EXECUTIVE SUMMARY

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The Orange County Sanitation District (District) conducted extensive ocean monitoring to evaluate potential environmental and public health effects from the discharge of treated wastewater off of Huntington Beach and Newport Beach, California. The data collected were used to determine compliance with receiving water conditions as specified in the District's National Pollution Discharge Elimination System (NPDES) permit, which was jointly issued in 2004 by the U.S. Environmental Protection Agency, Region IX (EPA) and the Regional Water Quality Control Board, Region 8 (RWQCB). The monitoring program was designed to determine compliance with permit criteria and to maintain the District's long-term data collection used for trend analyses. This report focuses on monitoring results and conclusions from July 2010 through June 2011.

Results of the monitoring program continued to show that ocean depth is the primary determinant of the distribution of organisms within the monitoring area. However, a trend of decreasing diversity and abundances for the infaunal (small invertebrates) communities within the zone of initial dilution (ZID) that began in 2005 now extends to the closest station beyond the ZID (0.3 km). In addition, the demersal fish community near the outfall also changed reflecting the altered infaunal communities (fish prey species) near the outfall. While changes in receiving water and sediment chemical and physical characteristics were identified near the outfall, these changes were typically small and not suggestive of causing adverse effects on biota. Biological communities more than 0.5 km beyond the ZID were generally healthy, diverse, and comparable to those occurring under similar environmental conditions throughout the Southern California Bight.

WATER QUALITY

Natural water quality conditions during 2010-11 were typical of previous years with only minor changes in measured water quality parameters, primarily characterized by temperature stratification (layering) of the water column throughout most of the year. Currents and stratification were primary factors in determining the location of the discharged wastewater plume. Predominant alongshore current flows and strong temperature stratification in spring and summer kept the plume below the ocean surface and away from shore. Even when strong stratification was not present, as was the case for the winter quarter, water quality monitoring data indicated that the wastewater plume remained at depth.

Plume-related changes in temperature, salinity, dissolved oxygen (DO), pH, and light transmissivity were measurable beyond the initial mixing zone during some surveys, but usually extended only into the nearfield stations, typically <2 km away from the outfall. None of these changes were determined to be environmentally significant since they fell within natural ranges to which marine organisms are exposed and compliance with California Ocean Plan (COP) criteria was high (95–100%). Values and patterns in DO and pH were driven more by natural rather than outfall processes. One exception was an apparent reduction in DO that occurred periodically due to secondary entrainment of deeper, lower oxygen water caused by the rising effluent plume.

During 2010-11, strong decreases in light transmittance (upwards to 30%) were associated with the Newport Canyon, while much smaller changes (less than 10%) were associated with the

discharge plume. Light transmittance was most strongly affected by phytoplankton. In all surveys, chlorophyll-*a* and, putatively, the resuspension of bottom sediments within the Newport Canyon had the greatest impacts on water clarity. Both Secchi depth and the 1% photosynthetically active radiation (PAR) value showed similar spatial patterns of reduced water clarity nearshore compared to offshore waters. However, the 10% PAR showed a better relationship with the subsurface chlorophyll-*a* maxima.

Maximum ammonia (NH3-N) concentrations were, respectively, 20 and 30 times less than the COP receiving water objectives for chronic (4 mg/L) and acute (6 mg/L) toxicity to marine organisms. Average values at all depths and for all seasons were several hundred times lower than these objectives. Only 16% of the NH3-N samples collected were above the detection limit of 0.02 mg/L and the vast majority of these (72%) were found below 15 m, typically below the 10% PAR and maximum chlorophyll-*a* depths. This subsurface distribution was limited primarily to within 2 km of the outfall. The low levels and limited distribution of ammonium along with the lack of association with chlorophyll-*a* suggests that the concentrations seen were not environmentally significant.

Since effluent disinfection began in August 2002, offshore bacterial concentrations have remained low and predominately below detection limits. This was the case for 2010-11 where 73–89% of the samples fell below the lower method detection limit of 10 MPN/100 mL. In response to changes in operational goals, final effluent disinfection levels were lowered in December 2010 that resulted in higher bacteria densities at several offshore. Prior to this change, none of the measured bacteria exceeded their respective single sample maximum value; after the change, three stations had total coliform values that exceeded the single sample limit of 10,000 MPN/100 mL at depths of 45 m and below in February 2011. However, these operational changes and higher bacteria concentrations did not affect compliance with recreational water quality and no station exceeded California Ocean Plan bacterial standards.

Overall, the measured environmental and public health effects to the receiving water continue to be relatively small, with values that remain within the ranges of natural variability for the study area. Seasonal and yearly changes are dominated by large-scale regional influences. Plume effects that were observed, occurred primarily at depth, even in the winter when temperature differences between the surface and subsurface were reduced. In summary, results from the2010-11 water quality program support the conclusion that the discharge is not adversely affecting the receiving water environment and that beneficial uses were maintained.

SEDIMENT QUALITY

Sediment quality (chemistry and physical characteristics) measurements in 2010-11 were consistent with results from previous years suggesting that the wastewater discharge has minimal potential for adverse impact on biota outside the ZID for those measured constituents. Organic loading was minimal and did not create anaerobic sediment conditions or exceed thresholds that would promote a shift towards declining conditions beyond the ZID. There were only minor changes to sediment grain size, which were localized near the outfall. Sediment sulfide concentrations were generally low, but higher within the ZID, in Newport Canyon, and deeper slope stations than at other mid-shelf stations. Stations near the discharge site, but outside the ZID were comparable to farfield sites.

Sediment quality guidelines, effects-range low (ERL) and effects-range median (ERM), were used as benchmarks in evaluating the potential for degradation by chemical contaminants. Most sites had sediment metal concentrations below both benchmarks, including those within the ZID. Beyond the ZID, arsenic, cadmium, copper and nickel exceeded the ERL at several canyon and slope sites.

Concentrations of polychlorinated biphenyls (PCBs) were higher in sediments near the outfall as compared to other 60-m stations; however, no concentration outside the ZID exceeded the ERL. Sediment dichloro-diphenyl-trichloroethane (DDT) concentrations exceeded the ERL at most 60-m sites, but did not exhibit any patterns related to the outfall. DDT is considered a legacy contaminant that is wide spread throughout the Southern California Bight (SCB). Polycyclic aromatic hydrocarbons (PAH) were higher at the outfall compared to farfield sites, but at concentrations well below the ERL.

Mean Effects-Range Median Quotient (mERMq) analysis indicated a very low probability of sediment toxicity at both within-ZID and non-ZID sites based on sediment contaminant levels. Whole-sediment toxicity testing at the quarterly 60-m stations showed low toxicity at within-ZID Stations 0 and ZB2 in April 2011. Toxicity at these sites in the absence of elevated measured chemical parameters, in combination with the changes in biological community, indicates that an unmeasured factor or factors (i.e., chlorination by-products) caused the toxicity.

BIOLOGICAL COMMUNITIES

Infaunal Invertebrate Communities

Similar to previous years, the 2010-11 results showed that natural features of the study region, including bottom depth, sediment grain size, and complex bathymetry (e.g., submarine canyon habitats), accounted for the larger-scale spatial patterns of infaunal communities within the monitoring area.

Since 2005, invertebrate communities within the ZID have been declining to the point of being considered degraded by the Infaunal Trophic Index (ITI) and as having a loss of biodiversity by the Benthic Response Index (BRI). This has been the result of a shift in community structure as crustaceans populations have decreased, while polychaetes, particularly several pollution-tolerant species, have increased in abundance. In 2010-11, these conditions continued at sites within the ZID, while the impacts beyond the ZID contracted somewhat. Nearfield Station 3, about 0.3 km from the outfall, characterized as changed (ITI) and reference (BRI), whereas nearfield Station 1, located 0.6 km from the outfall, improved to normal (ITI) or reference (BRI) this year. Invertebrate communities at the other 60-m stations beyond the ZID were characteristic of reference conditions, with the exception of Station C2, which is located within the Newport Canyon and supports a much different community. Several stations within the submarine canyons, slope, and basin areas are also classified as impacted (i.e., other than normal or reference), but it is not clear if these were related to the effluent discharge.

The causes of the decline in the infauna and the expansion of impacts away from the outfall are not known at this time as they do not correlate to currently monitored effluent, receiving water quality, or sediment constituents. Since 2002, major changes in District treatment processes and operations include the initiation of effluent disinfection, the construction of additional secondary treatment facilities, and the implementation of the Ground Water Replenishment

System. Studies are currently being conducted and more are planned to investigate the cause(s) of these impacts on the biological community, including a redistribution and increased density of sampling sites near the discharge in order to assess the spatial extent of these changes.

Demersal Fishes and Macroinvertebrates

With the exception of outfall Station T1, results for demersal fish and macroinvertebrates were generally consistent with past findings. Bottom depth, regional influences (e.g., El Niño, La Niña), and normal oceanographic cycles were more important than the effluent discharge in affecting the distribution and abundance of fish in the study area.

Fish communities at the outfall differed from the other 60-m stations reflecting a change in infaunal prey item availability as polychaete-eating species replaced crustacean eaters. Trawl invertebrates at the outfall also differed from the other 60-m stations. There were fewer species at the outfall compared to the other stations and two species comprised almost 60% of the total abundance indicating a loss of biodiversity.

Macroinvertebrate communities away from the outfall were comparable to local and regional reference stations with results within the range of values for non-POTW (Publically Owned Treatment Works) sites throughout the SCB. The results indicated that the outfall area was not degraded and that it supported normal macroinvertebrate populations.

Tissue Contaminants in Fish

The accumulation of contaminants by fish can occur due to direct exposure to contaminated water and sediments, and the ingestion of contaminated prey. Contaminants were examined in fish muscle, liver, and whole fish tissue. Findings for 2010-11 were representative of previous years. Concentrations of mercury, DDT, and other chlorinated pesticides in all edible fish tissues collected at near-outfall and farfield locations were below federal and state action levels and/or health advisory limits. PCB concentrations in edible fish tissue were generally higher in fish collected at the outfall or comparable to those in fish collected at the farfield station, but were well below the state and federal action levels. PCBs are legacy contaminants that are still found in sediments due to their long degradation times. The detection of PCBs in fish tissues is the result of this prolonged exposure, and not current discharge practices.

Fish Health

The types and frequencies of external health problems for fish can be important indicators of environmental health. Examinations of fish for ectoparasites, tumors, fin erosion, and skin lesions showed that fish in the monitoring area were generally healthy. External parasites and other external abnormalities occurred in less than 1% of the fish collected, with no outfall influence evident. These results were consistent with previous years and indicate that the outfall is not an epicenter of disease.

CONCLUSION

With the exception of the infauna and epibenthic (trawl) communities nearest the outfall, the findings and conclusions for the 2010-11 monitoring effort were consistent with long-term

reported findings that showed limited impacts to the receiving water, sediment, and trawl fish and macroinvertebrate communities. Plume-related changes to receiving water temperature, salinity, dissolved oxygen, pH, and transmissivity observed 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 ammonia and absence of associations of the wastewater plume with phytoplankton blooms, suggest that the discharge had no discernible impact on environmental or human health. The low levels of contaminants in fish tissues and the low incidents of external abnormalities and diseases in fish demonstrated that the outfall was not an epicenter of disease.

There was a slight improvement to the invertebrate communities from last year. Changed communities were localized to stations within the ZID and one nearfield station located 0.3 km offshore from the outfall. Otherwise, invertebrate communities beyond the ZID were normal and similar to SCB reference areas. The change in the fish community near the outfall appears to reflect a change in infaunal prey availability within the ZID

The cause(s) of the decline in invertebrate communities within the ZID has not yet been identified. District staff is conducting an investigation into this phenomenon with an expected completion date of January 2013. The investigation is focusing on infaunal community temporal and spatial trends with respect to changes in species over time, receiving environment conditions, effluent quality, and recent (<10 years) changes in treatment plant processes.