Chapter 2

COMPLIANCE DETERMINATIONS

Chapter 2
COMPLIANCE DETERMINATIONS

INTRODUCTION

This chapter provides compliance results for the 2009-10 monitoring year for the Orange County Sanitation District's (District) ocean monitoring program. 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. Compliance determinations were made by comparing OMP findings to the criteria specified in the District's NPDES permit (Order No. R8-2004-0062; NPDES Permit No. CA0110604).

Sampling locations included 17 nearshore (surfzone) and 29 offshore water quality stations (Figures 2-1, 3-1, and A-1 respectively), 49 stations to assess benthic (bottom-dwelling) communities and sediment chemistry (Figures 4-1 and 5-1), and 9 trawl stations to evaluate fish and macroinvertebrate communities (Figure 6-1). Monitoring frequencies varied by component, and ranged from 2 or 5 days per week for surfzone water quality to annual assessments of fish health and tissue analyses.

The water quality sampling stations comprised two groups. The first group was the 17 nearshore stations. This group of stations must comply with nearshore bacterial standards, as defined by the State of California. The second group was the 29 offshore stations that comprise a fixed-grid pattern around the outfall. Nine of these stations were located within 3 miles of the shoreline, and were considered Rec-1 stations (Table A-1). These stations were sampled for bacteria and must comply with offshore bacterial standards.

The 29 offshore stations were also separated into two zones (A and B) for determining compliance with physical and chemical water quality standards. Station locations were defined as either Zone A (stations located on the 2 inner most alongshelf transects) or Zone B (stations located on the 2 outer most alongshelf transects) as shown in Figure A-1.

Compliance evaluations were based on statistical comparisons to the corresponding upcurrent Zone A or Zone B reference station (OCSD 1999). This matching of Zone A or Zone B stations allowed comparisons of data from similar water depths.

Table 2-1. Listing of compliance criteria from NPDES ocean discharge permit (Order No. R8-2004-0062, Permit # CAO110604) and compliance status for each criterion in 2009-10.

Orange County Sanitation District, California.

Criteria	Description	Criteria Met	Comments
Bacterial Characteristics			
C.2.a.1	Total coliform (water contact)	Yes	Compliance was achieved 100% of the time in the Offshore Zone (Chapter 3). Nearshore compliance, based on more restrictive shellfish standard (C.2.b below), was achieved 96.6% and 95.6% of the time for 30-day median and the 20% standards, respectively (Appendix B).
C.2.a.2	Fecal coliform (water contact)	Yes	Offshore compliance was achieved 100% of the time (Chapter 3). Nearshore samples had 100% and 98.3% compliance for the geometric mean and 10% standards, respectively (Appendix B).
C.2.b	Total coliform (shellfish harvesting)	Yes	Nearshore samples had 96.6% and 95.6% compliance with the 30-day median and the 10% standards, respectively (Appendix B).
C.2.c	Enterococci (water contact)	Yes	Monitoring only. All Offshore Zone samples met 30-day and 6-month permit limits. Nearshore samples met 30-day and 6-month permit limits 97.1% and 96.7% of the time respectively (Appendix B).
Physical Characteristics			
C.3.a	Floating particulates, oils and grease	Yes	No wastewater particles, oils or grease were observed during the monitoring year in either the Nearshore or Offshore Zones (Chapter 3).
C.3.b	Water clarity and discoloration	Yes	Offshore compliance standards were met 100% of the time (Chapter 3).
C.3.c	Light transmittance	Yes	Greater than 96% of the Offshore values were in compliance. All out-of-compliance values fell within the range of natural variability and would not cause significant environmental effects (Chapter 3).
C.3.d	Inert solids	Yes	There were no measured effects to sediments from discharge-related inert solids (Chapter 4).
Chemical Characteristics			
C.4.a	Dissolved oxygen	Yes	Greater than 97% of the Offshore values were in compliance. All out-of-compliance values fell within the range of natural variability and would not cause significant environmental effects (Chapter 3).
C.4.b	Acidity (pH)	Yes	All (100%) of the values were in compliance (Chapter 3).
C.4.c	Dissolved sulfides	Yes	Dissolved sulfide concentrations in sediments did not result in anaerobic conditions (Chapter 4).
C.4.d	Table B substances in sediments	Yes	Several metals exceeded the Effects-Range-Low (ERL) at some stations in the submarine canyon or slope stations. No sample exceeded the Effects Range-Median concentration for any metal PCB concentrations were elevated near the outfall compared to other sites. DDT levels were elevated above the ERL at most sites. Whole sediment toxicity testing demonstrated measurable toxicity at within-ZID Station 0 (Chapter 4).
C.4.e	Organics in sediments	Yes	Sediment total organic carbon concentrations did not result in excessive organic loading or anaerobic conditions (Chapter 4).
C.4.f	Nutrients	Yes	Ammonium values were 20 to a couple of hundred times lower than California Ocean Plan objectives and there were no chlorophyll/plankton associated impacts (Chapter 3).
C.4.g	Table B substances in ZID	Yes	None of these constituents exceeded the effluent limitations established in the permit. Reported in Monthly Discharge Monitoring Reports.
Biological Characteristics			
C.5.a	Marine biological communities	Yes	Minor to moderate discharge effects were seen in infaunal assemblages near the outfall, beyond the ZID, but no sample outside of the ZID was classified as “degraded” (Chapter 5). Trawl sampling results showed that invertebrate and fish populations were generally normal and healthy beyond the ZID and the outfall was not a disease epicenter (Chapter 6).
C.5.b	Fish tissue (taste, odor, and color)	Yes	All collected fish exhibited normal color or odor. All fish muscle appeared normal and comparable to other areas within the Southern California Bight (Chapter 6).
C.5.c	Fish tissue (bioaccumulation)	Yes	Seven fish had muscle tissue PCB concentrations above the state human health guidelines. Five of these were collected from the farfield site and 2 from the outfall site. All muscle tissue samples contained mercury, PCB, and DDT concentrations below state and federal human consumption guidelines (Chapter 6).
Radioactivity Characteristics			
C.6	Radioactivity	Yes	Radioactivity is measured in effluent only and reported in the Discharge Monitoring Report. All limits met.

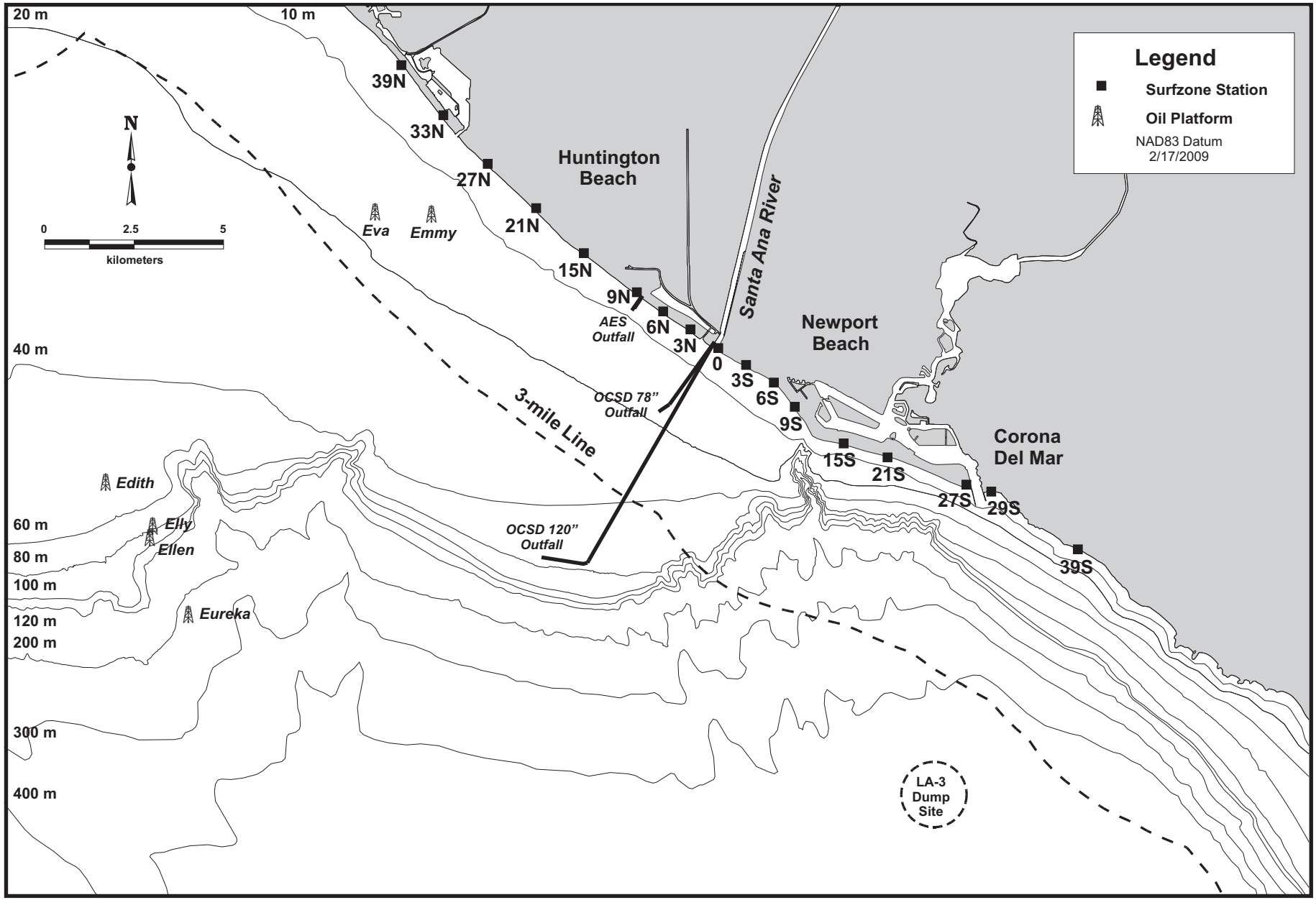

Figure 2-1. Sampling locations for nearshore (surfzone) monitoring stations, 2009-10.

Orange County Sanitation District, California.

RESULTS AND DISCUSSION

A compliance summary is presented in Table 2-1.

Bacterial Criteria

Criteria C.2.a.1 and C.2.a.2 require that the discharge not cause nearshore and offshore water contact standards to be exceeded for total coliform and fecal coliform bacteria. Additionally, for total coliforms, shellfish harvesting standards applied at the nearshore stations (Criterion C.2.b). Finally, monitoring only (bacterial assessment) was required for enterococci bacteria in both zones (Criterion C.2.c).

Water contact criteria have two standards that need to be met. Total coliform bacteria have a single sample maximum of 10,000/100 mL (if verified by a repeat sample taken within 48 hours) and a 30-day geometric mean limit of 1,000/100 mL, provided that no more than 20% of the samples at any station exceed 1,000/100 mL. Fecal coliform bacteria cannot exceed a 30-day geometric mean of 200/100 mL and no more than 10% of the samples can exceed 400/100 mL within any 60-day period. Enterococci limits are a 30-day geometric mean of 24/100 mL or 12/100 mL over a 6-month period. The shellfish harvesting standard limit for total coliform is a median density not to exceed 70/100 mL, provided that no more than 10% of the samples exceed 230/100 mL. For nearshore total coliform bacteria, compliance determinations for water contact criteria were made using the more restrictive shellfish standards.

Nearshore

The 30-day median and 30-day 10% standards were met at the 17 surfzone stations over 95% of the time (Tables B-1 and B-2). The fecal coliform benchmark was met 100% for the monthly geometric mean standard and >98% for the 60-day 10% standard (Tables B-3 and B-4). Enterococci benchmarks were met with >97% compliance for the 30-day geometric mean (Table B-5) and >96% compliance for the 6-month geometric mean standards (Table B-6). For those nearshore samples that exceeded the permit limits, 87–100% of them occurred at five contiguous stations (9N to 3S) that are either impacted by the Santa Ana River (3N, 0, and 3S) or associated with continued chronic bacterial contamination (9N and 6N).

Offshore

The offshore receiving water standards were met at the nine Rec-1 stations with 100% compliance for both total and fecal coliform bacteria (Tables B-7 and B-8). No total coliform sample exceeded 600 MPN/100 mL at any of these stations. The highest recorded value was 549 MPN/100 mL. The majority of values were less than the minimum detection level (Table B-7). No fecal coliform sample exceeded 100 MPN/100 mL. The highest recorded value was 17 MPN/100 mL (Table B-8). No offshore standards exist for enterococci. However, enterococci concentrations were low with the majority of values less than the minimum detection level. The highest recorded concentration was 67 MPN/100 mL (Table B-9).

This suggests that it was unlikely that the wastewater discharge impacted bacterial levels in recreational waters. Since the onset of effluent disinfection in August 2002, the incidence of detectable bacterial concentrations in offshore waters has decreased markedly.

Physical Criteria

The criteria for determining compliance with physical characteristics (C.3.a–d) are narrative and apply to the discharge of floatable material, substances that could

alter the color or transparency of the water, and/or contaminate sediments and degrade biological communities.

Floating Particulates and Oil and Grease

Criterion C.3.a states that "floating particulates and oil and grease shall not be visible." There were no observations of oils and grease at any offshore or nearshore station in 2009-10 (Tables B-10, B-11, and B-12). Therefore, compliance was achieved with this criterion.

Ocean Discoloration and Transparency

These criteria specify that "the discharge of waste shall not cause aesthetically undesirable discoloration of the ocean surface" (C.3.b) and that "natural light shall not be significantly reduced at any point outside the initial dilution zone" (C.3.c).

Secchi depth and water color data were generally consistent with the transmissivity results, showing the lowest surface water clarity at stations closer to shore and near the Newport Canyon with progressively clearer water with distance offshore (see Chapter 3). The lower water clarity at the shallower stations typically reflects higher natural turbidity due to runoff and resuspension of sediment due to wave activity. The general patterns noted for Secchi depth were consistent with results from prior monitoring years (OCSD 1991, 1996a, 2004, 2010a). Photosynthetically active radiation (PAR) results further confirmed the lack of an outfall signal for surface water clarity. There were no impacts from the wastewater discharge relative to ocean discoloration at any offshore station.

Transmissivity results used to assess compliance with COP narrative water clarity standards. These standards were met 99.8% and 92.6% of the time for Zone A and B stations, respectively (Table 2-2). For all stations combined, overall compliance for was 96.4%, which represents a slight decrease from the previous year. This small number of out-of-compliance values was not environmentally significant. For example, all transmissivity values were within natural ranges of variability to which marine organisms are exposed (OCSD 1996a). Additionally, no discharge related impacts were observed for Secchi, PAR, or water color assessments. Since 1998, compliance for all stations combined has ranged from 83.2 to 98.4%.

Inert Solids

Criterion C.3.d states that "the rate of deposition and the characteristics of inert solids in ocean sediments shall not be changed such that benthic communities are degraded." No effects on sediments from effluent solids discharge were evident from the sediment characteristics or marine community data (Chapters 4, 5, and 6).

Chemical Criteria

These criteria (C.4.a–g) include limits to the water column and sediments. With the exception of dissolved oxygen and acidity (pH), all of the criteria are narrative.

Dissolved Oxygen

Criterion C.4.a states that "the dissolved oxygen (DO) concentration outside the zone of initial dilution shall not at any time be depressed more than 10 percent from that which occurs naturally as the result of the discharge of wastes." In 2009-10, compliance with this standard was met 99.2% and 96.3% of the time for Zone A and B station groups, respectively. Overall compliance was met 97.8% of the time for all stations combined (Table 2-2). This represents an increase in compliance of about 1.5% from the 2008-09 program year and extends the upper end of the range seen since 1998 (86.1–97.5%). The dissolved oxygen values were well within the range of long-term monitoring results (OCSD 1996b). No environmentally significant

Table 2-2. Summary of offshore water quality compliance testing results for dissolved oxygen, pH, and transmissivity for 2009-10.

The Predominant Direction category includes results from either reference Stations 2104 or 2404 (Zone A), and Stations 2105 or 2406 (Zone B). The Opposite Direction category includes results using the opposite reference stations when a predominant current direction (based on ammonium or current meter data) was not evident.

Orange County Sanitation District, California.

Parameter	Number of Observations	Current Direction	Number of Out-of-Range Occurrences	Percent of Out-of-Range Occurrences	Number Out-of-Compliance	Percent Out-of-Compliance
Zone A Stations						
Dissolved Oxygen	480	Predominant Direction	49	10.2	4	0.8
		Opposite Direction	40	8.3	4	0.8
		Mean	44.5	9.3	4.0	0.8
pH	480	Predominant Direction	28	5.8	0	0.0
		Opposite Direction	28	5.8	0	0.0
		Mean	28.0	5.8	0.0	0.0
%Transmissivity	480	Predominant Direction	268	55.8	0	0.0
		Opposite Direction	300	62.5	2	0.4
		Mean	284.0	59.2	1.0	0.2
Zone B Stations						
Dissolved Oxygen	432	Predominant Direction	37	8.6	20	4.6
		Opposite Direction	27	6.3	12	2.8
		Mean	32.0	7.5	16.0	3.7
pH	432	Predominant Direction	11	0.0	0	0.0
		Opposite Direction	11	0.0	0	0.0
		Mean	11.0	0.0	0.0	0.0
%Transmissivity	432	Predominant Direction	142	32.9	31	7.2
		Opposite Direction	124	28.7	33	7.6
		Mean	133.0	30.8	32.0	7.4
Total (Zone A and Zone B Stations Combined)						
Dissolved Oxygen	912	Predominant Direction	63	6.9	24	2.6
		Opposite Direction	67	7.3	16	1.8
		Mean	65.0	7.1	20.0	2.2
pH	912	Predominant Direction	39	4.3	0	0.0
		Opposite Direction	39	4.3	0	0.0
		Mean	39.0	4.3	0.0	0.0
%Transmissivity	912	Predominant Direction	410	45.0	31	3.4
		Opposite Direction	424	46.5	35	3.8
		Mean	417.0	45.8	33.0	3.6

effects to DO from the wastewater discharge were observed.

Acidity (pH)

Criterion C.4.b specifies that "the pH shall not be changed at any time more than 0.2 units from that which occurs naturally outside the zone of initial dilution as a result of the waste discharge." Zone A and B station groups met this compliance standard 100% (Table 2-2). This is an increase in compliance from the previous year's value of 99.2% and extends the upper end of the range seen since 1998 (95–99.5%). Moreover, the pH values measured were within the range to which marine organisms are naturally exposed. Therefore, there were no environmentally significant effects to pH from the wastewater discharge.

Dissolved Sulfides

This criterion (C.4.c) requires that "the dissolved sulfide concentration of waters in and near sediments shall not be significantly increased above that present under natural conditions." Sediment sulfide concentrations were elevated within the zone of initial dilution (ZID) from 2 to 5 times that of the control stations and within a factor of 2 at non-ZID nearfield stations (see Chapter 4). The slight elevations in sediment sulfide concentrations outside the ZID are consistent with long-term monitoring results and did not appear to have adversely affected indigenous invertebrate or fish populations.

Total Organic Carbon (TOC)

Criterion C.4.e states that "the concentrations of organic materials in marine sediments shall not be increased to levels which would degrade marine life." Sediment TOC concentrations varied little among the 60-m stations (range = 0.296–0.558%) and were not likely to be ecologically significant (See Chapter 4). Thus, the monitoring results for sediment quality indicate that deposition of effluent-derived organic material did not cause excessive loading or anaerobic conditions and that compliance was achieved for this criterion.

Sediment Chemistry/Toxics

Criterion C.4.d states that "the concentrations of substances, set forth in Chapter IV, Table B, of the 1983 Water Quality Control Plan for Ocean Waters of California, in marine sediments shall not be increased to levels which would degrade indigenous biota" (C.4.d). There are no numeric limits for sediment chemical contaminants. For compliance assessment, sediment contaminant levels were evaluated by comparing chemical concentrations against background concentrations from control sites and sediment quality guidelines (SQG). SQGs were developed for the National Oceanographic and Atmospheric Administration (NOAA) Status and Trends Program (Long et al. 1995) and were used as benchmark values (see Chapter 4). The benchmarks, effects range-low (ERL) and effects range median (ERM), are defined by Long et al. (1995) as the 10^{th} percentile concentration of a chemical in sediment below which a toxic effect is unlikely and the 50^{th} percentile concentration above which a toxic effect occurs frequently, respectively.

Sediment Metals

Like previous years, sediment concentrations of mercury showed a spatial pattern seemingly related to the wastewater discharge, although no station exceeded the ERL value. Only copper and nickel exceeded ERL thresholds, but these occurred primarily at slope and canyon stations sampled in July 2009 with no outfall influence indicated.

Sediment Trace Organics

DDT was detected at all stations. Within-ZID Stations 4 and ZB and nearfield Station 9 were the only quarterly-sampled sites with

mean total DDT (tDDT) concentrations below the ERL. However, no quarterly or annual station exceeded the ERM, and there was no spatial pattern relative to the outfall evident. This is consistent with past results, which have shown that this legacy contaminant is distributed throughout the Southern California Bight. Nearly 63% of Bight mid-shelf sediments (30-120 m) have tDDT concentrations above the ERL (Schiff et al. 2006). In contrast, total PCB (tPCB) concentrations were higher in ZID station sediments suggesting an outfall influence; though no annual station value or quarterly station mean value exceeded the ERL. Total PAH concentrations were well below the ERL value, but were 2 to 9 times higher at outfall stations relative to the control stations. Overall, these results indicate minor impacts to sediment quality within the ZID and to a lesser degree at a few stations near the ZID, but with low possibility of adverse effects to biota from these compounds.

Toxicity

Although not a requirement of the District's NPDES permit, the District conducted whole sediment toxicity testing on samples collected from the ten 60-m quarterly stations in October 2009 and January 2010. Results showed measurable whole-sediment toxicity only at within-ZID Station 0 in October 2009. This is consistent with the high level of impact to the invertebrate community at that station, but in contrast to the predicted low-level of toxicity by the Mean-ERM-Quotient (mERMq) analysis based on sediment geochemistry concentrations. This suggests that the causative agent(s) is not being assessed in the mERMq analysis.

Nutrients

Criterion C.4.f specifies that "nutrient materials shall not cause objectionable aquatic growths or degrade indigenous biota." The District determines compliance with this criterion using ammonia concentrations in the water column. During 2009-10, 87% (n=2212) of the samples contained ammonia concentrations that were below the detection limit (Chapter 3). Detectable ammonia concentrations ranged from 0.02 (MDL) to 0.46 mg/L, with 63% (n=185) of the detected values collected from samples taken below 20 m. Plume-related changes in ammonia were not considered environmentally significant as maximum values were, respectively, about 10 to 15 times less than California Ocean Plan receiving water objectives for chronic (4 mg/L) and acute (6 mg/L) toxicity to marine organisms (OCSD 2004a) and there were no detectable plankton associated impacts (i.e., excessive plankton blooms caused by the discharge) (see Chapter 3).

Organics in the Water Column

Criterion C.4.g states that "the concentrations of substances set forth in Table B of the California Ocean Plan shall not be exceeded in the area within the waste field where initial dilution is completed." Based on the reasonable potential analysis conducted when the permit was adopted, 8 constituents from Table B of the Ocean Plan have effluent limitations established in this discharge permit (Order No. R8-2004-0062; NPDES Permit No. CA0110604). During the compliance period from July 2009 through June 2010, none of these constituents exceeded the effluent limitations established in the permit (OCSD 2010b).

Biological Criteria

Compliance criteria for biological communities specify that "marine communities, including vertebrates, invertebrates, and plant species, shall not be degraded" (C.5.a), "the natural taste, odor, and color of fish, shellfish, or other marine resources used for human consumption shall not be altered" (C.5.b), and "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" (C.5.c). The concept of a degraded community implies a loss of diversity or a significant change and/or loss of community function.

Invertebrates

Infaunal Community

Infaunal community measures were indicative of the environmental complexity of the monitoring area, including water depth effects, "reef" effects, and the influence of the wastewater discharge. In 2009-10, two stations within 0.6 Km of the ZID showed a marginal deviation from the reference condition or a changed community as measured by the Benthic Response Index (BRI) and Infaunal Trophic Index (ITI) respectively; but neither was considered degraded by either index (Chapter 5). Since 2005, there has been a trend towards declining infaunal community health at several stations within the ZID, particularly Stations 0 and ZB2 near the outfall terminus, which were categorized as having a loss of biodiversity as measured by the BRI to severe degradation as measured by the ITI. Infaunal community diversity and abundances within the monitoring area more distant (>1 km) from the outfall diffuser were comparable to regional values. Considering the degree of impact within the ZID and the apparent changes to the two nearfield stations, it appears that the discharge of the treated wastewater effluent negatively impacted infaunal communities near the point of discharge. However, there were no correlations to measured contaminants or conditions that might explain these changes, indicating the causative agent(s) were unmeasured by the core ocean monitoring program.

Trawl Macroinvertebrates

Results of community monitoring from the trawl monitoring stations showed that macroinvertebrate communities at outfall Station T1 were similar to the upcoast 60 m stations, as well as to regional reference areas. These results indicate that macroinvertebrate communities were not degraded (Chapter 6).

Vertebrates (Fishes)

Fish Community

Analysis of the demersal fish data indicates that the fish community at the outfall was not degraded. Fish community measures near the outfall were essentially the same as the upcoast 60 m stations, equaled or exceeded values for regional reference areas, and had Fish Response Index scores indicative of reference conditions (Chapter 6). Overall, there were no indications of a degraded demersal fish community in the area of the discharge or within the District's monitoring area.

Fish Tissue Contaminants

In 2009-10, fish tissue contaminant concentrations were generally low in all target species. Two English sole exceeded the State of California fish consumption guideline for the legacy contaminant PCB in muscle tissue. One fish was collected from near the outfall and the other from the farfield station. No statistically significant spatial differences were found between stations that could be attributable to the wastewater discharge.

Fish Health

Fish were examined visually for external parasites and abnormalities, such as skeletal deformities, tumors, lesions, and abnormal coloring. Less than 1% of the fish collected in 2009-10 showed evidence of irregularities. The most common irregularity was the presence of the eye parasite *Phrixocephalus cincinnatus* in Pacific sanddabs, which occurred in less than 1.4% of the fish examined (Chapter 6). These results are comparable to background levels found within the SCB

and do not indicate a degraded biota.

Fish Consumption

Compliance criteria (C.5.b and C.5.c) for fish consumption address the quality of seafood for human consumption relative to the taste, odor, color, and tissue contaminant concentrations of fish and shellfish. There are no numerical or objective criteria for assessing taste, odor, and color of organism tissues, so the evaluation was qualitative, based on observations only.

Fish collected during 2009-10 appeared normal in both color and odor. All fish muscle tissue appeared to be normal and comparable to that found in fresh specimens from other areas along the southern California coast. Estimates of carcinogenic and noncarcinogenic health risks from human consumption of seafood were not performed. However, all fish muscle tissue contaminant levels were below federal and most were below state human consumption guidelines for organic contaminants (Chapter 6). These results are comparable to results from other seafood consumption/health risk studies for this region, which show little risk from consuming fish from the monitoring area.

Radioactivity

This criterion (C.6) states that the "discharge of radioactive wastes shall not degrade marine life." The District measures the effluent for radioactivity, but not the receiving waters. The results of the effluent analyses consistently meet both state and federal standards and are published in the District's Discharge Monitoring Reports. As fish and invertebrate communities are generally diverse and healthy, compliance with this criterion is considered to be met.

CONCLUSIONS

In 2009-10, the District achieved compliance for all permit criteria. The overall frequency of compliance for all monitoring parameters cannot be expressed as a single numerical value because many of the criteria are descriptive rather than numeric. In summary, California Ocean Plan criteria for water quality were met. AB 411 bacterial standards were consistently achieved at near- and 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. Although impacts in the infaunal assemblages beyond the zone of initial dilution were documented for Stations 1 and 3, neither would be considered degraded. Finally, fish and trawl invertebrate communities in the monitoring area are healthy and diverse and the fish generally met federal and state fish consumption guidelines with no outfall influence indicated. These results indicate affects from the wastewater discharge are beginning to impact invertebrate communities immediately beyond the ZID, and that the causative agent(s) of changes is not being measured in the core ocean monitoring program; however the receiving environment was not degraded by the discharge of the treated wastewater, that environmental and human health were protected, and that all permit compliance criteria were met.

REFERENCES

Long, E.R., D.D. McDonald, S.L. Smith, and F.C. Calder. 1995. Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. *Environ. Manage*. 19:81–97.

OCSD (Orange County Sanitation District). 1991. Annual Report, 5-Year Perspective, 1985–1990. Marine Monitoring, Vol. 3 and Appendices. Fountain Valley, CA.

OCSD. 1996a. Science Report and Compliance Report, Ten Year Synthesis, 1985–1995. Marine Monitoring. Fountain Valley, CA.

OCSD. 1996b. Water Quality Atlas. Ten-Year Synthesis, 1985–1995. Marine Monitoring. Fountain Valley, CA.

OCSD. 1999. Annual Report, July 1997–June 1998. Marine Monitoring. Fountain Valley, CA.

OCSD. 2004a. Annual Report, Ocean Monitoring Program–Compliance Report, July 2002–June 2003. Marine Monitoring, Fountain Valley, CA.

OCSD. 2009. Annual Report, July 2007–June 2008. Marine Monitoring, Fountain Valley, CA.

OCSD. 2010a. Annual Report, July 2008–June 2009. Marine Monitoring, Fountain Valley, CA.

OCSD. 2010b. Annual Report, Operations and Maintenance, 2009–10. Fountain Valley, CA.

Schiff, K., K. Maruya, and K. Christensen. 2006. Southern California Bight 2003 Regional Monitoring Program: II. Sediment Chemistry. Southern California Coastal Water Research Project. Westminster, CA.