SANTA MONICA BAY SHORELINE MONITORING
MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4) REPORT
(July 1, 2003 – June 30, 2004)
Monitoring and Assessment by the City of Los Angeles

I. INTRODUCTION

The City of Los Angeles monitors bacterial densities at the Santa Monica Bay shoreline daily. Since the onset of the City of Los Angeles' monitoring in the 1950's, and Hyperion Treatment Plant's (HTP) construction of the 5-Mile Outfall, water quality monitoring has indicated that HTP's wastewater has not reached the shoreline. Urban runoff has been implicated as the largest source of bacterial contamination at Santa Monica Bay beaches (CLA, EMD 2003).

Urban runoff, which mainly originates from rainfall and street runoff (Dojiri et al., 2003) and reaches Santa Monica Bay through approximately 200 outlets, is the largest nonpoint source of pollution to Santa Monica Bay. Street runoff can result from domestic, commercial, and industrial activities, and irrigation water. It has been estimated that Santa Monica Bay receives a flow of 10-25 million gallons per day from storm drains during dry weather (SMBRP 1996). During rain events, the concentrations of pollutants (heavy metals, human and animal wastes, petroleum- and automobile-based chemicals) are more dilute, but the mass loading is much larger due to wash-down effects of the rain on the surrounding urban environment.

The City of Los Angeles has taken numerous actions to improve water quality in Santa Monica Bay. The City collaborated on the Santa Monica Urban Runoff Recycling Facility (SMURRF), which processes 500,000 gallons of runoff per day during dry weather. Additionally, the City of Los Angeles's Watershed Protection Division is employing Low-Flow Diversion systems to direct major storm drains to HTP during dry weather. Also, the City's Environmental Monitoring Division (EMD) provided co-leadership and proactive participation in drafting the Coordinated Monitoring Plan for the state and federally mandated Santa Monica Bay Beaches Bacterial Total Maximum Daily Load (SMBBB TMDL) program. The SMBBB TMDL, which became effective in July of 2003, has stringent compliance requirements for Santa Monica Bay shoreline storm drains. Based on daily monitoring, the summer and winter dry-weather SMBBB TMDLs allow for zero and three annual exceedences of AB 411 standards, respectively. The wet-weather portion, which allows for seventeen annual exceedances, must be met within eighteen years. In addition, EMD participated in the Southern California Bight 2003 Regional Monitoring Program, which attempts to gain insight into the dynamics of pollution along the Southern California coastline.

This report summarizes the City of Los Angeles EMD's Santa Monica Bay shoreline bacteriological data for the fiscal year 2003-2004 (July 1, 2003 to June 30, 2004). The bacteriological data consist of bacterial densities for three categories of bacteria (referred to as "indicator" bacteria) that indicate the presence of water-borne human disease causing (pathogenic) bacteria. These indicator groups are the total coliforms, the fecal coliforms or their dominant species *Escherichia coli* (*E. coli*), and the enterococci. Monitoring indicator bacteria is currently the most efficient method of assessing pathogen levels in marine water.

EMD prepares the daily shoreline report and evaluates the data relative to the California State AB411 bathing water quality standards for bacterial densities (Table 1). The Santa Monica Bay shoreline bacterial data are then reported to the Los Angeles County Department of Health Services (LACDHS). Subsequently, LACDHS takes steps (such as posting health hazard warning signs for beach users) to notify beach goers in case of an exceedance of bacterial standards.

Table 1. AB411 Bathing Standards

Density of bacteria in a single sample shall not exceed:

- 10,000 total coliform bacteria/100 ml; or
- 400 fecal coliform bacteria/100 ml; or
- 104 enterococcus bacteria/100 ml; or
- 1,000 total coliform bacteria/100 ml, if ratio of fecal/total coliform exceeds 0.1

Current indicator bacterial quantification methods depend on incubation and growth of bacteria in the laboratory. Hence, results are presently obtained 24–48 after sample collection, thus compromising early notification public health, and contamination source identifications. With continued commitment to technical progress in bacteriological data standardization and reporting, in December of 2002, EMD switched total coliform and fecal coliform/*E. coli* membrane filtration analytical methods to the chromogenic substrate method, which decreases indicator bacterial quantification times from 24 to 18 hours. Also, in 2003 and 2004, EMD participated in important innovative programs that included the 2003 Southern California Bight (Bight ’03) Regional Monitoring Program and the Southern California Coastal Water Research Project’s national Rapid Detection of Indicator Bacteria Program. Additionally, the City of Los Angeles participated and excelled in two regional bacteriological data quality assurance interlaboratory calibration events (Bight ’03 and SMBBB TMDL), which firmly established the validity of EMD’s bacteriological data.

II. MATERIALS AND METHODS

A. SAMPLE COLLECTION

Water samples from 18 Santa Monica Bay shoreline stations were collected daily. Geographically, shoreline stations ranged from Surfrider Beach in Malibu and southward to Malaga Cove in Palos Verdes Estates (Figure 1). All shoreline stations are sampled 50 yards away from where the storm drain flow meets the shoreline, if applicable. Otherwise, samples are taken 50 yards from a pier or jetty (with the exception of station S9 and S18). All samples were collected at ankle-depth level during daylight hours.

B. SAMPLE ANALYSIS

Water samples were collected and analyzed according to Standard Methods (APHA 1992). Total coliform and *E. coli* bacterial densities were determined by the chromogenic substrate method following Standard Methods section 9223. Enterococcus bacterial densities were determined by the membrane filtration method as recommended in the Standard Methods section 9230C (APHA 1992). Eighteen designated EMD station samples were tested daily for total coliforms and fecal coliforms/*E. coli*, and five times a month for enterococcus bacteria.

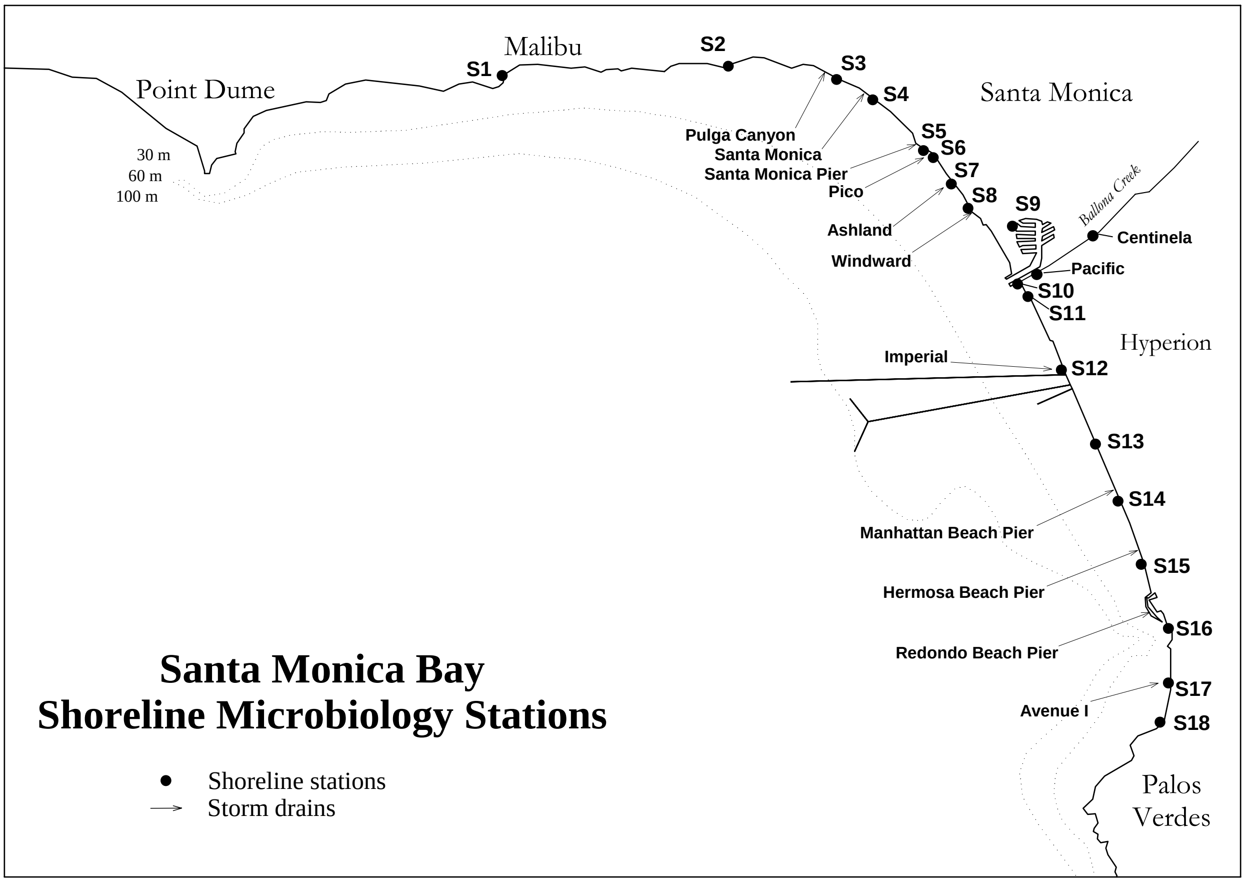

Figure 1. Location of Santa Monica Bay shoreline microbiology stations, stormdrains, and Piers.

Quality assurance and quality control procedures were conducted to confirm the validity of the analytical data collected. All areas impacting reported data were subjected to standard microbiological quality control procedures in accordance with Standard Methods (APHA 1992). These areas included sampling techniques, sample storage and holding, facilities, personnel, equipment, supplies, media, and analytical test procedures. Duplicate analyses were also performed on ten percent of all samples. When quality control results were not within acceptable limits, corrective action was initiated. This quality assurance program helped ensure the production of uniformly high quality and defensible data. In addition, EMD participates annually in the performance evaluation program managed by the California State Department of Health Services (CSDHS) as part of its Environmental Laboratory Accreditation Program (ELAP); CSDHS biennially certifies EMD.

C. DATA ANALYSIS

The results obtained from microbiological samples are generally not normally distributed. To compensate for a skewed distribution and to obtain a nearly normal distribution, data must be log-normalized prior to analysis. Geometric means are the best estimate of central tendency for log-normalized data and were calculated for each bacterial indicator group. Annual geometric means were calculated for all shoreline sampling sites.

Shoreline data were divided into periods of wet and dry weather to examine the effects of storm drain runoff on indicator bacterial concentrations. Regulatory agencies have defined wet weather as the day of rain plus two days following the rain event. Rain data were obtained from the National Weather Service's Los Angeles Civic Center records.

III. RESULTS

Rainfall

During the 2003 -2004 fiscal year, measurable rainfall occurred over a seven-month period. More than 90% of the rainfall was observed during the AB411 wet-weather season months (November 1

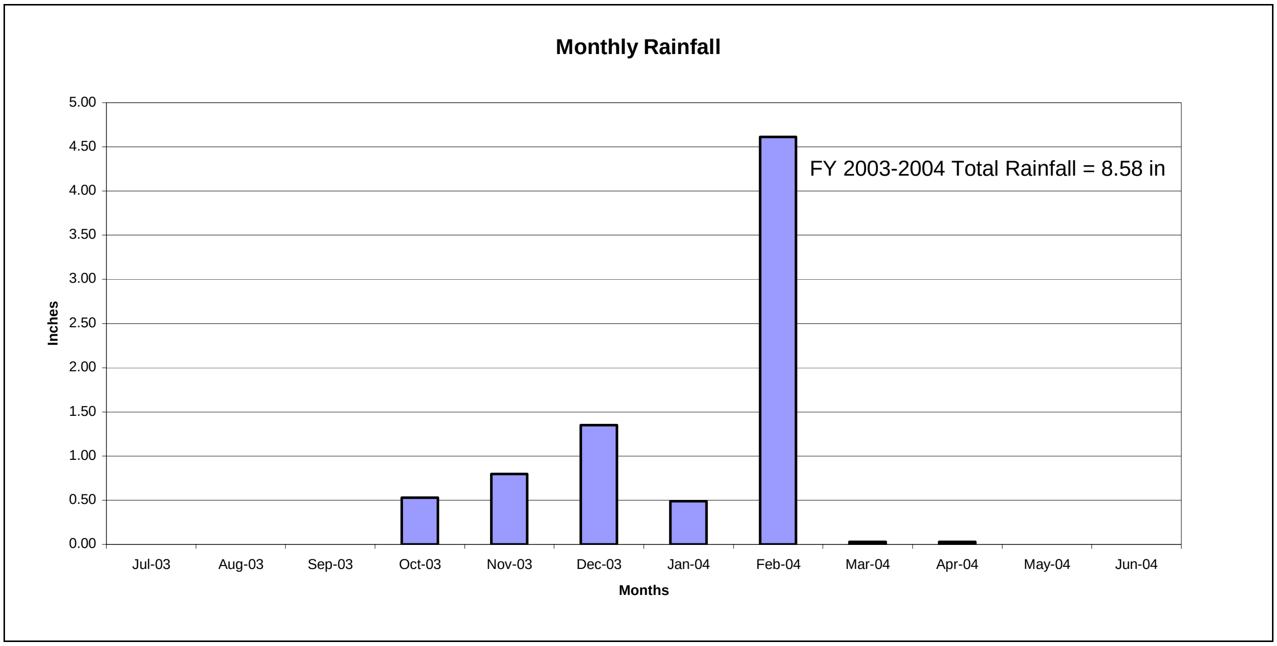

Figure 2. Monthly rainfall amounts at Los Angeles Civic Center, July 2002-June 2003.

to March 31). However, the 2003-2004 fiscal year's total rainfall of 8.58 inches was less than the annual average of 15 inches for Los Angeles, and was significantly less than the previous fiscal year's total rainfall of 16.43 inches. More than half of the total rain during the fiscal year fell in the month of February 2004 (4.61 inches, Figure 2).

Shoreline Stations

The annual geometric means for all indicator bacteria during wet weather were generally higher than those observed during dry weather (Figure 3). The highest bacterial densities during periods of dry weather were often found at stations associated with flowing storm drains, at stations adjacent to piers, or at stations with compromised circulation (Figure 1). The stations exhibiting the highest bacterial densities in northern Santa Monica Bay (SMB) were S1 (Surfrider Beach), S4 (Santa Monica Canyon), and S5 (Santa Monica Pier). Stations S10 (Ballona Creek) and S16 (Redondo Beach Pier) had the highest bacterial densities along the southern SMB shoreline.

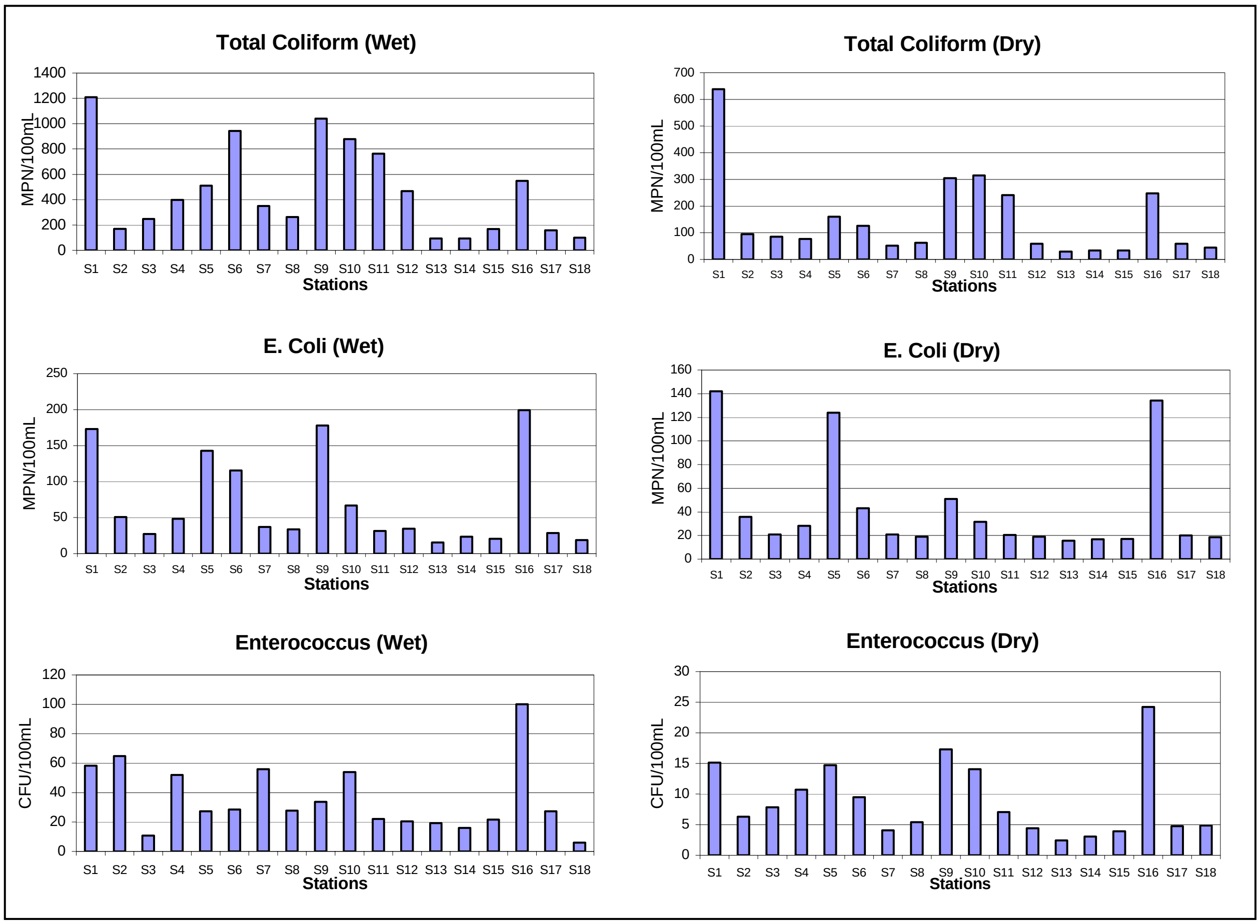

Figure 3. Annual geometric means for indicator bacteria at each shoreline station in Santa Monica Bay during FY 2003-04 wet and dry weather.

Northern Santa Monica Bay is comprised of stations from Malibu (S1-Surfrider Beach) to Marina del Rey (S9-Mother's Beach). The northern SMB shoreline stations annual bacterial geometric means generally were higher than the southern SMB shoreline stations for all indicator bacteria. Notable exceptions were stations S10 and S16 for total coliforms and enterococci during the dry-weather season. The northern SMB shoreline's highest total coliform densities were recorded at station S1 for both dry and wet weather; highest *E. coli* densities were measured at stations S1 and S5; and the highest enterococcus dry-weather densities were measured at station S9, followed by S1 and S5. High counts were consistently measured for all bacteria during dry-weather at stations S1, S5and S9. The stations with the least bacterial densities were stations S3 and S7, having consistently low bacterial counts for both dry and wet weather.

Southern Santa Monica Bay includes all of the stations south of Ballona Creek, starting from station S10 (50 yards south of Ballona Creek) to station S18 (Arroyo Circle, Palos Verdes). The bacterial densities in the south SMB shoreline stations were typically lower than those found at the north SMB shoreline stations, with the exception of station S16. Station S16 has the highest fecal coliform/*E. coli* and Enterococcus geometric means for both dry and wet seasons (Figure 3). In contrast, the lowest total coliform, *E. coli*, and enterococcus dry-weather geometric means were recorded at station S13.

Water Quality Standards Compliance

Table 2 lists the percent compliance of all AB411 bathing water quality standards for SMB shoreline stations during fiscal year 2003-2004. The percent compliances are based on dry-

Table 2. Percent compliance of bacterial densities at EMD Santa Monica Bay shoreline stations with California AB411 bathing water standards during dry weather between July 1, 2003 and June 30, 2004.

Station	Total[1]	Fecal[2]	Entero[3]	T:F Ratio[4]
S1	87.3	76.7	89.9	84.3
S2	99.7	95.9	96.7	98.9
S3	100	100	100	100
S4	99.5	99.2	93.4	98.9
S5	99.7	95.4	96.7	99.2
S6	98.1	94.0	93.3	95.1
S7	99.3	99.3	98.4	99.5
S8	100	99.3	100	99.5
S9	99.3	94.5	92.0	95.3
S10	97.0	97.6	93.4	97.6
S11	99.2	99.5	100	99.3
S12	99.7	99.7	100	99.5
S13	100	99.7	100	99.7
S14	100	100	96.7	100
S15	100	99.7	100	99.7
S16	99.7	92.0	93.3	96.1
S17	100	100	96.7	99.5
S18	99.7	98.9	96.7	99.8

[1] 10,000 total coliform bacteria/100 ml
[2] 400 fecal coliform bacteria/100 ml
[3] 104 enterococcus bacteria/100 ml
[4] Total coliform level greater than 1000 bacteria/100 ml and *E.coli*:TC ratio is greater than 0.1

weather bacterial densities and reflect a measure of water quality for public health. From July 1, 2003 to June 30, 2004, station S3 (Pulga Canyon) exhibited 100% compliance for all four AB411 standards. However, all of the other 17 Santa Monica Bay stations violated at least one of the listed limits. Seven stations along northern Santa Monica Bay (S1, S2, S4, S5, S6, S7, and S9) violated all of the AB411 bathing water quality standards. Station S1 had the lowest percent compliance for all the bathing water quality standards indicating a high exceedance frequency.

The percentage exceedance of any of the AB411 standards during the fiscal year 2003-2004 is presented in Figure 4. The results include values for dry- and wet-weather periods combined. Results for station S1 clearly exceed those of all of other stations in Santa Monica Bay and are followed by high exceedances for station S9 (Mother's Beach in Marina del Rey). The lowest percent exceedances in north and south SMB are for stations S3 (Pulga Canyon) and S13 (Manhattan Beach at 40th Street), respectively.

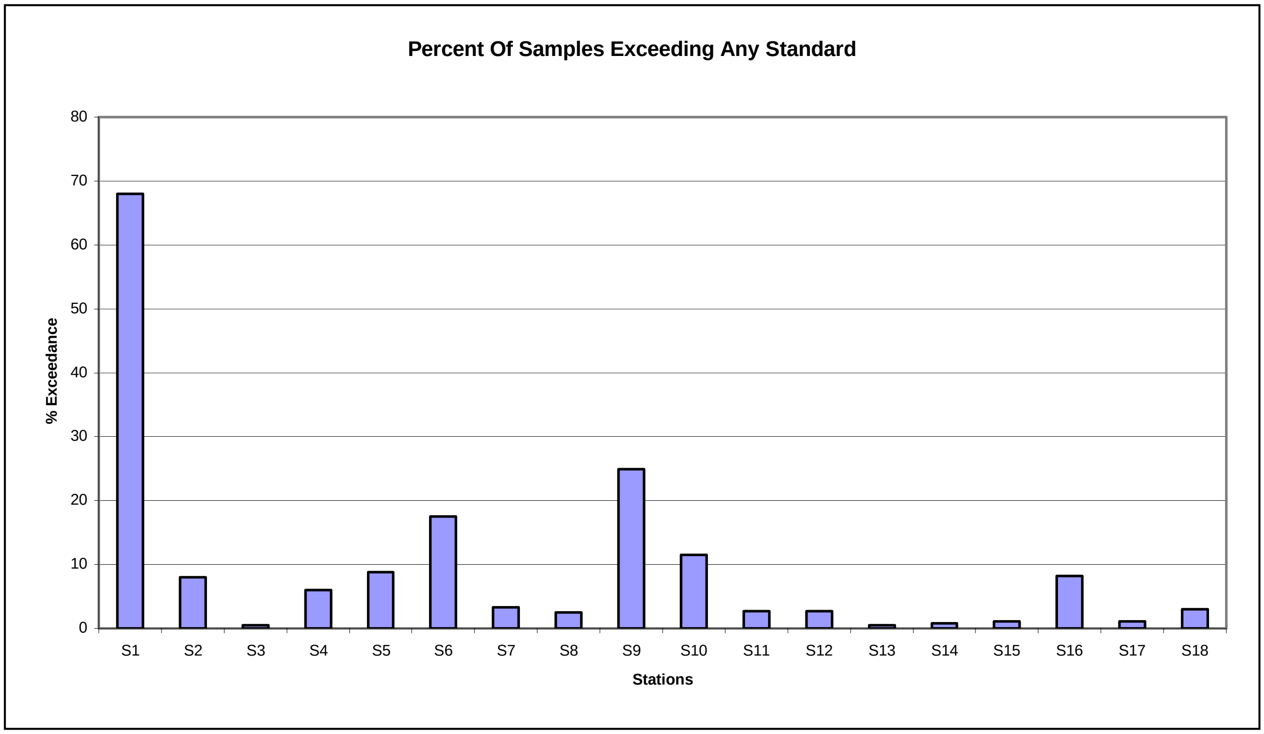

Figure 4. Percent exceedances of any of the four AB411 standards at SMB shoreline stations, dry- and wet-weather combined.

In the southern Santa Monica Bay, the exceedance rate of samples was generally lower than in the north with the exception of station S16, which had a relatively high percentage of exceedance.

IV. DISCUSSION

Generally, water quality at the Santa Monica Bay beaches was highly compliant with the State of California public health standards during the 2003 -2004 fiscal year. The City of Los Angeles's EMD AB411 bacterial water quality compliance measurements remained above 92% for all four categories of compliance (Tables 1 and 2) with the exception of Malibu Lagoon (S1). This is a similar rate of compliance when compared to the 2002-2003 fiscal year, which complied 84% - 100% for all 18 City of Los Angeles monitoring stations. The results are compatible with the Santa Monica Bay Restoration Commission's determination that 90% of Santa Monica Bay's beaches are safe for recreation during the summer dry season in sites non-adjacent to storm drains (Santa Monica Bay Restoration Commission, 2004).

Factors affecting water quality at shoreline monitoring sites include rain events, proximity to storm drains and piers, and the circulation dynamics of water. This monitoring period was a dry year relative to the previous monitoring period, with the 8.58 inches of rain delivering substantially less runoff to the shoreline waters. Urban and stormwater runoff are the biggest contributors of bacterial contamination to Santa Monica Bay. Runoff flows over rooftops, freeways, parking lots, construction sites, industrial facilities, and other impervious surfaces, collecting pollutants and transporting them through open channels and underground pipes directly to the Bay. Even in dry-weather, ten to twenty-five million gallons of water flow through storm drains into Santa Monica Bay every day (Santa Monica Bay Restoration Commission, 2004).

The northern part of the Bay contains the majority of flowing storm drains. Station S1, a popular recreational site for the surfing community, was consistently the site of highest indicator counts during both dry and wet weather. Station S1 is located at the outlet of the entire Malibu Creek watershed and is mainly affected by flows from the Malibu Lagoon located 50 yards to the north. Malibu Lagoon flowed consistently from November 2003 to June 2004, with relatively high flows in both dry and wet weather. The lagoon also serves as a habitat for numerous bird species, an added risk of contamination at this monitoring site.

In addition to station S1, high counts were consistently measured at Santa Monica Pier (S5) and Mother's Beach (S9) for dry weather. Station S5 is located next to Santa Monica Pier. The storm drain located at the pier has been diverted to the Santa Monica Urban Runoff Recycling Facility (SMURRF) during dry weather. A more likely source of contamination at this station is the pier and attendant structures. Santa Monica Pier houses several food concession stands, restroom and parking facilities, as well as a small marine aquarium, and attracts thousands of California local visitors and tourists.

Station S9, located in Marina del Rey at Mother's Beach, is not associated with any visible storm drain. However, station S9 is located in an area of stagnant or low flow and poor water circulation, resulting in slow flushing of contaminants out of the area. Overhead filamentous wire structures to discourage the presence of birds on the shore have been installed at the site to mitigate possible avian fecal contamination. The Los Angeles County Department of Beaches and Harbors

(LACDBH) has initiated a project to identify and mitigate contamination sources (Lauri Ames, LACDBH, personal communication).

Stations S2, S4, and S6 are associated with a lagoon and storm drains, respectively, and had relatively moderate flows into the Santa Monica Bay for 48, 119 and 89 days of the monitoring period, respectively (Figure 5).

Storm drains in the southern portion of Santa Monica Bay, with the exception of those at stations S12, and S17 (Imperial Hwy, and Ave I storm drains, respectively), rarely exhibit visible flow in dry weather. Stations S10 (Ballona Creek) and S16 (Redondo Pier) exhibited the highest bacterial counts of the southern Santa Monica Bay shoreline stations.

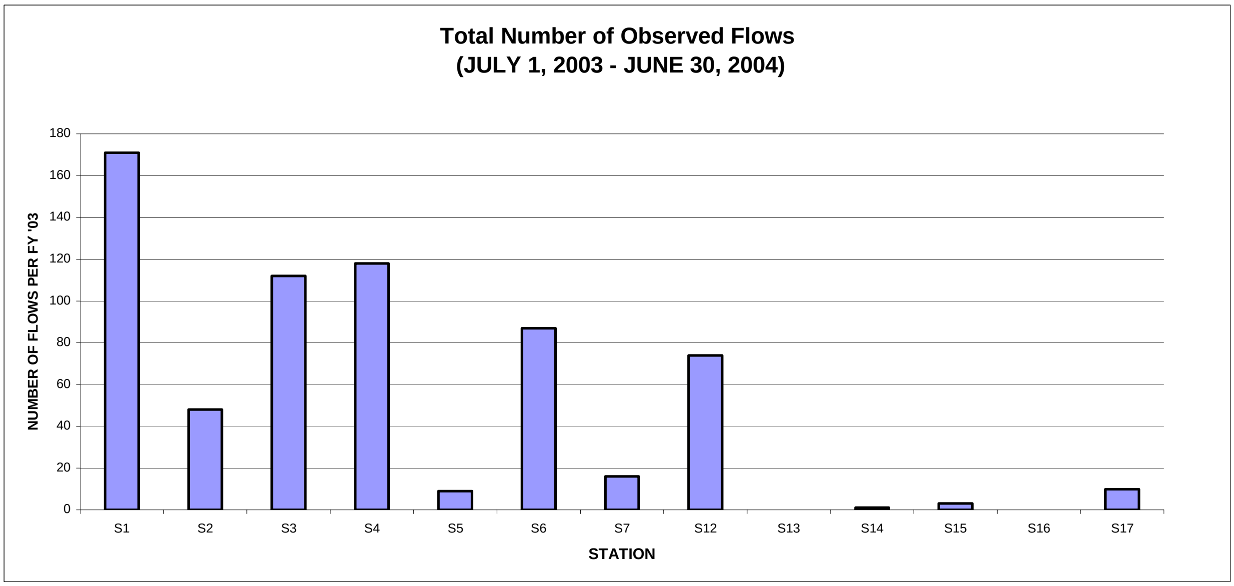

Figure 5. Number of days that flows from Santa Monica Bay stormdrains and lagoons were observed at monitoring stations.

Station S10 is adjacent to Ballona Creek, which is one of the largest freshwater nonpoint sources to drain directly into the Bay. In 1987 and 1988, Ballona Creek accounted for 58% and 71%, respectively, of the total freshwater runoff into the Bay. Winter storm flow in the creek accounts for at least 50% of the total annual volume discharge into the Bay based on 1987-1988 observations (Interdisciplinary Oceanographic Group 1998). This flow carries high concentrations of bacteria. For example, at Pacific Ave, EMD's upstream monitoring site nearest to the mouth of Ballona Creek, an average annual geometric mean of 4200 cfu/100 ml for total coliforms and 370 cfu/100 mL for fecal coliforms, wet and dry weather combined, were measured. Counts at stations S10 and S11 are a reflection of the discharge from Ballona Creek, especially during wet weather when flows are increased. Most current measurements in Santa Monica Bay in the winter- storm period indicate a mean flow toward the northwest, but near-shore measurements indicate a southward flow along the coast. Such a southward flow in the Bay would advect plume waters from Ballona Creek toward the beaches of Playa del Rey (Interdisciplinary Oceanographic Group 1998). In addition to being subject to stormwater plumes from Ballona Creek, station S11 is located adjacent to the

Culver storm drain. However, possible impacts from flows through this drain have not been effectively assessed.

Station S16, located at the far end of the southern portion of the Bay, is adjacent to Redondo Beach Pier and was found to have the highest dry-weather total and fecal coliform/*E. coli* counts in southern Santa Monica Bay. This site, much like station S5 (Santa Monica Pier), is subjected to similar influences of bacterial contamination. The pier contains a large restaurant, food concessions, restroom and parking facilities, and has a large tourist population. Though there is an associated storm drain in the area, it rarely flows across the sandy surface. The counts here can be attributed most likely to the pier activity.

Water quality within the Santa Monica Bay has improved in recent years due to the efforts of the City of Los Angeles' Low-Flow Diversion Program, the City of Santa Monica's Urban Runoff Recycling Facility (SMURRF), and the efforts of other municipalities within the watershed in implementing several best management practices (BMPs). These programs are designed to prevent harmful pollutants from reaching our local water bodies, enhance economic development and growth through increased beach usage and tourism, and to protect human health and the environment. These programs are part of a continuing process to reduce or prevent discharge of harmful pollutants into the receiving waters of the Bay. Other measures for improving water quality along Santa Monica Bay beaches include (Santa Monica Bay Restoration Commission, 2004):

- Structural Best Management Practices (BMPs), such as installation of in-stream trash capture devices, catch basin retrofits, and installation of filtration devices along roadways or in parking lots.
- Non-structural BMPs, such as catch-basin stenciling, enhanced catch basin/trash can cleaning, and street sweeping,
- Public education and outreach
- Enhanced storm drain inspection
- Implementation of programs that eliminate illicit connection and illegal discharge into the storm drains
- Promotion and enforced implementation of BMPs at industrial facilities and construction sites
- Implementation of new land use practices to increase on-site storm water infiltration and to reduce erosion, and
- Enaction and enforcement of local ordinances that prohibit activities that contribute to storm water pollution, such as illegal disposal, dumping or washing of waste (from domestic animals, restaurants, automobiles, and etc.) into the storm drain system.

Some of the above recommendations have already been implemented and, given the cooperative spirit of municipalities, environmental organizations, and concerned communities, additional progress is being made each year to enhance and protect our water bodies.

V. LITERATURE CITED

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