chapter 1

THE OCEAN MONITORING PROGRAM

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INTRODUCTION

The Orange County Sanitation District (District) operates two wastewater treatment facilities in coastal southern California. The District discharges the treated wastewater to the Pacific Ocean through an offshore, submarine outfall located off Huntington Beach and Newport Beach, California (Figure 1-1). This discharge is regulated by the US Environmental Protection Agency, Region IX (EPA) and the Regional Water Quality Control Board, Region 8 (RWQCB) 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. R8-2004-0062, NPDES Permit No. CA0110604) in October 2004. 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.

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). 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 in Huntington Beach and Newport Beach during the winter months can exceed 450,000 visitors per month. For 2009-10, total beach attendance for the cities of Huntington Beach and Newport Beach was over 18 million (Figure 1-2) (City of Huntington Beach 2010; and City of Newport Beach 2010). Total monthly visitations ranged from 4,550,350 in July 2009 to 467,116 visitors in December 2009. The 2009-10 seasonal pattern was identical to previous years with increases seen each month until April 2010 when beach visitation dropped below average for the remainder of the year. Overall, beach usage for 2009-10 was 7% higher than average (Figure 1-2).

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. These data are analyzed, interpreted, and reported annually. This report presents OMP data summaries and results from July 2009 through June 2010. This and earlier annual reports are available digitally at the District's web site: (http://www.OCSD.com/about/reports/annual_reports).

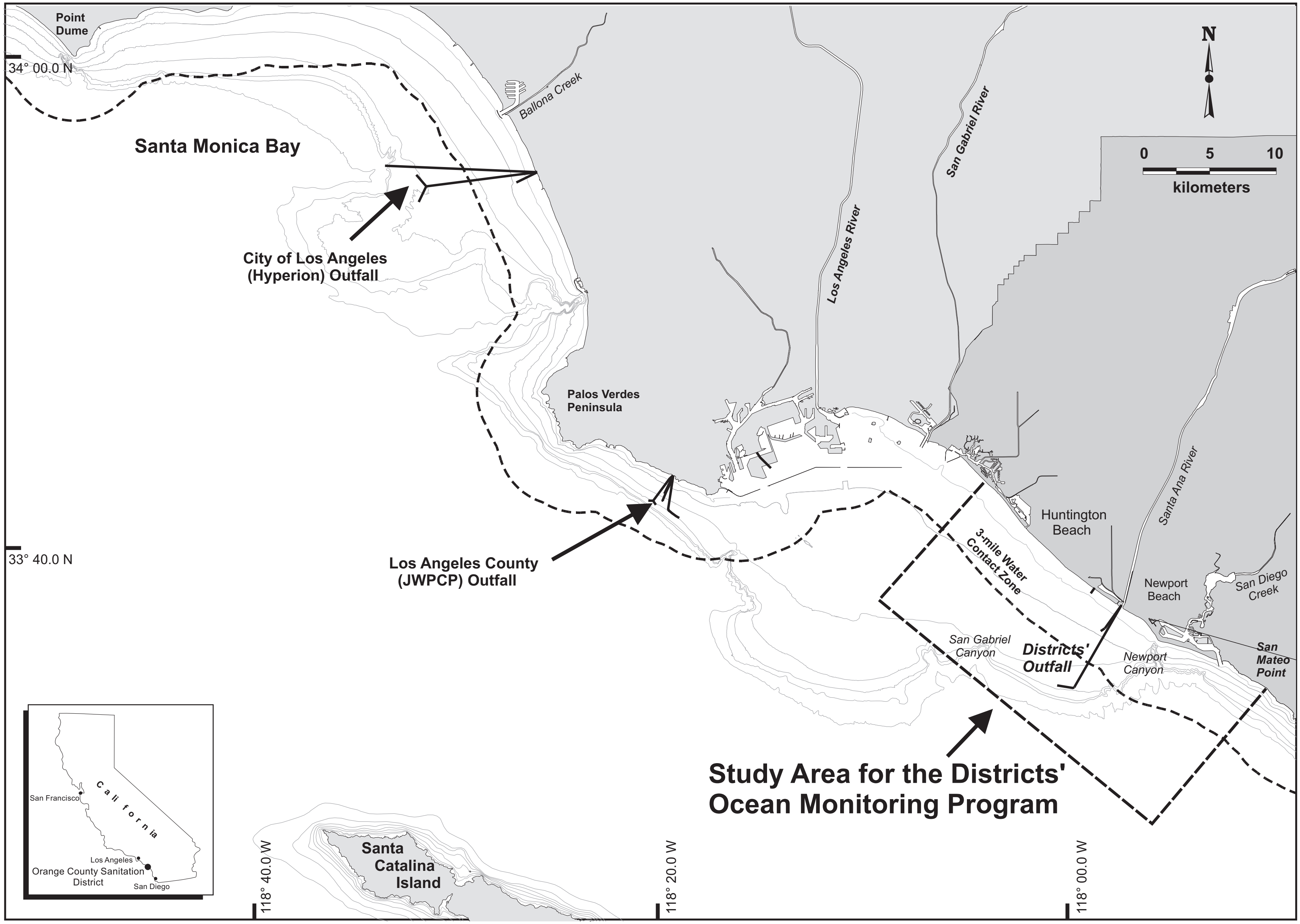

Figure 1-1. **Regional setting for the District's ocean monitoring program.**

Orange County Sanitation District, California.

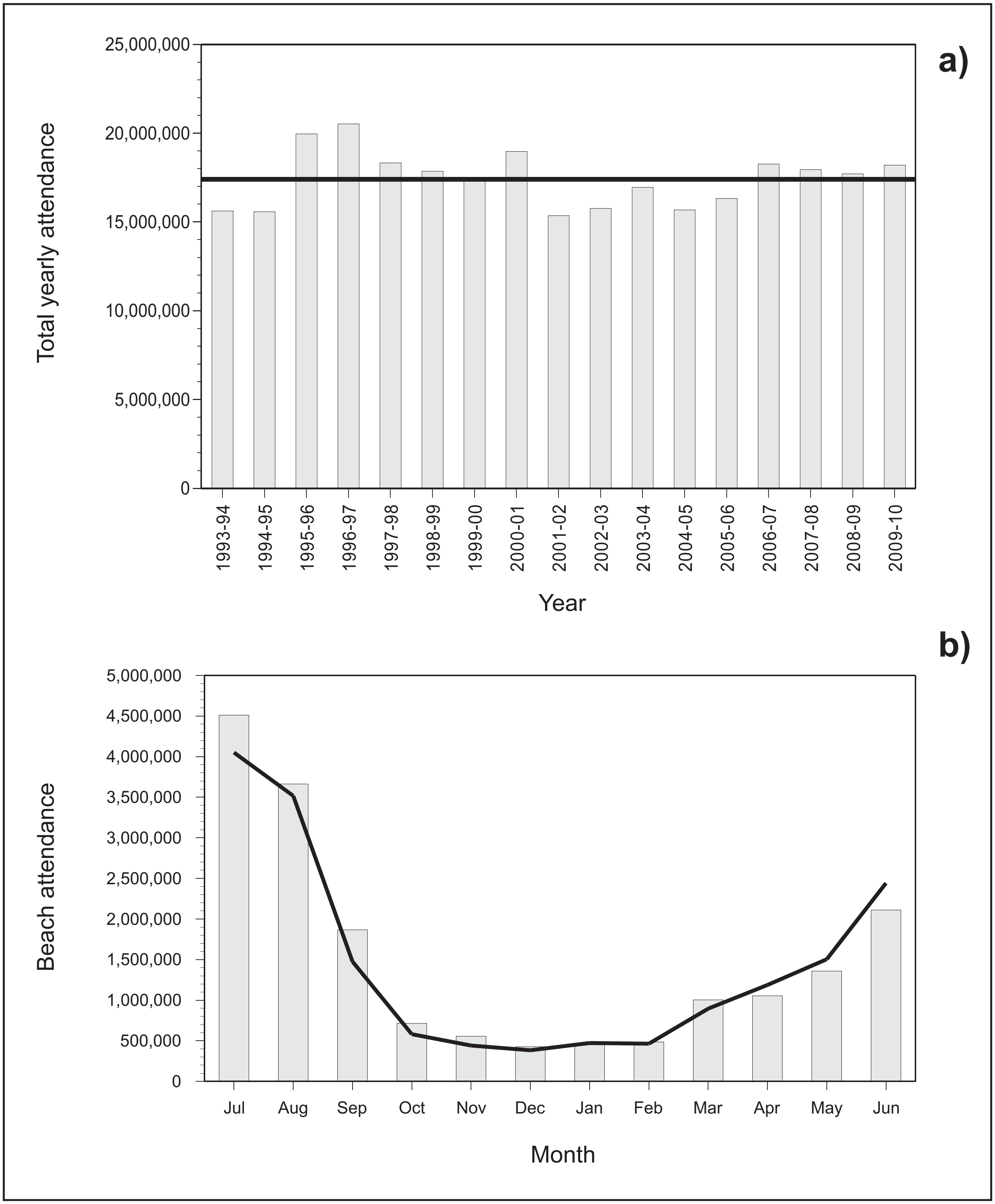

Figure 1-2. Annual (a) and monthly (b) total beach attendance for Huntington Beach and Newport Beach. Annual values represent from July 1 to June 30 of each year. Solid black line on each plot represents historical mean value (1993-2010).

Source: City of Huntington Beach – Marine Safety Operations, City of Newport Beach – Fire Department and Lifeguard Operations.

Orange County Sanitation District, California.

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), a combination of primary, advanced primary, and secondary treatment processes, biosolids management, and water reuse programs. The District is presently constructing facilities that will accomplish full secondary treatment of all wastewater by 2012 (U.S. vs. OCSD 2004).

The District's two wastewater treatment plants are located in Fountain Valley (Plant 1) and in Huntington Beach (Plant 2), California (Figure 1-1). Together, the two plants receive domestic sewage from approximately 80% of the county's 3.2 million residents and industrial wastewater from 710 permitted businesses within the District's service area. The treated wastewater (effluent) is discharged through the ocean outfall, which extends 7.1 km (4.4 miles) from the Huntington Beach shoreline (Figure 1-1). A 1.8 km (1.1 miles) diffuser at the end of the outfall has 503 discharge ports and is at an approximate bottom depth of 60 meters (197 ft).

Since 1999, influent volumes to the treatment plants have included dry weather urban runoff from diverted storm water pump stations owned by the City of Huntington Beach, the City of Newport Beach, the Irvine Ranch Water District, and from three 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 bacterial pollution associated with chronic dry-weather flows that affect water quality within the watershed and cause contamination of local beaches. The flow range of 0.5–2.4 million gallons per day (MGD) during dry weather and number of urban runoff diversion has remained steady for the last 9 years.

In August 2002, the District began disinfecting the treated wastewater using chlorine to reduce fecal indicator bacteria levels in the final effluent. The District's NPDES permit does not specify compliance limits for bacteria in the treatment plants or the final effluent, but it does contain receiving water limits for bacteria that apply within 3 miles of shore. To ensure meeting these limits, the District has operational goals for 30-day geometric mean bacteria levels in the final effluent while also meeting permit limits on residual chlorine levels. These goals (<180,000 MPN/100 mL total coliform, <36,000 MPN/100 mL fecal coliform, and <6,300 MPN/100 mL enterococci) are based on meeting California's single sample bacteria standards after initial dilution using a conservative 180:1 ratio of effluent to seawater (OCSD 2002). Since 2002, the District has consistently met its internal operational goals for all three indicator bacteria (Figure 1-3). For 2009-10, the daily maximum counts exceeded OCSD's operational goals, while the running 30-day geometric mean, with the exception of enterococcus remained below these goals.

Historically, a small portion, approximately 10 MGD, of the final effluent had been transferred 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) or pumped into a local aquifer to provide a saltwater intrusion barrier. In January 2004, OCWD shut down tertiary treatment operations, started using well water for the salt-water intrusion barrier, and began construction of significant upgrades. In January of 2008

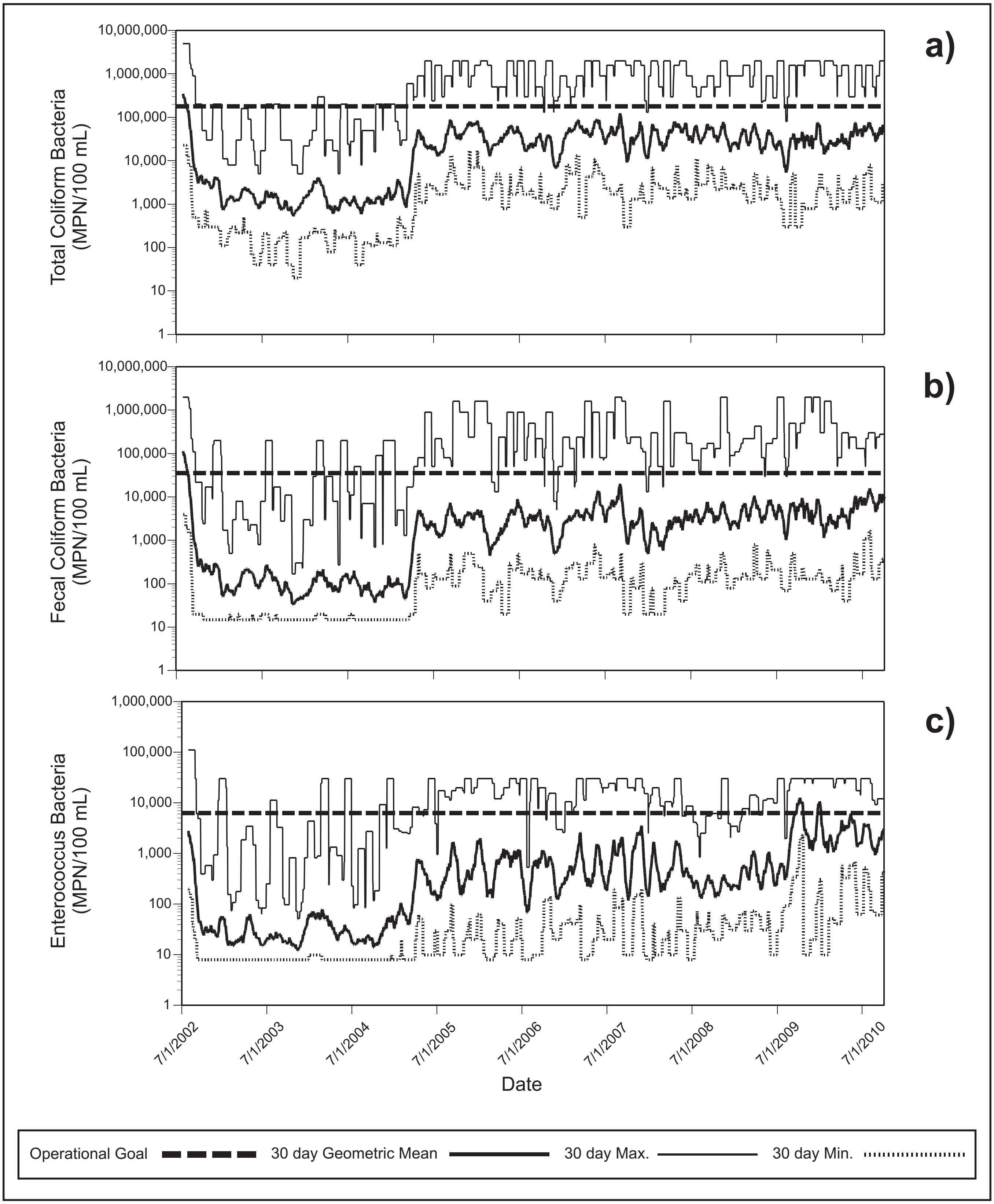

Figure 1-3. **30-day geometric means, 30-day running minimums, and 30-day running maximums for (a) total coliform bacteria, (b) fecal coliform bacteria, and c) enterococcus bacteria measured in the District's final effluent from July 1, 2002 to June 30, 2010. Operational goals are 180,000 MPN/100 mL, 36,000 MPN/100 mL, and 6,300 MPN/100 mL, respectively.**

Orange County Sanitation District, California.

the District began diverting ~75 MGD of secondary effluent to OCWD's Groundwater Replenishment System (GWRS). This flow is treated using microfiltration, reverse osmosis, and ultraviolet disinfection to achieve constituent levels that meet or exceed drinking water standards. GWRS product water is pumped to existing spreading basins in Anaheim for percolation into the ground water basin and injected into an expanded seawater intrusion barrier in the cities of Fountain Valley and Huntington Beach.

During 2009-10, the two wastewater treatment plants received and processed influent volumes averaging 207 MGD (OCSD 2009). This flow included dry-weather urban runoff that averaged 1.2 MGD. After diversions to the GWRS, the District discharged an average of 151 MGD (5.72×10^8 L/day) of treated wastewater, with a 90% reduction in suspended solids concentrations (OCSD 2009). Peak flows were well below historical high flows of up to 550 MGD (2.1×10^9 L/day) that occurred during high rainfall periods 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, and reclamation. The 2009-10 total rainfall for Newport Harbor was 8.37 inches, below the Newport Harbor mean of 11.09 inches for the fifth year in a row. Rain was concentrated in the three winter months (December 2009–February 2010) with drier than normal fall and spring seasons (Figure 1-4). While rainfall was lower than normal, the total annual flow from the Santa Ana River was higher than the record mean of 24,222 cubic feet per second. Monthly average flows were well below the long-term average flow during every month except December 2009–February 2010, coinciding with the year's highest monthly rainfall (Figure 1-4).

Over the past three decades, wastewater discharge volumes have generally increased due to continuing population growth within the District's service area (Figure 1-5). For example, wastewater flows increased through 1990, but decreased in 1991-92 due to drought conditions and consequent water conservation measures. Since then, average flows have remained relatively constant until the startup of the GWRS, which reclaims water that previously would have been discharged to the ocean.

Concentrations and mass emissions for many of the wastewater constituents have declined over the past three decades as a result of changes in the District's treatment processes and source control programs. For example, concentrations of total suspended solids (TSS), biological oxygen demand (BOD), and copper (Cu) in the final effluent decreased substantially during the early 1980s (Figure 1-5). TSS discharges have decreased from over 200,000 lbs/day from the late 1970s and early 1980s to present levels of approximately 43,000 lbs/day. After two full years of GWRS operation, and resultant lower volume discharged, mass emissions in TSS and BOD are 42% and 53% lower, respectively, than two years ago. Decreases in copper mass emissions in the final effluent are largely due to Source Control efforts and lower flow.

REGULATORY SETTING FOR THE OCEAN MONITORING PROGRAM

The District's permit includes a requirement to monitor influent, effluent, and the receiving water. Effluent flows, constituent concentrations, and toxicity are monitored in order to determine compliance with permit limits and to provide data for interpreting changes to receiving water conditions. Effluent quality during 2009-10 is discussed in the Operations and

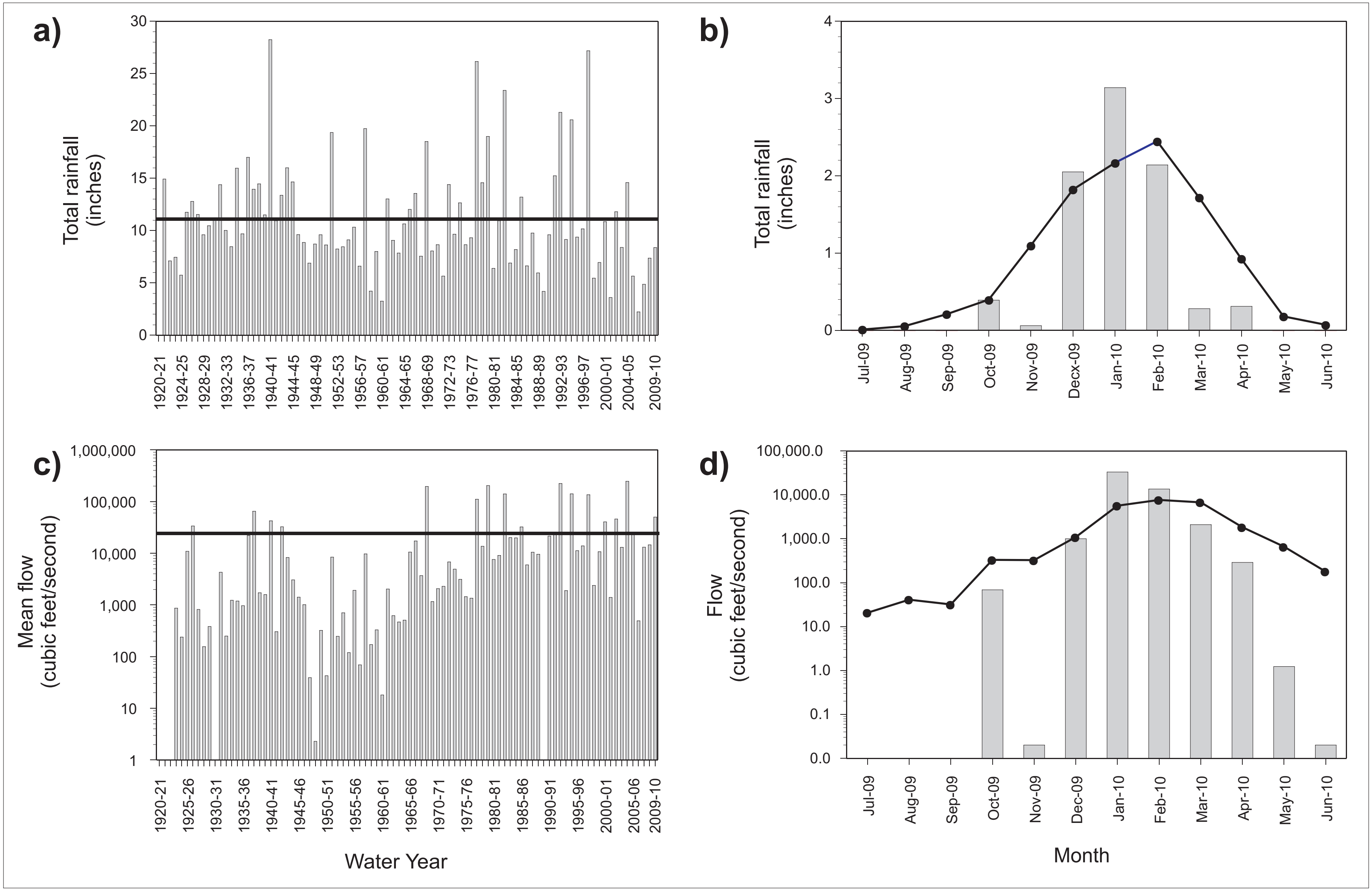

Figure 1-4. **Annual (a) and monthly (b) total rainfall for Newport Harbor, California with annual (c) and monthly (d) total flow for the Santa Ana River. Annual water year rainfall values represent from October 1 to September 30 of each year. Solid line on each plot represents historical mean (1923–2010).**

Source: (SAR: USGS, 5th Street Station, Santa Ana, http://waterdata.usgs.gov/usa/nwis/uv?site_no=11078000**)**
(Rainfall: OC Public Works; Station 88/Newport Beach)
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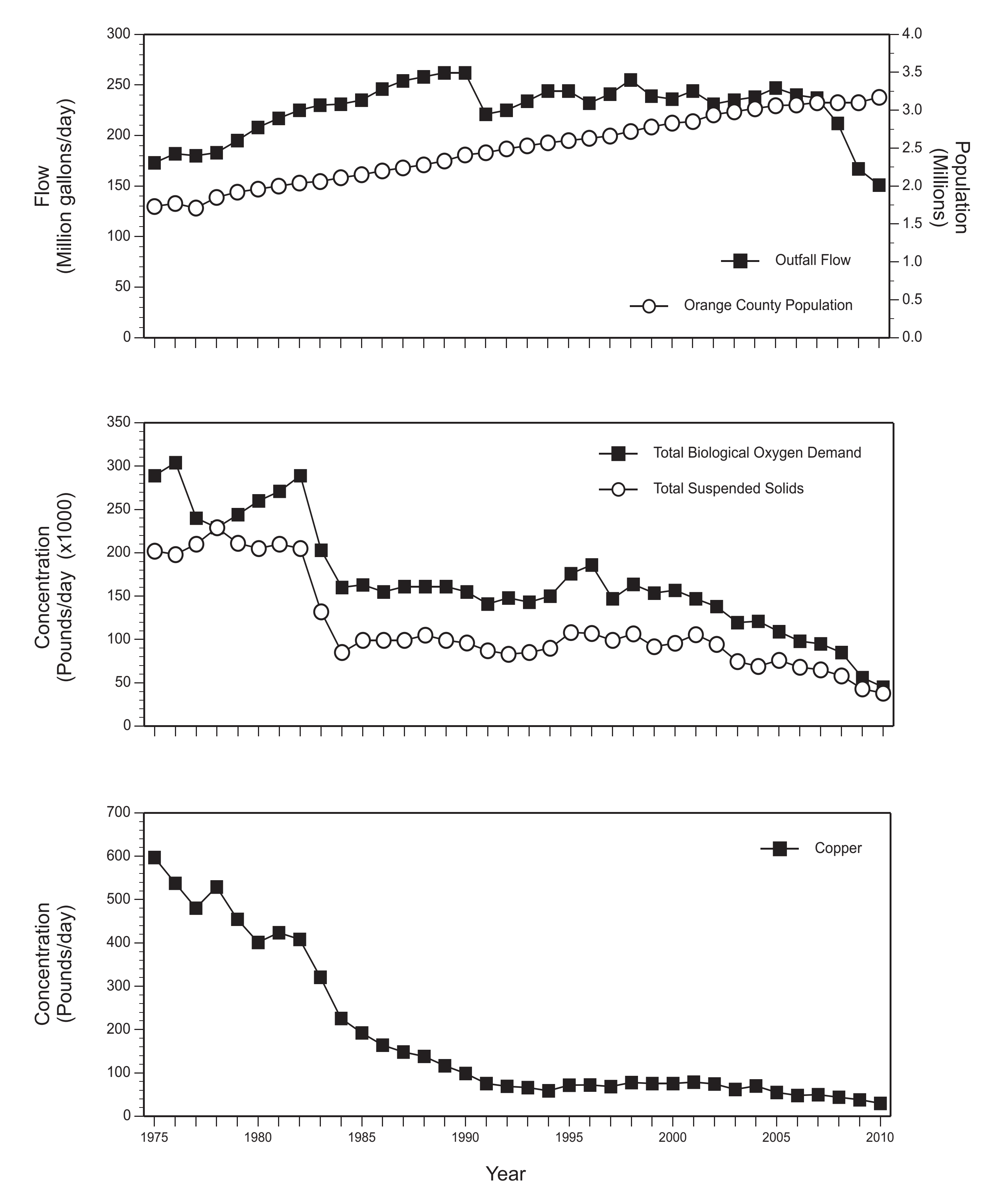

Figure 1-5. **Trends in the District's effluent flow compared to Orange County population and selected effluent constituent discharges to the San Pedro shelf region, 1975–2010.**

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Maintenance Annual Report (OCSD 2009). Wastewater impacts to the coastal receiving waters are evaluated by the District's OMP based on three integrated components: Core monitoring, Strategic Process Studies (SPS), and Regional monitoring. Each of the program elements is summarized below. 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.

The Core monitoring program was designed to measure compliance with permit conditions and analysis of trends. Four major components comprise the program; (1) coastal oceanography and water quality, (2) sediment quality, (3) benthic infaunal community health, and (4) fish and macroinvertebrate community health, which includes 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 biological effects of the discharged effluent. Presently, the District is continuing studies of currents on the San Pedro Shelf, effects of endocrine disrupting compounds (EDC) on fish, and a sediment mapping study. The objective of the sediment mapping study is to determine the optimal sediment station array for accurate map generation of the District's outfall footprint for sediment geochemistry analytes and benthic infaunal community metrics. These studies are being done collectively with local universities, publicly owned treatment works (POTW), and research groups.

Since 1994, the District has participated in four Regional monitoring studies of environmental conditions within the Southern California Bight (SCB): 1994 Southern California Bight Pilot Project (SCBPP), Bight'98, Bight'03, and Bight'08. 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 collaborative monitoring 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. Program documents, data, and reports on all of these studies can be found at the Southern California Coastal Water Research Project's website (http://sccwrp.org).

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 POTWs, including the District. Finally, the District has been working with the Southern California Coastal Ocean Observing System (SCCOOS) to provide real time meteorological data and historical and ongoing offshore and beach water quality data to further understand region-wide oceanographic trends (http://www.sccoos.org).

The District also conducts studies not mandated by the NPDES permit. Recent examples include work on source tracking of bacterial contamination and evaluating rapid tests for fecal indicator bacteria.

Attempting to better understand GWRS, the District also assessed the removal efficiency of certain chemical constituents by Plant 1 treatment processes. The project was divided into 3 phases. The first and second phases were designed to test the Plant 1 process efficiencies without the contribution of the return flows from GWRS. The third phase was designed to include the contribution of the return flows from GWRS. The study was completed recently and the final report is pending.

ENVIRONMENTAL SETTING

The District's OMP study 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 80 meters, after which the depth increases rapidly as it slopes down to the open basin. The outfall diffuser lies on the shelf at about 60 meters between the Newport and San Gabriel submarine canyons, which are located southeast and northwest, respectively (Figure 1-1). The 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 study area (OCSD 2000a; CDFG 1989).

Conditions within the District's study area are affected by large and regional-scale current patterns that influence the water characteristics and the direction of water flow along the Orange County coastline. The predominant current flows in the monitoring area are upcoast and downcoast (OCSD 1997, 1998, 2004; SAIC 2001, 2009). The specific direction of the flows varies with depth and is subject to reversals over time periods of days to weeks. The average monthly near-surface currents show mainly downcoast flows, with some weak upcoast flows during the fall. Conversely, near-bottom flows are upcoast most of the year and are weakest in the spring and strongest in the fall. At mid-depths (30 m), the monthly mean flows are midway between those in the near-surface and near-bottom layer, with downcoast flow during the first half of the year and upcoast flow during the second half of the year. The directions of these mid-depth flows are important because they are primarily responsible for the initial transport direction of the wastewater plume.

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 sediments. Tidal currents in the study region are relatively weak compared to background (lower frequency) currents (OCSD 2001, 2004). These combined processes contribute to the variability of seawater movement observed within the study area.

Episodic storms, drought, and climatic cycles also influence environmental conditions and biological communities within the study area. For example, storm water runoff has a large influence on sediment movement into the study region (Brownlie and Taylor 1981; Warrick and Millikan 2003), and 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 and periodic oceanographic events, such as El Niño and La Niña conditions and periods of drought. The last wet period occurred during 2004-05 when >15 inches of rain fell on Newport Beach (Figure 1-4). This was followed by a 5-year dry period 2005 through 2010, with an average yearly rainfall of 5.7 inches. A better understanding of the effects from cumulative changes in inputs from rivers and watersheds, particularly non-point source runoff, is important for evaluating trends in the environmental quality of coastal areas. For example, the Santa Ana and San Gabriel Rivers (Figure 1-1) transport much of the runoff from the local mountain ranges (Figure 1-4). River flows, together with urban storm water runoff, represent significant, episodic sources of freshwater, sediments, suspended particles, nutrients, and contaminants to the coastal area (Hood 1993; Grant et al. 2001). 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 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 and San Gabriel Rivers are also responsible for substantial inputs of contaminants to the SCB (SCCWRP 1992; Schafer and Gossett 1988). Similarly, outflow from Newport and Anaheim Bays, which receive pollutants from urban, agricultural, and industrial runoff, as well as waste from boats and marinas within the bays, provide a potential source of contaminants to the ocean.

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 1970's (Figure 1-5). The complexities of the environmental setting and related difficulties in assigning a cause or source to a pollution event are the reasons for OCSD's extensive monitoring program. Interpretations of data related to the receiving waters monitoring program relative to other potential sources of impact are included in the chapters that follow.

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