Recovery	Target Precision % RPD
Summer	NH3WQ140807-1	Ammonium	Blank	5	5	<2X MDL	N/A
			Blank Spike	5	5	90-110	N/A
			Matrix Spike	9	9	80-120	N/A
			Matrix Spike Dup	9	9	80-120	N/A
			Matrix Spike Precision	9	9	N/A	<11%
Summer	NH3WQ140811-1	Ammonium	Blank	4	4	<2X MDL	N/A
			Blank Spike	4	4	90-110	N/A
			Matrix Spike	7	7	80-120	N/A
			Matrix Spike Dup	7	7	80-120	N/A
			Matrix Spike Precision	7	7	N/A	<11%
Summer	NH3WQ140812-1	Ammonium	Blank	5	5	<2X MDL	N/A
			Blank Spike	5	5	90-110	N/A
			Matrix Spike	9	9	80-120	N/A
			Matrix Spike Dup	9	9	80-120	N/A
			Matrix Spike Precision	9	9	N/A	<11%
Summer	NH3WQ140820-1	Ammonium	Blank	4	4	<2X MDL	N/A
			Blank Spike	4	4	90-110	N/A
			Matrix Spike	7	7	80-120	N/A
			Matrix Spike Dup	7	7	80-120	N/A
			Matrix Spike Precision	7	7	N/A	<11%
Summer	NH3WQ140903-1	Ammonium	Blank	4	4	<2X MDL	N/A
			Blank Spike	4	4	90-110	N/A
			Matrix Spike	7	7	80-120	N/A
			Matrix Spike Dup	7	7	80-120	N/A
			Matrix Spike Precision	7	7	N/A	<11%
Summer	NH3WQ140904-1	Ammonium	Blank	5	5	<2X MDL	N/A
			Blank Spike	5	5	90-110	N/A
			Matrix Spike	9	9	80-120	N/A
			Matrix Spike Dup	9	9	80-120	N/A
			Matrix Spike Precision	9	9	N/A	<11%
Summer	NH3WQ140909-1	Ammonium	Blank	3	3	<2X MDL	N/A
			Blank Spike	3	3	90-110	N/A
			Matrix Spike	5	5	80-120	N/A
			Matrix Spike Dup	5	5	80-120	N/A
			Matrix Spike Precision	5	5	N/A	<11%
Summer	NH3WQ140925-1	Ammonium	Blank	8	8	<2X MDL	N/A
			Blank Spike	8	8	90-110	N/A
			Matrix Spike	16	16	80-120	N/A
			Matrix Spike Dup	16	16	80-120	N/A
			Matrix Spike Precision	16	16	N/A	<11%

Table C-4 continues.

Table C-4 continued.

Quarter	Sample Set	Parameter	Description	Number of Compounds Tested	Number of Compounds Passed	Target Accuracy % Recovery	Target Precision % RPD
Fall	NH3WQ141023-1	Ammonium	Blank	5	5	<2X MDL	N/A
			Blank Spike	5	5	90-110	N/A
			Matrix Spike	9	9	80-120	N/A
			Matrix Spike Dup	9	9	80-120	N/A
			Matrix Spike Precision	9	9	N/A	<11%
Fall	NH3WQ141028-1	Ammonium	Blank	4	4	<2X MDL	N/A
			Blank Spike	4	4	90-110	N/A
			Matrix Spike	7	7	80-120	N/A
			Matrix Spike Dup	7	7	80-120	N/A
			Matrix Spike Precision	7	7	N/A	<11%
Fall	NH3WQ141029-1	Ammonium	Blank	4	4	<2X MDL	N/A
			Blank Spike	4	4	90-110	N/A
			Matrix Spike	7	7	80-120	N/A
			Matrix Spike Dup	7	7	80-120	N/A
			Matrix Spike Precision	7	7	N/A	<11%
Fall	NH3WQ141118-1	Ammonium	Blank	4	4	<2X MDL	N/A
			Blank Spike	4	4	90-110	N/A
			Matrix Spike	8	8	80-120	N/A
			Matrix Spike Dup	8	8	80-120	N/A
			Matrix Spike Precision	8	8	N/A	<11%
Fall	NH3WQ141120-1	Ammonium	Blank	4	4	<2X MDL	N/A
			Blank Spike	4	4	90-110	N/A
			Matrix Spike	8	8	80-120	N/A
			Matrix Spike Dup	8	8	80-120	N/A
			Matrix Spike Precision	8	8	N/A	<11%
Fall	NH3WQ141205-1	Ammonium	Blank	4	4	<2X MDL	N/A
			Blank Spike	4	4	90-110	N/A
			Matrix Spike	7	7	80-120	N/A
			Matrix Spike Dup	7	7	80-120	N/A
			Matrix Spike Precision	7	7	N/A	<11%
Fall	NH3WQ141209-1	Ammonium	Blank	4	4	<2X MDL	N/A
			Blank Spike	4	4	90-110	N/A
			Matrix Spike	7	7	80-120	N/A
			Matrix Spike Dup	7	7	80-120	N/A
			Matrix Spike Precision	7	7	N/A	<11%
Fall	NH3WQ141216-1	Ammonium	Blank	8	8	<2X MDL	N/A
			Blank Spike	8	8	90-110	N/A
			Matrix Spike	16	16	80-120	N/A
			Matrix Spike Dup	16	16	80-120	N/A
			Matrix Spike Precision	16	16	N/A	<11%

Table C-4 continues.

Table C-4 continued.

Quarter	Sample Set	Parameter	Description	Number of Compounds Tested	Number of Compounds Passed	Target Accuracy % Recovery	Target Precision % RPD
Winter	NH3WQ150129-1	Ammonium	Blank	4	4	<2X MDL	N/A
			Blank Spike	4	4	90-110	N/A
			Matrix Spike	8	8	80-120	N/A
			Matrix Spike Dup	8	8	80-120	N/A
			Matrix Spike Precision	8	8	N/A	<11%
Winter	NH3WQ150203-1	Ammonium	Blank	4	4	<2X MDL	N/A
			Blank Spike	4	4	90-110	N/A
			Matrix Spike	8	8	80-120	N/A
			Matrix Spike Dup	8	8	80-120	N/A
			Matrix Spike Precision	8	8	N/A	<11%
Winter	NH3WQ150206-1	Ammonium	Blank	4	4	<2X MDL	N/A
			Blank Spike	4	4	90-110	N/A
			Matrix Spike	7	7	80-120	N/A
			Matrix Spike Dup	7	7	80-120	N/A
			Matrix Spike Precision	7	7	N/A	<11%
Winter	NH3WQ150218-1	Ammonium	Blank	5	5	<2X MDL	N/A
			Blank Spike	5	5	90-110	N/A
			Matrix Spike	9	9	80-120	N/A
			Matrix Spike Dup	9	9	80-120	N/A
			Matrix Spike Precision	9	9	N/A	<11%
Winter	NH3WQ150219-1	Ammonium	Blank	4	4	<2X MDL	N/A
			Blank Spike	4	4	90-110	N/A
			Matrix Spike	7	7	80-120	N/A
			Matrix Spike Dup	7	7	80-120	N/A
			Matrix Spike Precision	7	7	N/A	<11%
Winter	NH3WQ150225-1	Ammonium	Blank	4	4	<2X MDL	N/A
			Blank Spike	4	4	90-110	N/A
			Matrix Spike	7	7	80-120	N/A
			Matrix Spike Dup	7	7	80-120	N/A
			Matrix Spike Precision	7	7	N/A	<11%
Winter	NH3WQ150302-1	Ammonium	Blank	4	4	<2X MDL	N/A
			Blank Spike	4	4	90-110	N/A
			Matrix Spike	7	7	80-120	N/A
			Matrix Spike Dup	7	7	80-120	N/A
			Matrix Spike Precision	7	7	N/A	<11%
Winter	NH3WQ150421-1	Ammonium	Blank	5	5	<2X MDL	N/A
			Blank Spike	5	5	90-110	N/A
			Matrix Spike	9	9	80-120	N/A
			Matrix Spike Dup	9	9	80-120	N/A
			Matrix Spike Precision	9	9	N/A	<11%
Winter	NH3WQ150422-1	Ammonium	Blank	4	4	<2X MDL	N/A
			Blank Spike	4	4	90-110	N/A
			Matrix Spike	7	7	80-120	N/A
			Matrix Spike Dup	7	7	80-120	N/A
			Matrix Spike Precision	7	7	N/A	<11%

Table C-4 continues.

Table C-4 continued.

Quarter	Sample Set	Parameter	Description	Number of Compounds Tested	Number of Compounds Passed	Target Accuracy % Recovery	Target Precision % RPD
Spring	NH3WQ150512-1	Ammonium	Blank	5	5	<2X MDL	N/A
			Blank Spike	5	5	90-110	N/A
			Matrix Spike	9	9	80-120	N/A
			Matrix Spike Dup	9	9	80-120	N/A
			Matrix Spike Precision	9	9	N/A	<11%
Spring	NH3WQ150513-1	Ammonium	Blank	4	4	<2X MDL	N/A
			Blank Spike	4	4	90-110	N/A
			Matrix Spike	8	8	80-120	N/A
			Matrix Spike Dup	8	8	80-120	N/A
			Matrix Spike Precision	8	8	N/A	<11%
Spring	NH3WQ150518-1	Ammonium	Blank	5	5	<2X MDL	N/A
			Blank Spike	5	5	90-110	N/A
			Matrix Spike	8	8	80-120	N/A
			Matrix Spike Dup	8	8	80-120	N/A
			Matrix Spike Precision	8	8	N/A	<11%
Spring	NH3WQ150519-1	Ammonium	Blank	5	5	<2X MDL	N/A
			Blank Spike	5	5	90-110	N/A
			Matrix Spike	8	8	80-120	N/A
			Matrix Spike Dup	8	8	80-120	N/A
			Matrix Spike Precision	8	8	N/A	<11%
Spring	NH3WQ150527-1	Ammonium	Blank	5	5	<2X MDL	N/A
			Blank Spike	5	5	90-110	N/A
			Matrix Spike	8	8	80-120	N/A
			Matrix Spike Dup	8	8	80-120	N/A
			Matrix Spike Precision	8	8	N/A	<11%
Spring	NH3WQ150528-1	Ammonium	Blank	4	4	<2X MDL	N/A
			Blank Spike	4	4	90-110	N/A
			Matrix Spike	7	7	80-120	N/A
			Matrix Spike Dup	7	7	80-120	N/A
			Matrix Spike Precision	7	7	N/A	<11%
Spring	NH3WQ150529-1	Ammonium	Blank	5	5	<2X MDL	N/A
			Blank Spike	5	5	90-110	N/A
			Matrix Spike	9	9	80-120	N/A
			Matrix Spike Dup	9	9	80-120	N/A
			Matrix Spike Precision	9	9	N/A	<11%
Spring	NH3WQ150601-1	Ammonium	Blank	3	3	<2X MDL	N/A
			Blank Spike	3	3	90-110	N/A
			Matrix Spike	6	6	80-120	N/A
			Matrix Spike Dup	6	6	80-120	N/A
			Matrix Spike Precision	6	6	N/A	<11%
Spring	NH3WQ150602-1	Ammonium	Blank	3	3	<2X MDL	N/A
			Blank Spike	3	3	90-110	N/A
			Matrix Spike	6	6	80-120	N/A
			Matrix Spike Dup	6	6	80-120	N/A
			Matrix Spike Precision	6	6	N/A	<11%

Table C-4 continues.

Table C-4 continued.

Quarter	Sample Set	Parameter	Description	Number of Compounds Tested	Number of Compounds Passed	Target Accuracy % Recovery	Target Precision % RPD
Spring	NH3WQ150624-1	Ammonium	Blank	6	6	<2X MDL	N/A
			Blank Spike	6	6	90-110	N/A
			Matrix Spike	11	11	80-120	N/A
			Matrix Spike Dup	11	11	80-120	N/A
			Matrix Spike Precision	11	11	N/A	<11%
Spring	NH3WQ150625-1	Ammonium	Blank	3	3	<2X MDL	N/A
			Blank Spike	3	3	90-110	N/A
			Matrix Spike	5	5	80-120	N/A
			Matrix Spike Dup	5	5	80-120	N/A
			Matrix Spike Precision	5	5	N/A	<11%

N/A = Not Applicable.

wavelength (365 nm) ultraviolet light. For samples collected along the surfzone, samples were analyzed by culture-based methods for direct count of bacteria. EPA Method 1600 was applied to enumerate enterococci bacteria. For enumeration of total and fecal coliforms, respectively, Standards Methods 9222B and 9222D were used. MDLs for bacteria are presented in Table C-3.

QA/QC

All samples were analyzed within the required holding time. Recreational (REC-1) samples were processed and incubated within 8 hours of sample collection. Duplicate analyses were performed on a minimum of 10% of samples with at least 1 sample per sample batch. All equipment, reagents, and dilution waters used for sample analyses were sterilized before use. Each lot of medium was tested for sterility and performance with known positive and negative controls prior to use. For surfzone samples, a positive and a negative control were run simultaneously with each batch of sample for each type of media used to ensure performance. New lots of Quanti-Tray and petri dish were checked for sterility before use. Each Quanti-Tray sealer was checked monthly by addition of Gram stain dye to 100 mL of water, and the tray was sealed and subsequently checked for leaking. Each lot of dilution blanks commercially purchased was checked for appropriate volume. New lots of ≤10 mL volume pipettes were checked for accuracy by weighing volume delivery on a calibrated top loading scale.

SEDIMENT GEOCHEMISTRY CHEMISTRY NARRATIVE

First Quarter Semi-annual Collection (July 2014)

Introduction

All samples were collected and stored according to ELOM SOPs. All samples were analyzed for organochlorine pesticides, polychlorinated biphenyl congeners (PCBs), polycyclic aromatic hydrocarbons (PAHs), linear alkylbenzenes (LABs), trace metals, mercury, dissolved sulfides (DS), total organic carbon (TOC), total nitrogen (TN), total phosphorus (TP), and grain size.

Analytical Methods – PAHs and LABs

The analytical methods used to detect PAHs and LABs in the samples are described in the ELOM SOPs. All sediment samples were extracted using an accelerated solvent extractor (ASE). Approximately 10 g dry weight of sample was used for each analysis. A separatory funnel extraction was performed using 100 mL of sample when field and rinse blanks were included in the batch.

A typical sample batch included 20 field samples with required QC samples. Sample batches for PAHs included the following QC samples: 1 sand blank, 1 reporting level spike, 2 standard reference materials (SRMs), 1 matrix spike set, and 2 sample extraction duplicates. There was 1 batch extracted and analyzed for PAHs. MDLs for PAHs are presented in Table C-5. Acceptance criteria for PAH SRMs are presented in Tables C-6.

QC samples for LAB analyses included 1 sand blank, 1 reporting level spike, 2 SRMs, 1 matrix spike set, and 2 sample extraction duplicates. MDLs for LABs are presented in Table C-5.

Sediment PAH and LAB QA/QC summary data are shown in Table C-7. All analyses were performed within holding times and with appropriate quality control measures. Any variances are noted in the footnotes of Table C-7.

Analytical Methods - Organochlorine Pesticides and PCB Congeners

The analytical methods used to process the samples for organochlorine pesticides and PCB congeners are described in the ELOM SOPs. Sediment samples were extracted within their holding time using an ASE. All sediment extracts were analyzed by GC/MS. Approximately 10 g dry weight of sample was used for each analysis. If a field blank and rinse were included in the batch, a separatory funnel extraction was performed using 100 mL of sample.

A typical sample batch consisted of 20 field samples with required QC samples, which included 1 sand blank, 2 SRMs, 1 reporting level spike, 2 matrix spike set, and 2 duplicate sample extractions. MDLs for PCBs/pesticides are presented in Table C-5. Acceptance criteria for PCB/pesticide SRMs are presented in Tables C-8.

Sediment PCB/pesticide QA/QC summary data are presented in Table C-9. All analyses were performed within holding times and with appropriate quality control measures. When

Table C–5. Method detection limits (MDLs) for PAHs, LABs, pesticides, and PCBs in sediments, July 2014–June 2015.

Parameter	MDL (ng/g wet weight)	Parameter	MDL (ng/g wet weight)
PAH Compounds			
Acenaphthene	0.4	Fluoranthene	0.4
Acenaphthylene	0.4	Fluorene	0.4
Anthracene	0.3	Indeno[1,2,3-c,d]pyrene	0.3
Benz[a]anthracene	0.2	Naphthalene	1.1
Benzo[a]pyrene	0.2	Perylene	0.6
Benzo[b]fluoranthene	0.4	Phenanthrene	0.8
Benzo[e]pyrene	0.4	Pyrene	0.2
Benzo[g,h,i]perylene	0.4	1-Methylnaphthalene	0.5
Benzo[k]fluoranthene	0.5	2-Methylnaphthalene	0.9
Biphenyl	0.8	2,6-Dimethylnaphthalene	0.4
Chrysene	0.3	1,6,7-Trimethylnaphthalene	0.4
Dibenz[a,h]anthracene	0.2	2,3,6-Trimethylnaphthalene	0.5
Dibenzothiophene	0.3	1-Methylphenanthrene	0.5
LAB Compounds			
2-Phenyldecane	0.1	6-Phenyltetradecane	0.1
3-Phenyldecane	0.1	7-Phenyltetradecane	0.1
4-Phenyldecane	0.1	2-Phenyltridecane	0.3
5-Phenyldecane	0.1	3-Phenyltridecane	0.2
2-Phenyldodecane	0.3	4-Phenyltridecane	0.3
3-Phenyldodecane	0.1	5-Phenyltridecane	0.4
4-Phenyldodecane	0.2	7+6-Phenyltridecane	1.0
5-Phenyldodecane	0.3	2-Phenylundecane	0.2
6-Phenyldodecane	0.3	3-Phenylundecane	0.1
2-Phenyltetradecane	0.1	4-Phenylundecane	0.1
3-Phenyltetradecane	0.1	5-Phenylundecane	0.1
4-Phenyltetradecane	0.1	6-Phenylundecane	0.1
5-Phenyltetradecane	0.1		
Pesticides			
Aldrin	0.34	Hexachlorobenzene	0.75
cis-Chlordane	0.38	Mirex	0.26
trans-Chlordane	0.38	*trans*-Nonachlor	0.32
Dieldrin	0.48	2,4’-DDD	0.41
Endosulfan-alpha	0.46	4,4’-DDD	0.48
Endosulfan-beta	0.32	2,4’-DDE	0.32
Endosulfan-sulfate	0.45	4,4’-DDE	0.30
Endrin	0.46	2,4’-DDT	0.32
gamma-BHC	0.42	4,4’-DDT	0.48
Heptachlor	0.43	4,4’-DDMU	0.35
Heptachlor epoxide	0.50		

Table C-5 continues.

Table C-5 continued.

Parameter	MDL (ng/g wet weight)	Parameter	MDL (ng/g wet weight)
PCB Congeners			
PCB 18	0.16	PCB 126	0.22
PCB 28	0.18	PCB 128	0.21
PCB 37	0.16	PCB 138	0.17
PCB 44	0.16	PCB 149	0.17
PCB 49	0.16	PCB 151	0.19
PCB 52	0.17	PCB 153/168	0.34
PCB 66	0.18	PCB 156	0.20
PCB 70	0.18	PCB 157	0.19
PCB 74	0.18	PCB 167	0.20
PCB 77	0.18	PCB 169	0.22
PCB 81	0.18	PCB 170	0.21
PCB 87	0.18	PCB 177	0.21
PCB 99	0.18	PCB 180	0.20
PCB 101	0.19	PCB 183	0.19
PCB 105	0.17	PCB 187	0.21
PCB 110	0.17	PCB 189	0.19
PCB 114	0.20	PCB 194	0.18
PCB 118	0.18	PCB 201	0.22
PCB 119	0.19	PCB 206	0.24
PCB 123	0.18		

Table C–6. Acceptance criteria for standard reference materials of PAH in sediments, July 2014–June 2015.

Parameter	True Value (ng/g)	Acceptance Range (ng/g)	
		Minimum	Maximum
SRM 1941b; Organics in Marine Sediment, National Institute of Standards and Technology			
Acenaphthene *	38.4	33.2	43.6
Acenaphthylene *	53.3	46.9	59.7
Anthracene *	184	166	202
Benz[a]anthracene	335	310	360
Benzo[a]pyrene	358	341	375
Benzo[b]fluoranthene	453	432	474
Benzo[e]pyrene	325	300	350
Benzo[g,h,i]perylene	307	262	352
Benzo[k]fluoranthene	225	207	243
Biphenyl *	74	66	82
Chrysene	291	260	322
Dibenz[a,h]anthracene	53	43	63
Fluoranthene	651	601	701
Fluorene *	85	70	100
Indeno[1,2,3-c,d]pyrene	341	284	398
Naphthalene *	848	753	943
Perylene	397	352	442
Phenanthrene	406	362	450
Pyrene	581	542	620
1-Methylnaphthalene *	127	113	141
2-Methylnaphthalene *	276	223	329
2,6-Dimethylnaphthalene *	75.9	71.4	80.4
1,6,7-Trimethylnaphthalene *	25.5	20.4	30.6
1-Methylphenanthrene *	73.2	67.3	79.1
Percent Dry Weight	1.3		

Table C-6 Continues.

Table C-6 Continued.

Parameter	True Value (ng/g)	Acceptance Range (ng/g)	
		Minimum	Maximum
SRM 1944; New York/New Jersey Waterway Sediment, National Institute of Standards and Technology			
Acenaphthene *	390	360	420
Anthracene *	1130	1060	1200
Benz[a]anthracene	4720	4610	4830
Benzo[a]pyrene	4300	4170	4430
Benzo[b]fluoranthene	3870	3450	4290
Benzo[e]pyrene	3280	3170	3390
Benzo[g,h,i]perylene	2840	2740	2940
Benzo[k]fluoranthene	2300	2100	2500
Biphenyl *	250	230	270
Chrysene	4860	4760	4960
Dibenz[a,h]anthracene	424	355	493
Dibenzothiophene *	500	470	530
Fluoranthene	8920	8600	9240
Fluorene *	480	440	520
Indeno[1,2,3-c,d]pyrene	2780	2680	2880
Naphthalene *	1280	1240	1320
Perylene	1170	930	1410
Phenanthrene	5270	5050	5490
Pyrene	9700	9280	10120
1-Methylnaphthalene *	470	450	490
2-Methylnaphthalene *	740	680	800
1-Methylphenanthrene *	1700	1600	1800
Percent Dry Weight	1.3		

* Non-certified values provided for this analyte.

Table C–7. Sediment PAH/LAB QA/QC summary, July 2014–June 2015.

Quarter	Sample Set	Parameter	Description	Number of Compounds Tested	Number of Compounds Passed	Target Accuracy % Recovery	Target Precision % RPD
Summer	SEDPAHLAB-1407_EW	PAHs and LABs	Blank	51	48	<3X MDL	N/A
			Blank Spike	25	25	60-120	N/A
			Matrix Spike (Based on Mean of MS and MSD)	51	51	40-120	N/A
			Duplicate	102	79	N/A	<20%@3 x MDL of sample mean
			SRM Analysis	30	29	25% of the certified or published acceptance limits	N/A
Summer	SEDPAHLAB-1407_EX	PAHs and LABs	Blank	51	35	<3X MDL	N/A
			Blank Spike	51	47	60-120	N/A
			Matrix Spike (Based on Mean of MS and MSD)	51	51	40-120	N/A
			Duplicate	102	64	N/A	<20%@3 x MDL of sample mean
			SRM Analysis	30	30	25% of the certified or published acceptance limits	N/A
Summer	SEDPAHLAB-1407_EY	PAHs and LABs	Blank	51	48	<3X MDL	N/A
			Blank Spike	51	49	60-120	N/A
			Matrix Spike (Based on Mean of MS and MSD)	51	47	40-120	N/A
			Duplicate	102	65	N/A	<20%@3 x MDL of sample mean
			SRM Analysis	30	29	25% of the certified or published acceptance limits	N/A
Summer and Winter	SEDPAHLAB-1407_EZ	PAHs and LABs	Blank	51	36	<3X MDL	N/A
			Blank Spike	51	47	60-120	N/A
			Matrix Spike (Based on Mean of MS and MSD)	51	49	40-120	N/A
			Duplicate	102	40	N/A	<20%@3 x MDL of sample mean
			SRM Analysis	30	28	25% of the certified or published acceptance limits	N/A

Table C-7 Continues.

Table C-7 Continued.

Quarter	Sample Set	Parameter	Description	Number of Compounds Tested	Number of Compounds Passed	Target Accuracy % Recovery	Target Precision % RPD
Winter	SEDPAHLAB-1501_FA	PAHs	Blank	26	24	<3X MDL	N/A
			Blank Spike	26	25	60-120	N/A
			Matrix Spike (Based on Mean of MS and MSD)	26	26	40-120	N/A
			Duplicate	52	44	N/A	<20%@3 x MDL of sample mean
			SRM Analysis	30	29	25% of the certified or published acceptance limits	N/A
Winter	SEDPAHLAB-1501_FB	PAHs	Blank	26	26	<3X MDL	N/A
			Blank Spike	26	26	60-120	N/A
			Matrix Spike (Based on Mean of MS and MSD)	26	25	40-120	N/A
			Duplicate	26	19	N/A	<20%@3 x MDL of sample mean
			SRM Analysis	30	28	25% of the certified or published acceptance limits	N/A
Winter	SEDPAHLAB-1501_FC	PAHs	Blank	26	26	<3X MDL	N/A
			Blank Spike	26	26	60-120	N/A
			Matrix Spike (Based on Mean of MS and MSD)	26	26	40-120	N/A
			Duplicate	26	12	N/A	<20%@3 x MDL of sample mean
			SRM Analysis	30	29	25% of the certified or published acceptance limits	N/A

District laboratory results are not corrected for surrogate recoveries, causing some analytes with lower molecular weights and boiling points to fail the established criteria for SRM certified values.

Higher RSD values occurred for the individual analytes that were associated with concentrations near the method detection limits. Corrective action for low % precision involved a review of sample prep. before extraction.

Matrix interferences from duplicate analyses and or matrix spike samples have caused some analytes to fail the established criteria for precision factors and % recoveries respectively. Visual inspection of the replicate samples and the spike samples did not reveal any obvious interferences. A system check was performed prior to sample analysis and all the analytes of concern from calibration standards were within specifications. Data set integrity was verified and accepted.

N/A = Not Applicable.

Table C–8. Acceptance criteria for standard reference materials of PCB/pesticides in sediments, July 2014–June 2015.

Parameter	True Value (ng/g)	Acceptance Range (ng/g)	
		Minimum	Maximum
SRM 1941b; Organics in Marine Sediment, National Institute of Standards and Technology			
cis-Chlordane	0.85	0.74	0.96
trans-Chlordane	0.57	0.47	0.66
Hexachlorobenzene	5.83	5.45	6.21
cis-Nonachlor	3.70	3.00	4.40
trans-Nonachlor	0.44	0.37	0.51
4,4'-DDD	4.66	4.20	5.12
2,4'-DDE *	0.38	0.26	0.50
4,4'-DDE	3.22	2.94	3.50
4,4'-DDT *	1.12	0.70	1.54
PCB 18	2.39	2.10	2.68
PCB 28	4.52	3.95	5.09
PCB 44	3.85	3.65	4.05
PCB 49	4.34	4.06	4.62
PCB 52	5.24	4.96	5.52
PCB 66	4.96	4.43	5.49
PCB 70 *	4.99	4.7	5.28
PCB 74 *	2.04	1.89	2.19
PCB 77 *	0.31	0.28	0.34
PCB 8	1.65	1.46	1.84
PCB 87	1.14	0.98	1.30
PCB 99	2.90	2.54	3.26
PCB 101	5.11	4.77	5.45
PCB 105	1.43	1.33	1.53
PCB 110	4.62	4.26	4.98
PCB 118	4.23	4.04	4.42
PCB 128	0.70	0.65	0.74
PCB 138	3.60	3.32	3.88
PCB 149	4.35	4.09	4.61
PCB 153/168	5.47	5.15	5.79
PCB 156	0.51	0.42	0.60
PCB 158 *	0.65	0.50	0.80
PCB 170	1.35	1.26	1.44
PCB 180	3.24	2.73	3.75
PCB 183	0.98	0.89	1.07
PCB 187	2.17	1.95	2.39
PCB 194	1.04	0.98	1.10
PCB 195	0.65	0.59	0.71
PCB 201	0.78	0.74	0.81
PCB 206	2.42	2.23	2.61
PCB 209	4.86	4.41	5.31
Percent Dry Weight	1.3		

Table C-8 continues.

Table C-8 continued

Parameter	True Value (ng/g)	Acceptance Range (ng/g)	
		Minimum	Maximum
SRM 1941b; Organics in Marine Sediment, National Institute of Standards and Technology			
cis-Chlordane	16.51	15.68	17.34
trans-Chlordane *	19	17.3	20.7
gamma-BHC *	2	1.7	2.3
Hexachlorobenzene	6.03	5.68	6.38
cis-Nonachlor *	3.70	3.00	4.40
trans-Nonachlor	8.2	7.69	8.71
2,4'-DDD *	38	30.00	46
2,4'-DDE *	19	16	22.00
4,4'-DDD *	108	92.00	124
4,4'-DDE *	86	74.00	98
4,4'-DDT *	170	138	202
PCB 8	22.3	20	24.6
PCB 18	51	48.4	53.6
PCB 28	80.8	78.1	83.5
PCB 44	60.2	58.2	62.2
PCB 49	53	51.3	54.7
PCB 52	79.4	77.4	81.4
PCB 66	71.9	67.6	76.2
PCB 87	29.9	25.6	34.2
PCB 99	37.5	35.1	39.90
PCB 101	73.40	70.9	75.9
PCB 105	24.5	23.4	25.6
PCB 110	63.5	58.8	68.2
PCB 118	58	53.7	62.3
PCB 128	8.47	8.19	8.75
PCB 138	62.1	59.1	65.1
PCB 149	49.70	48.5	50.9
PCB 151	16.93	16.57	17.29
PCB 153/168	74	71.1	76.9
PCB 156	6.52	5.86	7.18
PCB 170	22.6	21.20	24.00
PCB 180	44.3	43.1	45.5
PCB 183	12.19	11.62	12.76
PCB 187	25.1	24.1	26.1
PCB 194	11.2	9.8	12.6
PCB 195	3.75	3.36	4.14
PCB 206	9.21	8.7	9.72
PCB 209	6.81	6.48	7.14
Percent Dry Weight	1.3		

* Non-certified values provided for this analyte.

Table C–9. Sediment PCB/pesticides QA/QC summary, June 2014–June 2015.

Quarter	Sample Set	Parameter	Description	Number of Compounds Tested	Number of Compounds Passed	Target Accuracy % Recovery	Target Precision % RPD
Summer	SED1407_FN	PCBs and Pesticides	Blank	60	60	<3X MDL	N/A
			Blank Spike	60	60	60-120	N/A
			Matrix Spike	60	59	40-120	N/A
			Matrix Spike Dup	60	60	40-120	N/A
			Matrix Spike Precision	60	57	N/A	<20%
			Duplicate	120	118	N/A	<20%@3 x MDL of sample mean
			SRM Analysis	67	55	80-120% or certified value whichever is greater.	N/A
Summer	SED1407_FP	PCBs and Pesticides	Blank	60	60	<3X MDL	N/A
			Blank Spike	60	59	60-120	N/A
			Matrix Spike	60	60	40-120	N/A
			Matrix Spike Dup	60	60	40-120	N/A
			Matrix Spike Precision	60	60	N/A	<20%
			Duplicate	120	120	N/A	<20%@3 x MDL of sample mean
			SRM Analysis	67	59	80-120% or certified value whichever is greater.	N/A
Summer	SED1407_FR	PCBs and Pesticides	Blank	60	60	<3X MDL	N/A
			Blank Spike	60	60	60-120	N/A
			Matrix Spike	60	52	40-120	N/A
			Matrix Spike Dup	60	55	40-120	N/A
			Matrix Spike Precision	60	57	N/A	<20%
			Duplicate	120	120	N/A	<20%@3 x MDL of sample mean
			SRM Analysis	67	59	80-120% or certified value whichever is greater.	N/A

Table C-9 Continues.

Table C-9 Continued.

Quarter	Sample Set	Parameter	Description	Number of Compounds Tested	Number of Compounds Passed	Target Accuracy % Recovery	Target Precision % RPD
Summer and Winter	SED1407_FS	PCBs and Pesticides	Blank	60	60	<3X MDL	N/A
			Blank Spike	60	58	60-120	N/A
			Matrix Spike	60	58	40-120	N/A
			Matrix Spike Dup	60	59	40-120	N/A
			Matrix Spike Precision	60	59	N/A	<20%
			Duplicate	120	116	N/A	<20%@3 x MDL of sample mean
			SRM Analysis	67	58	80-120% or certified value whichever is greater.	N/A
Winter	SED1407_FT	PCBs and Pesticides	Blank	60	60	<3X MDL	N/A
			Blank Spike	60	58	60-120	N/A
			Matrix Spike	60	57	40-120	N/A
			Matrix Spike Dup	60	59	40-120	N/A
			Matrix Spike Precision	60	59	N/A	<20%
			Duplicate	120	120	N/A	<20%@3 x MDL of sample mean
			SRM Analysis	67	58	80-120% or certified value whichever is greater.	N/A
Winter	SED1407_FU	PCBs and Pesticides	Blank	60	60	<3X MDL	N/A
			Blank Spike	60	60	60-120	N/A
			Matrix Spike	0	NR *	40-120	N/A
			Matrix Spike Dup	60	57	40-120	N/A
			Matrix Spike Precision	0	NA	N/A	<20%
			Duplicate	60	59	N/A	<20%@3 x MDL of sample mean
			SRM Analysis	32	30	80-120% or certified value whichever is greater.	N/A

* Not reported due to error in sample preparation process.
N/A = Not Applicable.

constituent concentrations exceeded the calibration range of the instrument, dilutions were performed and the samples reanalyzed. Any variances are noted in Table C-9.

Analytical Methods - Trace Metals

Dried sediment samples were analyzed for trace metals in accordance with methods in the ELOM SOPs. A typical sample batch for silver, cadmium, chromium, copper, nickel, lead, zinc, selenium, arsenic, and beryllium analyses included 3 blanks, a blank spike, and 1 SRM. Additionally, duplicate samples, spiked samples and duplicate spiked samples were analyzed a minimum of once every 10 sediment samples. QC for a typical sample batch for aluminum and iron analyses included 3 blanks, an SRM, sediment samples with duplicates, spiked samples, and duplicate spiked samples analyzed a minimum of once every 10 sediment samples. The analysis of the blank spike and SRM provided a measure of the accuracy of the analysis. The analysis of the sample, its duplicate, and the 2 spiked samples were evaluated for precision. The samples that were spiked with aluminum and iron were not evaluated for spike recoveries because the spike levels were extremely low (20 mg/kg dry weight) compared to the concentrations of aluminum and iron in the native samples (5,000 and 35,000 mg/kg dry weight).

All samples were analyzed within their 6-month holding times. If any analyte exceeded the appropriate calibration curve and Linear Dynamic Range, the sample was diluted and reanalyzed. MDLs for metals are presented in Table C-10. Acceptance criteria for trace metal SRMs are presented in Table C-11.

The digested samples were analyzed for silver, cadmium, chromium, copper, nickel, lead, zinc, selenium, arsenic, and beryllium by inductively coupled mass spectroscopy (ICPMS). Aluminum and iron were analyzed using inductively coupled emission spectroscopy (ICPES).

Table C–10. Method detection limits (MDLs) for trace metals in sediments, July 2014–June 2015.

Parameter	MDL (mg/kg dry weight)
Aluminum	50
Antimony	0.10
Arsenic	0.15
Barium	0.10
Beryllium	0.01
Cadmium	0.01
Chromium	0.15
Copper	0.10
Iron	50
Lead	0.10
Mercury	0.00
Nickel	0.10
Selenium	0.15
Silver	0.02
Zinc	0.15

Table C–11. Acceptance criteria for standard reference materials of metals in sediments, July 2014–June 2015.

Environmental Resource Associates D074-540 Priority PollutnT™ /CLP Inorganic Soils – Microwave Digestion Environmental Resource Associates			
Parameter	True Value (mg/kg)	Certified Acceptance Criteria (mg/kg)	
		Min.	Max.
Aluminum	9510	4160	14800
Antimony	72.9	18.7	206
Arsenic	161	114	209
Barium	385	286	484
Beryllium	146	110	182
Cadmium	149	110	191
Chromium	180	127	233
Copper	162	122	207
Iron	13000	4220	21800
Lead	103	73	132
Nickel	133	97.4	172
Mercury	3.73	1.9	5.55
Selenium	153	103	202
Silver	71.1	47.8	94.5
Zinc	352	254	450

Sediment trace metal QA/QC summary data are presented in Table C-12.

Analytical Methods - Mercury

Dried sediment samples were analyzed for mercury in accordance with methods described in the ELOM SOPs. QC for a typical batch included a blank, blank spike, and SRM. Sediment samples with duplicates, spiked samples and duplicate spiked samples were run approximately once every 10 sediment samples. All samples were analyzed within their 6-month holding time. When sample mercury concentration exceeded the appropriate calibration curve, the sample was diluted with the reagent blank and reanalyzed. The samples were analyzed for mercury on a Perkin Elmer FIMS 400 system.

The MDL for sediment mercury is presented in Table C-10. Acceptance criteria for mercury SRM is presented in Table C-11. All QA/QC summary data are presented in Table C-12.

All samples, with some noted exceptions, met the QA/QC criteria guidelines for accuracy and precision.

Analytical Methods - Dissolved Sulfides

Dissolved sulfides (DS) samples were analyzed in accordance with methods described in the ELOM SOPs. The MDL for DS is presented in Table C-13. Sediment DS QA/QC summary

Table C–12. Sediment metals QA/QC summary, July 2014–June 2015.

Quarter	Sample Set	Parameter	Description	Number of Compounds Tested	Number of Compounds Passed	Target Accuracy % Recovery	Target Precision % RPD
Summer	ALFESED141217-1	Aluminum, Iron	Blank	10	10	<3X MDL	N/A
Summer	ALFESED141217-2	Aluminum, Iron	Blank	2	2	<3X MDL	N/A
Summer	HGSED141103-1	Mercury	Blank	3	3	<3X MDL	N/A
			Blank Spike	3	3	90-110	N/A
			Matrix Spike	7	6 *	70-130	N/A
			Matrix Spike Dup	7	7	70-130	N/A
			Matrix Spike Precision	7	7	N/A	<20%
			Duplicate Analysis	7	6 **	N/A	@≥10 X MDL <20%
			SRM Analysis	1	1	80-120% or certified value whichever is greater.	N/A
Summer	HMSED141212-1	Arsenic, Beryllium, Cadmium, Chromium, Copper, Lead, Nickel, Selenium, Silver, Zinc	Blank	60	56 ***	<3X MDL	N/A
			Blank Spike	36	36	90-110	N/A
			Matrix Spike	72	63 *	70-130	N/A
			Matrix Spike Dup	72	61 *	70-130	N/A
			Matrix Spike Precision	72	71 **	N/A	<20%
			Duplicate Analysis	72	71 **	N/A	@≥10 X MDL <20%
			SRM Analysis	12	12	80-120% or certified value whichever is greater.	N/A
Summer	HMSED141215-1	Arsenic, Beryllium, Cadmium, Chromium, Copper, Lead, Nickel, Selenium, Silver, Zinc	Blank	12	12	<3X MDL	N/A
			Blank Spike	12	12	90-110	N/A
			Matrix Spike	12	10	70-130	N/A
			Matrix Spike Dup	12	10	70-130	N/A
			Matrix Spike Precision	12	12	N/A	<20%
			Duplicate Analysis	12	12	N/A	@≥10 X MDL <20%

Table C-12 Continues.

Table C-12 Continued.

Quarter	Sample Set	Parameter	Description	Number of Compounds Tested	Number of Compounds Passed	Target Accuracy % Recovery	Target Precision % RPD
Winter	ALFESED150604-1	Aluminum, Iron	Blank	8	8	<3X MDL	N/A
Winter	HGSED150224-1	Mercury	Blank	2	2	<3X MDL	N/A
			Blank Spike	2	2	90-110	N/A
			Matrix Spike	3	3	70-130	N/A
			Matrix Spike Dup	3	3	70-130	N/A
			Matrix Spike Precision	3	3	N/A	<20%
			Duplicate Analysis	3	3	N/A	@≥10 X MDL <20%
			SRM Analysis	1	1	80-120% or certified value whichever is greater.	N/A
Winter	HMSED150602-1	Arsenic, Beryllium, Cadmium, Chromium, Copper, Lead, Nickel, Selenium, Silver, Zinc	Blank	48	48	<3X MDL	N/A
			Blank Spike	24	24	90-110	N/A
			Matrix Spike	36	27 *	70-130	N/A
			Matrix Spike Dup	36	28 *	70-130	N/A
			Matrix Spike Precision	36	35 **	N/A	<20%
			Duplicate Analysis	36	32 **	N/A	@≥10 X MDL <20%
			SRM Analysis	12	12	80-120% or certified value whichever is greater.	N/A

* Out of contol due to matrix interference.
** Out of control due to non-homogenous sample.
*** Batch average for blanks = ND.
N/A = Not Applicable.

Table C–13. Method detection limits (MDLs) for dissolved sulfides, total organic carbon, grain size, total nitrogen, and total phosphorus in sediments, July 2014–June 2015.

Parameter	MDL
Dissolved Sulfides	1.03 mg/kg dry weight
Total Organic Carbon	0.10%
Grain Size	0.00%
Total Nitrogen	0.33 mg/kg dry
Total Phosphorus	5.3 mg/kg dry weight

data are presented in Table C-14. All samples were analyzed within their required holding times. All analyses met the QA/QC criteria for blanks, blank spikes, matrix spike, matrix spike duplicates, and matrix spike precisions.

Analytical Methods - Total Organic Carbon

Total Organic Carbon (TOC) samples were analyzed by ALS Environmental Services, Kelso, WA. The MDL for TOC is presented in Table C-13. Sediment TOC QA/QC summary data are presented in Table C-15. The samples were analyzed within their required holding times. Seven samples were analyzed in duplicate and matrix spike. The samples and their duplicate analyses had a RPD of less than 10%. The recoveries for matrix spike were within 80-120% range.

Analytical Methods - Grain Size

Grain size samples were analyzed by EMSL Analytical, Cinnaminson, NJ. The MDL for sediment grain size is presented in Table C-13. Sediment grain size QA/QC summary data are presented in Table C-16. Seven samples and their duplicate analyses had a RPD ≤10%. Thirty replicates of Station 12 samples were analyzed as grain size standard reference material (SRM) and all analysis results were within 3 standard deviations of SRM for the statistical parameters (median phi, dispersion, and skewness), percent gravel, percent sand, percent clay, and percent silt.

Analytical Methods - Total Nitrogen

Total nitrogen (TN) samples were analyzed by Weck Laboratories, Inc., City of Industry, CA. The MDL for TN is presented in Table C-13. Sediment TN QA/QC summary data are presented in Table C-17. The samples were analyzed within their required holding times.

Table C–14. Sediment dissolved sulfides QA/QC summary, July 2014–June 2015.

Quarter	Sample Set	Parameter	Description	Number of Compounds Tested	Number of Compounds Passed	Target Accuracy % Recovery	Target Precision % RPD
Summer	SULFIDE140917-1 SULFIDE140918-1 SULFIDE140923-1 SULFIDE140924-1 SULFIDE141023-1 SULFIDE141024-1 SULFIDE141029-1	Dissolved Sulfides	Method Blank	7	7	<2X MDL	N/A
			Blank Spike	7	7	80-20	N/A
			Matrix Spike	7	7	70-130	N/A
			Matrix Spike Dup	7	7	70-130	N/A
			Matrix Spike Precision	7	7	N/A	<30%
Winter	SULFIDE150324-1 SULFIDE150325-1 SULFIDE150326-1	Dissolved Sulfides	Method Blank	3	3	<2X MDL	N/A
			Blank Spike	3	3	80-20	N/A
			Matrix Spike	3	3	70-130	N/A
			Matrix Spike Dup	3	3	70-130	N/A
			Matrix Spike Precision	3	3	N/A	<30%

N/A = Not Applicable.

Table C–15. Sediment total organic carbon QA/QC summary, July 2014–June 2015.

Quarter	Sample Set	Parameter	Description	Number of Compounds Tested	Number of Compounds Passed	Target Accuracy % Recovery	Target Precision % RPD
Summer	TOC-140814-1	Total Organic Carbon	Duplicate and matrix spike	7	7	80-120 [a]	<10% [a]
Winter	TOC-150226-1	Total Organic Carbon	Duplicate and matrix spike	3	2 [b]	80-120 [a]	<10% [a]

[a] TOC Target Precision/Accuracy of QC Criteria is not described in the Core Monitoring Quality Assurance Project Plan.

[b] One sample duplicate RPD (10.5%) was out of control due to matrix interferences.

Table C–16. Sediment grain size QA/QC summary, July 2014–June 2015.

Quarter	Sample Set	Parameter	Description	Number of Compounds Tested	Number of Compounds Passed	Target Accuracy % Recovery	Target Precision % RPD
Summer	PSIZE140827-1	Grain Size	Reference Standard	30	30	N/A	Mean ±3 σ of the reference standard for median phi, skewness, dispersion, % gravel, % sand, % clay, and % silt
			Duplicate	7	7	N/A	≤10%
Winter	PSIZE150302-1	Grain Size	Reference Standard	0	0	N/A	Mean ±3 σ of the reference standard for median phi, skewness, dispersion, % gravel, % sand, % clay, and % silt
			Duplicate	3	3	N/A	≤10%

N/A = Not Applicable.

Table C–17. Sediment total nitrogen and total phosphorus QA/QC summary, July 2014–June 2015.

Quarter	Sample Set	Parameter	Description	Number of Compounds Tested	Number of Compounds Passed	Target Accuracy % Recovery	Target Precision % RPD
Summer	TN141002-1	Total Nitrogen	Method Blank	5	5	N/A	N/A
			Blank Spike	5	5	80-20	N/A
			Matrix Spike	3	3	70-130	N/A
			Matrix Spike Dup	3	3	70-130	N/A
			Matrix Spike Precision	3	3	N/A	<30%
Winter	TN150302-1	Total Nitrogen	Method Blank	3	3	N/A	N/A
			Blank Spike	3	3	80-20	N/A
			Matrix Spike	2	2	70-130	N/A
			Matrix Spike Dup	2	2	70-130	N/A
			Matrix Spike Precision	2	2	N/A	<30%
Summer	TP141002-1	Total Phosphorus	Method Blank	5	5	N/A	N/A
			Blank Spike	5	5	80-20	N/A
			Duplicate and Precision	10	10	N/A	<30%
			Matrix Spike	3	2 *	70-130	N/A
			Matrix Spike Dup/Precision	3/3	1/3 *	70-130	<30%
Winter	TP150302-1	Total Phosphorus	Method Blank	2	2	N/A	N/A
			Blank Spike	2	2	80-120	N/A
			Duplicate and Precision	3	3	N/A	<30%
			Matrix Spike	2	1 *	70-130	N/A
			Matrix Spike Dup/Precision	2/2	0/2 *	70-130	<30%

* Matrix spike recovery was out of control due to matrix interferences. The associated laboratory control sample (LCS) met acceptance criteria.

N/A = Not Applicable.

Three samples were analyzed in matrix spike and matrix spike duplicate. The matrix spikes and their duplicate analyses had a RPD of less than 30%. The recoveries for matrix spike and matrix spike duplicate were within 70-130% range.

Analytical Methods - Total Phosphorus

Total phosphorus (TP) samples were analyzed by Weck Laboratories, Inc., City of Industry, CA. The MDL for TP is presented in Table C-13. Sediment TP QA/QC summary data are presented in Table C-17. The samples were analyzed within their required holding times. Three samples were analyzed in matrix spike and matrix spike duplicate. Ten samples and their duplicate analyses had a RPD of less than 30%. One sample spike and 2 spike duplicate analyses did not meet target recoveries of 70-130% range due to matrix interferences. The associated laboratory control sample (LCS) met the acceptance criteria.

Third Quarter Semi-annual Collection (January 2015)

All samples were stored according to methods described in the ELOM SOPs. All samples were analyzed for organochlorine pesticides, PCB congeners, PAHs, trace metals, mercury, DS, grain size, TOC, TN, and TP.

All sediment samples analyzed for organochlorine pesticides, PCB congeners, and PAHs were extracted using an ASE. All sediment extracts were analyzed by GC/MS within their holding times. Any QA/QC variances are noted in Tables C-7 and C-9.

All samples analyzed for metals were conducted within their holding times. Sediment metals and mercury QA/QC summary data are presented in Table C-12. All samples met the QA criteria guidelines.

The analyses for TOC, DS, grain size, TN, and TP met the QA criteria guidelines. QA/QC summary data are presented in Tables C-14 through C-17. Recoveries of 1 matrix spike and 2 matrix spike duplicates for TP were not in the target ranges due to matrix interferences. The associated LCS met the acceptance criteria.

FISH TISSUE CHEMISTRY NARRATIVE

Third Quarter (January 2015)

Introduction

All individual samples were stored, dissected, and homogenized according to methods described in the ELOM SOPs. A 1:1 muscle to water ratio was used for muscle samples. No water was used for liver samples. After the individual samples were homogenized, equal aliquots of muscle from each rig fish sample, and equal aliquots of muscle and liver from each trawl fish sample were frozen and distributed to the metals and organic chemistry sections of the analytical chemistry laboratory for analyses.

In addition to the percent lipid content determination, the organic chemistry section extracted 20 rig fish muscle samples, 31 trawl fish muscle samples, and 31 trawl fish liver samples, and analyzed them for PCB congeners and organochlorine pesticides. Of the 31 trawl fish liver samples, results from 15 samples were not reported due to an error made in the extract preparation process, resulting in the failure of all QC samples contained in that batch. A laboratory QA/QC corrective action notice was filed.

A typical organic tissue sample batch included 15 field samples with required QC samples. The QC samples included 1 hydromatrix blank, 2 duplicate sample extractions, 1 matrix spike, 1 matrix duplicate spike, 2 SRMs, and 1 reporting level spike (matrix of choice was tilapia).

For mercury, arsenic and selenium analyses, 1 sample batch consisted of 15–20 fish tissue samples and the required QC samples, which included a blank, blank spike, SRM, sample duplicates, matrix spikes, and matrix spike duplicates.

Analytical Methods - Organochlorine Pesticides and PCB Congeners

The analytical methods used for organochlorine pesticides and PCB congeners were according to methods described in the ELOM SOPs. All fish tissue was extracted using an ASE 200 and analyzed by GC/MS.

The MDLs for pesticides and PCBs in fish tissue are presented in Table C-18. Acceptance criteria for PCB and pesticides SRMs in fish tissue are presented in Tables C-19. Fish tissue pesticide and PCB QA/QC summary data are presented in Table C-20. All analyses were performed within the required holding times and with appropriate quality control measures. In cases where constituent concentrations exceeded the calibration range of the instrument, the samples were diluted and reanalyzed. Any variances that occurred during sample preparation or analyses are noted in Table C-20.

Analytical Methods – Lipid Content

Percent lipid content was determined for each fish sample using methods described in the ELOM SOPs. Lipids were extracted by dichloromethane from approximately 1 to 2 g of sample and concentrated to 2 mL. A 100 µL aliquot of the extract was placed in a tared aluminum weighing boat and the solvent allowed to evaporate to dryness. The remaining residue was weighed, and the percent lipid content calculated. Lipid content QA/QC summary data are presented in Table C-21. All analyses were performed within the required holding times and with appropriate quality control measures. No variances occurred during sample preparation or analyses (Table C-21).

Analytical Methods – Mercury, Arsenic and Selenium

Fish tissue samples were analyzed for mercury, arsenic, and selenium in accordance with ELOM SOPs. Typical QC analyses for a tissue sample batch included a blank, a blank spike, and SRMs (liver and muscle). In the same batch, additional QC samples included duplicate analyses of the sample, spiked samples and duplicate spiked samples, which were run approximately once every 10 samples.

The MDL for fish mercury, arsenic, and selenium are presented in Table C-18. Acceptance criteria for the mercury, arsenic, and selenium SRMs are presented in Table C-22. Fish tissue mercury, arsenic, and selenium QA/QC summary data are presented in Table C-23. All samples were analyzed within their 6-month holding times and met the QA criteria guidelines.

Table C–18. Method detection levels (MDLs) for pesticides, PCB congeners, arsenic, mercury, and selenium in fish tissue, DSQ II, July 2014–June 2015.

Parameter	MDL (ng/g wet weight)	Parameter	MDL (ng/g wet weight)
cis-Chlordane	0.33	PCB 105	0.13
trans-Chlordane	0.25	PCB 110	0.19
Oxychlordane *	1.0	PCB 114	0.10
Dieldrin	0.31	PCB 118	0.22
Heptachlor	0.23	PCB 119	0.14
Heptachlor epoxide	0.37	PCB 123	0.21
cis-Nonachlor	0.19	PCB 126	0.11
trans-Nonachlor	0.21	PCB 128	0.08
2,4'-DDD	0.33	PCB 138	0.16
4,4'-DDD	0.16	PCB 149	0.33
2,4'-DDE	0.23	PCB 151	0.22
4,4'-DDE	0.31	PCB 153/168	0.23
2,4'-DDT	0.33	PCB 156	0.10
4,4'-DDT	0.24	PCB 157	0.10
4,4'-DDMU	0.43	PCB 167	0.09
PCB 18	0.24	PCB 169	0.15
PCB 28	0.21	PCB 170	0.18
PCB 37	0.27	PCB 177	0.09
PCB 44	0.36	PCB 180	0.18
PCB 49	0.17	PCB 183	0.13
PCB 52	0.17	PCB 187	0.06
PCB 66	0.26	PCB 189	0.12
PCB 70	0.23	PCB 194	0.17
PCB 74	0.24	PCB 201	0.20
PCB 77	0.21	PCB 206	0.11
PCB 81	0.19	Arsenic	100
PCB 87	0.17	Mercury	0.00
PCB 99	0.44	Selenium	69
PCB 101	0.14		

* Reporting limit used.

Table C–19. Acceptance criteria for standard reference materials of PCB/pesticides in fish tissue, July 2014–June 2015.

Parameter	True Value (ng/g)	Acceptance Range (ng/g)	
		Minimum	Maximum
CARP-2; National Research Council Canada.			
trans-Chlordane *	4.50	21.1	22.5
Dieldrin *	8.30	2.40	3.40
trans-Nonachlor *	11.0	82.4	99.4
2,4'-DDD *	21.8	144	172
4,4'-DDD *	90.9	7.50	9.10
2,4'-DDE *	2.90	3.80	5.20
4,4'-DDE *	158	10.1	11.9
PCB 18	27.3	23.3	31.3
PCB 28	34.0	26.8	41.2
PCB 44	86.6	60.7	112
PCB 52	138	95.5	181
PCB 66 *	174	122	226
PCB 101 *	145	97.0	193
PCB 105 *	53.2	37.6	68.8
PCB 118	148	115	181
PCB 128	20.4	16.0	24.8
PCB 138 *	103	73.0	133
PCB 153/168	105	83.0	127
PCB 170 *	20.6	17.7	23.5
PCB 180	53.3	40.3	66.3
PCB 187 *	37.1	30.8	43.4
PCB 194	10.9	7.80	14.0
PCB 206	4.4	3.30	5.50
Lipid	7.00		

Table C-19 Continues.

Table C-19 Continued.

Parameter	True Value (ng/g)	Acceptance Range (ng/g)	
		Minimum	Maximum
SRM 1946, Lake Superior Fish Tissue; National Institute of Standards and Technology.			
cis-Chlordane	32.5	1.95	2.45
trans-Chlordane	8.36	0.75	1.33
Oxychlordane	18.9	19.1	25.5
Dieldrin	32.5	14.9	20.5
Heptachlor epoxide	5.50	325	421
cis-Nonachlor	59.1	33.7	40.7
trans-Nonachlor	99.6	30.7	34.3
2,4'-DDD	2.20	55.5	62.7
4,4'-DDD	17.7	29.0	36.0
2,4'-DDE *	1.04	5.27	5.73
4,4'-DDE	373	17.4	20.4
2,4'-DDT *	22.3	7.45	9.27
4,4'-DDT	37.2	92.0	107
PCB 18 *	0.84	0.73	0.95
PCB 28 *	2.00	1.76	2.24
PCB 44	4.66	3.80	5.52
PCB 49	3.80	3.41	4.19
PCB 52	8.10	7.10	9.10
PCB 66	10.8	8.90	12.7
PCB 70	14.9	14.3	15.5
PCB 74	4.83	4.32	5.34
PCB 77	0.33	0.30	0.35
PCB 87	9.40	8.00	10.8
PCB 99	25.6	23.3	27.9
PCB 101	34.6	32.0	37.2
PCB 105	19.9	19.0	20.8
PCB 110	22.8	20.8	24.8
PCB 118	52.1	51.1	53.1
PCB 126	0.38	0.36	0.40
PCB 128	22.8	20.9	24.7
PCB 138	115	102	128
PCB 149	26.3	25.0	27.6
PCB 153/168	170	161	179
PCB 156	9.52	9.01	10.0
PCB 170	25.2	23.0	27.4
PCB 180	74.4	70.4	78.4
PCB 183	21.9	19.4	24.4
PCB 187	55.2	53.1	57.3
PCB 194	13.0	11.7	14.3
PCB 201 *	2.83	2.7	2.96
PCB 206	5.40	4.97	5.83
Lipid *	10.2		

* Non-certified value.

Table C–20. Fish PCB/Pest QA/QC summary, July 2014–June 2015.

Quarter	Sample Set	Parameter	Description	Number of Compounds Tested	Number of Compounds Passed	Target Accuracy % Recovery	Target Precision % RPD
Winter	FISHJAN15_LR	PCBs and Pesticides	Blank	108	108	<3X MDL	N/A
			Blank Spike	54	52	75-125	N/A
			Matrix Spike	54	47	70-130	N/A
			Matrix Spike Dup	54	48	70-130	N/A
			Matrix Spike Precision	54	54	N/A	<25%
			Duplicate	108	108	N/A	<25%@ 3 x MDL of sample mean
			CRM Analysis	64	55	80-120% or certified value whichever is greater.	N/A
Winter	FISHJAN15_MQ	PCBs and Pesticides	Blank	108	108	<3X MDL	N/A
			Blank Spike	54	51	75-125	N/A
			Matrix Spike	54	52	70-130	N/A
			Matrix Spike Dup	54	52	70-130	N/A
			Matrix Spike Precision	54	54	N/A	<25%
			Duplicate	108	105	N/A	<25%@ 3 x MDL of sample mean
			CRM Analysis	64	52	80-120% or certified value whichever is greater.	N/A
Winter	FISHJAN15_MR	PCBs and Pesticides	Blank	108	108	<3X MDL	N/A
			Blank Spike	54	49	75-125	N/A
			Matrix Spike	54	52	70-130	N/A
			Matrix Spike Dup	54	52	70-130	N/A
			Matrix Spike Precision	54	54	N/A	<25%
			Duplicate	108	107	N/A	<25%@ 3 x MDL of sample mean
			CRM Analysis	64	49	80-120% or certified value whichever is greater.	N/A

Table C-20 Continues.

Table C-20 Continued.

Quarter	Sample Set	Parameter	Description	Number of Compounds Tested	Number of Compounds Passed	Target Accuracy % Recovery	Target Precision % RPD
Winter	FISHJAN15_MS	PCBs and Pesticides	Blank	108	108	<3X MDL	N/A
			Blank Spike	54	46	75-125	N/A
			Matrix Spike	54	50	70-130	N/A
			Matrix Spike Dup	54	52	70-130	N/A
			Matrix Spike Precision	54	50	N/A	<25%
			Duplicate	108	106	N/A	<25%@ 3 x MDL of sample mean
			CRM Analysis	64	NA *	80-120% or certified value whichever is greater.	N/A
Winter	FISHJAN15_MT	PCBs and Pesticides	Blank	108	108	<3X MDL	N/A
			Blank Spike	54	51	75-125	N/A
			Matrix Spike	54	50	70-130	N/A
			Matrix Spike Dup	54	50	70-130	N/A
			Matrix Spike Precision	54	53	N/A	<25%
			Duplicate	108	107	N/A	<25%@ 3 x MDL of sample mean
			CRM Analysis	64	53	80-120% or certified value whichever is greater.	N/A

* CRMs not analyzed (NA) due to matrix interference on internal standards.

N/A = Not Applicable.

Table C–21. Fish tissue percent lipid QA/QC summary, July 2014–June 2015.

Sample Set	Tissue Type	Parameter	Description	Number of Compounds Tested	Number of Compounds Passed	Target Precision % RPD
FISH-EXLIPJAN15_LR	Liver	Percent Lipid	Duplicate Samples	2	2	<25%
FISH-EXLIPJAN15_MQ	Muscle	Percent Lipid	Duplicate Samples	2	2	<25%
FISH-EXLIPJAN15_MR	Muscle	Percent Lipid	Duplicate Samples	2	2	<25%
FISH-EXLIPJAN15_MS	Muscle	Percent Lipid	Duplicate Samples	2	2	<25%
FISH-EXLIPJAN15_MT	Muscle	Percent Lipid	Duplicate Samples	2	2	<25%

Table C–22. Acceptance criteria for standard reference materials of metals in fish tissue, July 2014–June 2015.

Parameter	True Value (ng/g)	Acceptance Range (ng/g)	
		Minimum	Maximum
DORM-3; Dogfish Muscle and Liver Reference Material for Mercury, National Research Council Canada.			
Mercury	0.38	0.32	0.44
Arsenic	6.88	6.58	7.18
Selenium	3.3	N/A	N/A

N/A = Not Applicable.

Table C–23. Fish tissue metals QA/QC summary, July 2014–June 2015.

Quarter	Sample Set	Parameter	Description	Number of Compounds Tested	Number of Compounds Passed	Target Accuracy % Recovery	Target Precision % RPD
Winter	HGFISH150316-1	Mercury	Blank	2	2	<2X MDL	N/A
			Blank Spike	2	2	90-110	N/A
			Matrix Spike	4	4	70-130	N/A
			Matrix Spike Dup	4	4	70-130	N/A
			Matrix Spike Precision	4	4	N/A	<25%
			Duplicate	4	4	N/A	@ ≥10X MDL <30%
			CRM Analysis	1	1	80-120% or certified value whichever is greater.	
Winter	HGFISH150323-1	Mercury	Blank	3	3	<2X MDL	N/A
			Blank Spike	3	3	90-110	N/A
			Matrix Spike	6	6	70-130	N/A
			Matrix Spike Dup	6	6	70-130	N/A
			Matrix Spike Precision	6	6	N/A	<25%
			Duplicate	6	5 *	N/A	@ ≥10X MDL <30%
			CRM Analysis	1	1	80-120% or certified value whichever is greater.	N/A
Winter	HMFISH150624-1	Arsenic and Selenium	Blank	8	6 **	<2X MDL	N/A
			Blank Spike	4	4	90-110	N/A
			Matrix Spike	6	6	70-130	N/A
			Matrix Spike Dup	6	6	70-130	N/A
			Matrix Spike Precision	6	6	N/A	<25%
			Duplicate	6	6	N/A	@ ≥10X MDL <30%
			CRM Analysis	2	2	80-120% or certified value whichever is greater.	N/A

* Non-homogenous sample.

** Blank for SE out of QA/QC, however average of blanks is ND.

N/A = Not Applicable.

Pretreated (resected and 1:1 Muscle: water homogenized) fish samples were analyzed for mercury, arsenic, and selenium in accordance with methods described in the ELOM SOPs. QC for a typical batch included a blank, a blank spike, and an SRM (whole fish). Fish samples with duplicates, spiked samples, and duplicate spiked samples were run approximately once every 10 fish samples. When sample mercury, arsenic, or selenium concentration exceeded the appropriate calibration curve, the sample was diluted with the reagent blank and reanalyzed. The samples were analyzed for mercury on a Perkin Elmer FIMS 400 system and for arsenic and selenium on a Perkin Elmer ELAN 6100 system.

All samples met the QA criteria guidelines for accuracy and precision (Table C-23).

BENTHIC INFAUNA NARRATIVE

Sorting and Taxonomy QA/QC

The sorting and taxonomy QA/QC follows the District's QAPP. These QA/QC procedures were conducted on sediment samples collected for infaunal community analysis in July 2014 (summer) from 29 semi-annual stations (52–65 m) and 39 annual stations (40–300 m), and in January 2015 (winter) from the same 29 semi-annual stations (Figure 2-2, Table A-1), for a total of 97 samples for the year. A single sample was collected at each station for infauna.

Sorting QA/QC Procedures

The sorting procedure involved removal, by the contractor (Marine Taxonomic Services, Inc. (MTS)), of organisms including their fragments from sediment samples into separate vials by major taxa. The abundance of countable organisms (heads only) per station was recorded. After MTS's in-house sorting efficiency criteria were met, the organisms and remaining particulates (grunge) were returned to the District. Ten percent of these samples (10 of 97) were randomly selected for re-sorting by District staff. A tally was made of any countable organisms missed by MTS. A sample passed QC if the total number of countable animals found in the re-sort was ≤ 5% of the total number of individuals originally reported.

2014-15 Sorting QA/QC Results

Sorting results for all 2014-15 QA samples were well below the 5% QC limit.

Taxonomic Identification QA/QC Procedures

Benthic infauna samples underwent comparative taxonomic analysis by 2 taxonomists. Samples were randomly chosen for re-identification from each taxonomist's allotment of assigned samples. These were swapped between taxonomists with the same expertise in the major taxa. The resulting data sets were compared and a discrepancy report generated. The participating taxonomists reconciled the discrepancies. Necessary corrections to taxon names or abundances were made to the database. The results were scored and errors tallied by station. Percent errors were calculated using the equations below:

Equation 1. $\%Error_{\#\,Taxa} = [(\#\,Taxa_{Resolved} - \#\,Taxa_{Original}) \div \#\,Taxa_{Resolved}] \times 100$

Equation 2. $\%Error_{\#\,Individuals} = [(\#\,Individuals_{Resolved} - \#\,Individuals_{Original}) \div \#\,Individuals_{Resolved}] \times 100$

Equation 3. $\%Error_{\#\,ID\,Taxa} = (\#\,Taxa_{Misidentification} \div \#\,Taxa_{Resolved}) \times 100$

Equation 4. $\%Error_{\#\,ID\,Individuals} = (\#\,Individuals_{Misidentification} \div \#\,Individuals_{Resolved}) \times 100$

Please refer to the District's QAPP for detailed explanation of the variables.

The first 3 equations are considered gauges of errors in accounting (e.g., recording on wrong line, miscounting, etc.), which, by their random nature, are difficult to predict. Equation 4 (Eq. 4) is the preferred measure of identification accuracy. It is weighted by abundance and has a more rigorous set of corrective actions (e.g., additional taxonomic training) when errors exceed 10%.

In addition to the re-identifications, a synoptic data review was conducted upon completion of all data entry and QA. This consisted of a review of the infauna data for the survey year, aggregated by taxonomist (including both in-house and contractor). From this, any possible anomalous species reports, such as species reported outside its known depth range and possible data entry errors, were flagged.

<u>2014-15 Taxonomic QA/QC Results</u>

QC objectives for identification accuracy (Eq. 4) were met in 2014-15 (Table C-24). No significant changes to the 2014-15 infauna dataset were made following the synoptic data review.

Table C–24. Percent error rates calculated for July 2014 QA samples.

Error Type	Station			
	C	59	70	Mean
1. $\%Error_{\#\ Taxa}$	6.9	5.8	6.8	6.5
2. $\%Error_{\#\ Individuals}$	1.4	0.2	0.7	0.8
3. $\%Error_{\#\ ID\ Taxa}$	4.0	10.0	7.8	7.2
4. $\%Error_{\#\ ID\ Individuals}$	1.2	5.8	2.4	3.1

OTTER TRAWL NARRATIVE

The District's trawl sampling protocols are based upon regionally developed sampling methods (Mearns and Stubs 1974, Mearns and Allen 1978) and US Environmental Protection Agency 301(h) guidance documents (Tetra Tech 1986). These methods require that a portion of the trawl track must pass within a 100-m circle centered on the nominal sample station position and be within 10% of the station's nominal depth. In addition, the speed of the trawl should range from 0.77 to 1.0 m/s (1.5 to 2.0 kts). Since 1985, the District has trawled a set distance of 450 m (the distance that the net is actually on the bottom collecting fish and invertebrates). This contrasts with previous regional trawl surveys which factored in time on the bottom, not distance. Station locations and trawling speeds and paths were determined using Global Positioning System (GPS) navigation. Trawl depths were determined using a Sea-Bird Electronics SBE 39 pressure sensor attached to one of the trawl boards.

For the 2014-15 monitoring period, all trawl QA/QC compliance criteria were met, except for trawl speed (Figures C-1 to C-4, Table C-25).

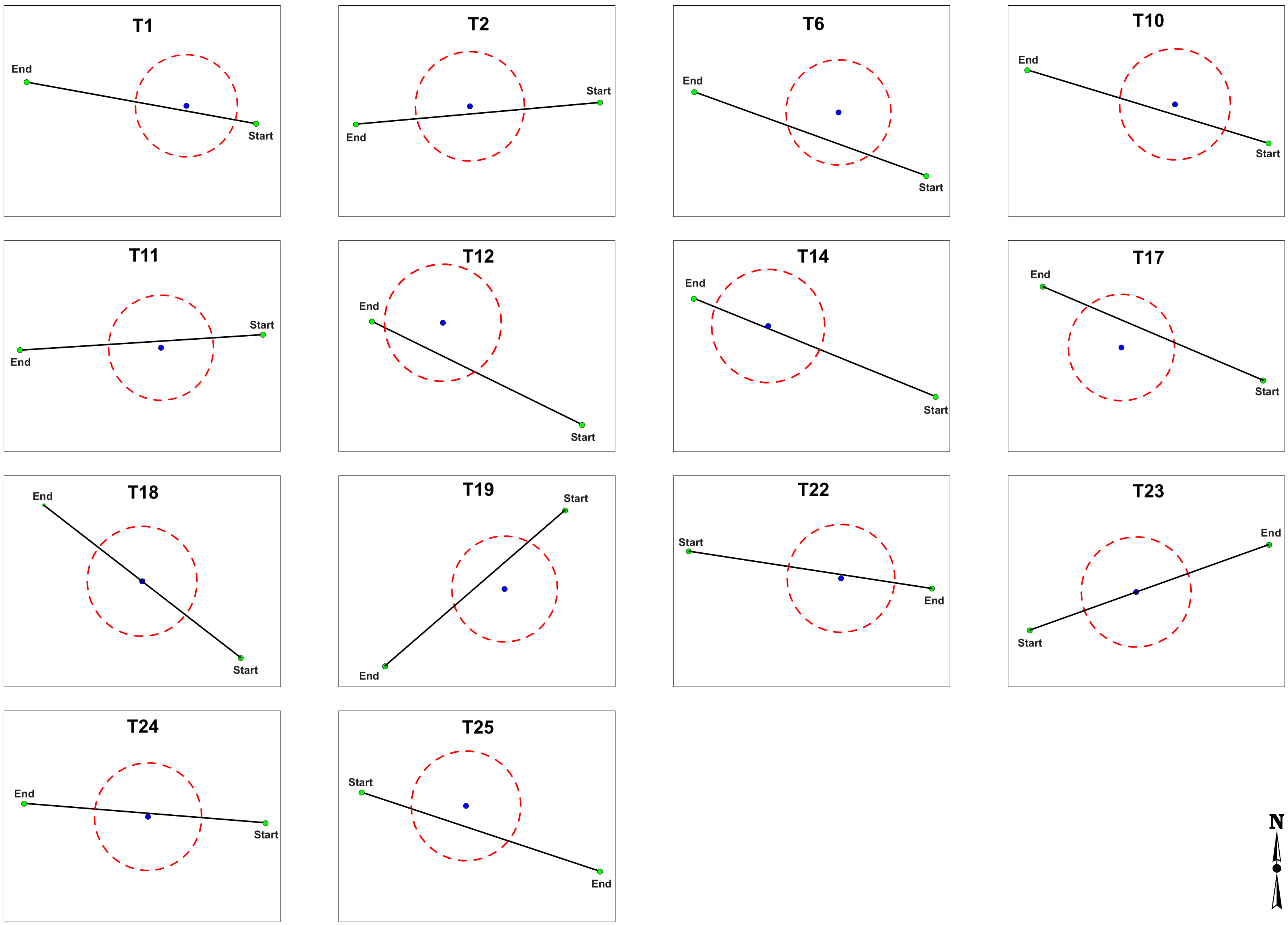

Figure C–1. **Quality assurance plots of otter trawl paths in relation to a 100-m circle (red dashes) surrounding each nominal station position, July 2014.**

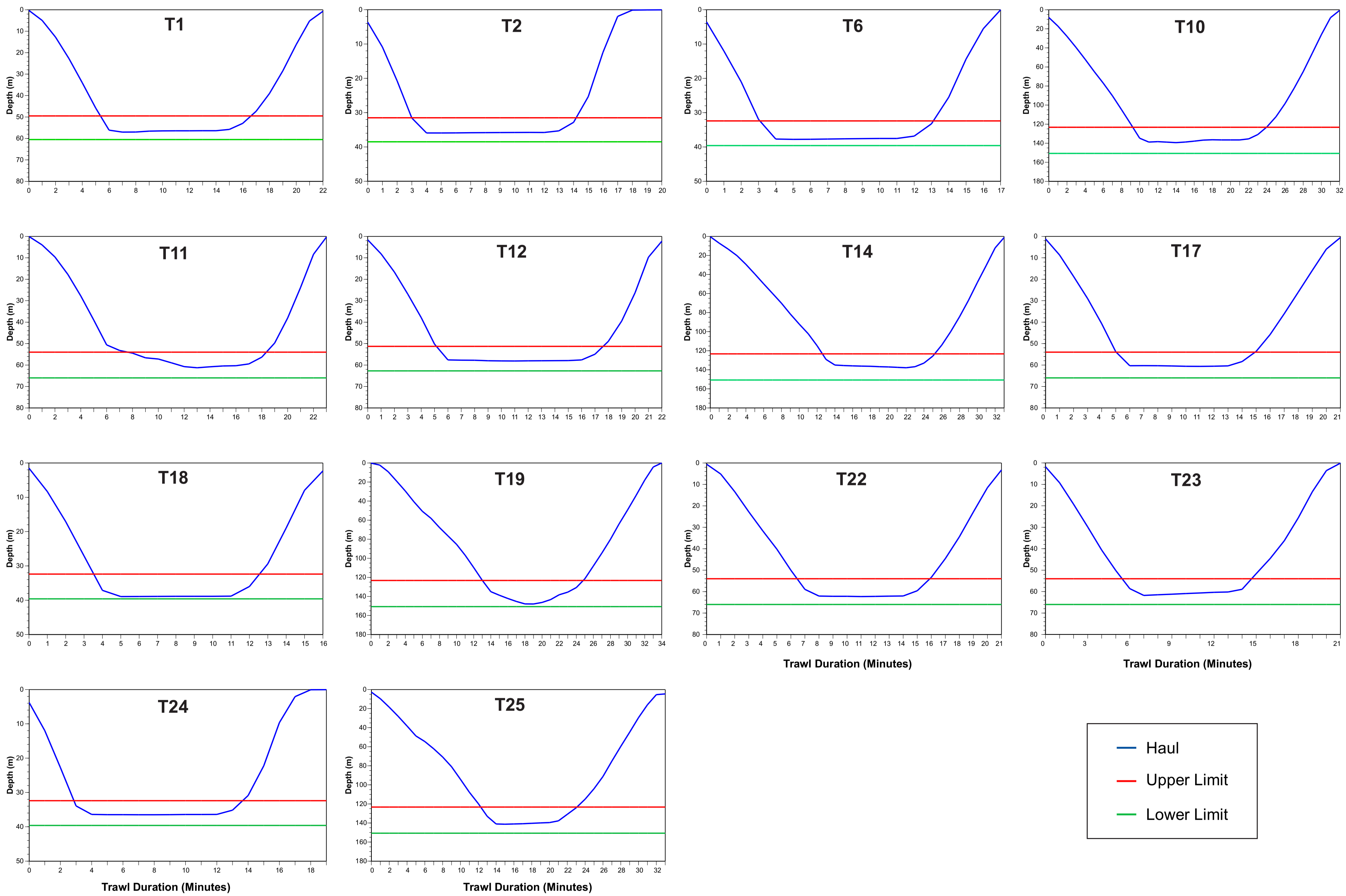

Figure C–2. Quality assurance plots of trawl depth per haul for otter trawl stations, July 2014.
Upper and lower limit lines are ±10% of nominal trawl depth.

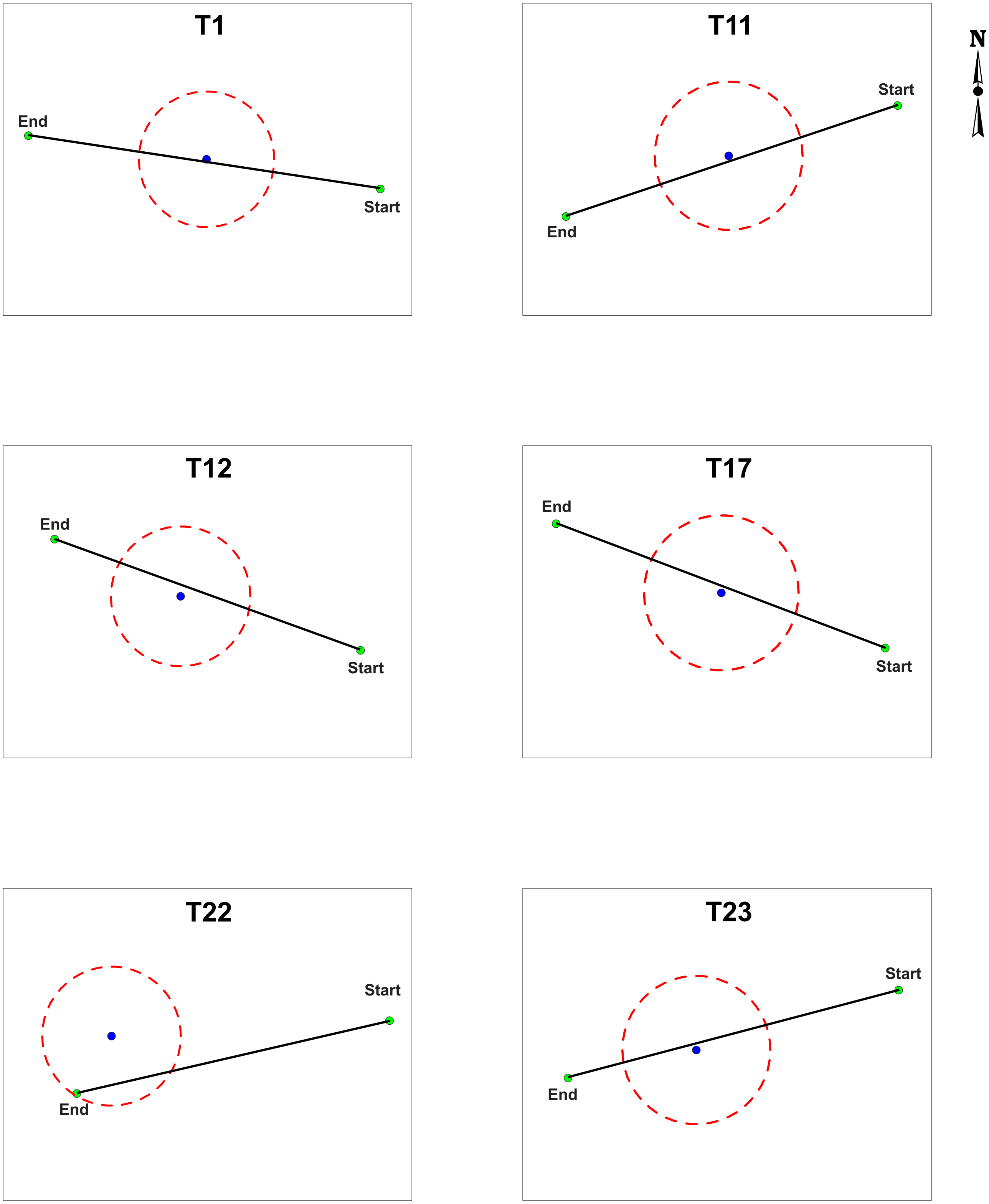

Figure C–3. Quality assurance plots of otter trawl paths in relation to a 100-m circle (red dashes) surrounding each nominal station position, January 2015.

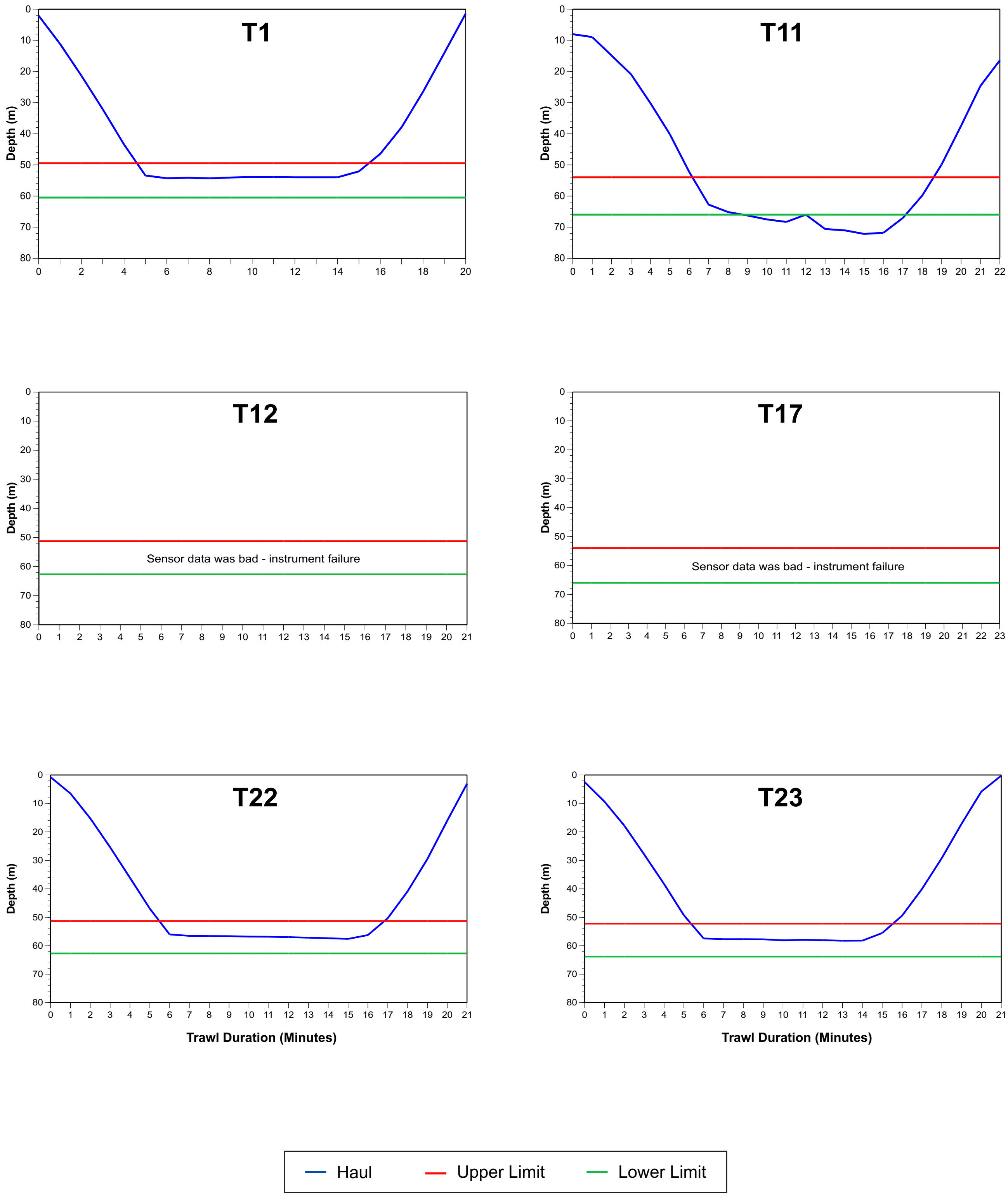

Figure C–4. Quality assurance plots of trawl depth per haul for otter trawl stations, January 2015. Upper and lower limit lines are ±10% of nominal trawl depth.

Table C–25. Trawl track distances and vessel speed for sampling conducted in Summer 2014 and Winter 2015.

Season	Station	Distance Trawled (m)	Vessel speed (kts) *
Summer	T1	460.8	**1**
	T2	449.3	**0.9**
	T6	474.2	**1**
	T10	452.1	**0.9**
	T11	460.3	**0.9**
	T12	398.1	**0.9**
	T14	458.5	**0.9**
	T17	459.3	**1**
	T18	459.2	**1.1**
	T19	451.5	**0.9**
	T22	455.8	**1**
	T23	462.4	**1.1**
	T24	453.4	**0.9**
	T25	458.9	**0.9**
	Mean	451.5	0.9
Winter	T1	519.7	**1.1**
	T11	473.2	**1.1**
	T12	468	**1**
	T17	452.8	**1.1**
	T22	461	**0.9**
	T23	463.2	**1.1**
	Mean	474.9	1.1

* Vessel speeds outside of the QA range of 1.5-2 knots are denoted in bold.

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