SANTA MONICA BAY SHORELINE MONITORING
MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4) REPORT
(July 1, 2005 – June 30, 2006)
Monitoring and Assessment by the City of Los Angeles

EXECUTIVE SUMMARY

The City of Los Angeles is required to monitor shoreline stations to evaluate the impacts to coastal receiving waters and the loss of recreational beneficial uses resulting from storm water/urban runoff. Also, the Municipal Storm Water Permit requires the City of Los Angeles to annually assess shoreline water quality data and submit it to the Principal Permittee for inclusion in the monitoring report. Therefore, the City of Los Angeles assessment is included in Appendix D of this monitoring report.

Beginning July 2005, a change in the SMBBB TMDL plan impacted the monitoring frequency of the MS4 program. The monitoring frequency for nine stations was reduced to 5 days per week and the monitoring frequency of the remaining nine stations was reduced to weekly.

The Hyperion Treatment Plant effluent has never been observed to impact water quality of the Santa Monica Bay shoreline; rather, the major source of impacts to the Bay is runoff. Those sites with the greatest number of exceedances tend to be stations adjacent to a flowing storm drain and/or a heavily used pier. Bacterial standards at shoreline stations during 2005-2006 were most often exceeded at Stations S01 (Malibu Lagoon), S02 (Topanga Canyon), S04 (Santa Monica Canyon), and S10 (adjacent to Ballona Creek). The sites with 100% compliances were stations S12 (Imperial Hwy), S13 (40th Street, Manhattan Beach), S14 (Manhattan Beach Pier), S15 (Hermosa Beach Pier), and S18 (Malaga Cove); these sites, with the fewest exceedances, are all in the southern portion of the Bay.

The highest bacteria concentrations typically occur during or following rain events, providing additional evidence that storm drains are the major source of bacteria. The growing evidence of storm drains as the major source of bacteria to Santa Monica Bay beaches, along with the generally low bacterial concentrations at stations not being adjacent to a flowing storm drain/or heavily used pier, lends additional credibility to the conclusion that the HTP discharge makes little or no contribution to bacterial levels at these beaches.

Following conversion to full secondary treatment in November 1998, the HTP effluent has shown a substantial improvement and reduction in its bacterial levels. Additionally, the number of floatable materials such as plastic and rubber goods, which often originate from HTP, has declined from previous years as a result of the revamp in the treatment process. This pattern continued during this reporting period.

I. INTRODUCTION

Santa Monica Bay (SMB) plays a very important part in Southern California's recreation, tourism, and commercial economy, but for decades it has been used as a repository for point and non-point source discharges. These discharges include those from wastewater treatment plants, storm drains, rivers, and creeks. Major concerns regarding the effects of these discharges on the natural environment, recreation, and other beneficial uses of the Bay, in addition to public health, led to the regulation of treatment plant discharges. Because of effluent discharge from the Hyperion Treatment Plant (HTP) into Santa Monica Bay waters, the City of Los Angeles (CLA) has been monitoring Santa Monica Bay shoreline water since the late 1940's. Historic water quality monitoring data has indicated that Hyperion's discharge has no discernible impact on the water quality of the SMB shoreline. Instead, test results suggest that runoff to the Bay originating inland and reaching the Bay via storm drains (particularly during periods of heavy rainfall), sewage spills, and illicit discharges, is an important source of contamination (CLA, EMD 2005).

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 irrigation, domestic, commercial, and industrial activities. 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 CLA collaborated with the City of Santa Monica 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 has employed Low-Flow Diversion systems to direct flows from 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 Shoreline Monitoring Plan for the state and federally mandated Santa Monica Bay Beaches Bacterial Total Maximum Daily Load (SMBBB TMDL) program. The SMBBB TMDLs, which became effective July 2003, have 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 up to three annual exceedences of AB 411 standards, respectively. Compliance must be obtained within three years for the summer dry-weather period and within six years for winter dry-weather. The wet-weather portion, which allows for up to seventeen annual exceedances, must be met within eighteen years. The implementation of the coordinated monitoring plan began in November 2004. With the approval from the Regional Water Quality Control Board (RWQCB), the shoreline monitoring requirements under the SMBBB TMDL were incorporated into the Municipal Separate Storm Water Sewer System (MS4) permit to promote consistency of the monitoring programs and to conserve resources and staffing, while improving compliance monitoring and protecting public health.

The following changes in the MS4 monitoring program became effective in November 2004:

- Sampling locations moved from 50 yards from storm drains to point zero.
- Monitoring frequency decreased from seven to six days per week;
- Frequency of enterococcus testing changed from five times per month to five days per week
- Enterococcus testing method changed from membrane filtration to the chromogenic substrate method.
- In July 2005, monitoring frequency for nine stations was reduced to 5 days per week.
- In July 2005, monitoring frequency for nine stations was reduced to weekly.

This report summarizes the City of Los Angeles EMD's Santa Monica Bay shoreline bacteriological data for the Fiscal Year 2005-2006 (July 1, 2005 to June 30, 2006). The bacteriological data consists of bacterial densities for three groups of indicator bacteria. These indicator groups are the total coliforms, fecal coliforms/*E. coli*, and the enterococci. Their presence in water, especially fecal coliforms/*E. coli* and enterococci, is an indicator of recent fecal contamination, which is the major source of many waterborne diseases (Csuros and Csuros 1999). Monitoring indicator bacteria is currently one of the most efficient means of predicting the presence pathogen 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 when an exceedance of bacterial standards occurs.

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 the ratio of fecal/total coliform exceeds 0.1

Current indicator bacterial quantification methods depend on incubation and growth of bacteria in the laboratory. Results are presently obtained approximately 18 to 24 hours after sample collection, thus compromising early notification of public health and contamination source identifications. Beginning in November 2004, the chromogenic substrate method was used for all SMB shoreline indicator bacterial quantification, including enterococcus which had previously been quantified using membrane filtration, an analytical method that took 48 hours to complete. The City also participated in the Southern California Coastal Water Research Project Rapid Indicator Detection Methods Study to develop newer methods that can provide results faster.

II. MATERIALS AND METHODS

A. SAMPLE COLLECTION

Geographically, EMD monitors 18 SMB shoreline stations ranging from Surfrider Beach (S1, Malibu Lagoon) in Malibu southward to Malaga Cove (S18) in Palos Verdes Estates (Figure 1). On November 1, 2004, the City of Los Angeles implemented the Coordinated Shoreline Monitoring Plan (CSMP) for the Santa Monica Bay Beaches Bacterial TMDLs. Some TMDL monitoring requirements were incorporated into the MS4 permit, and as a result, the monitoring frequency of nine stations, S3, S11 through S15, S17, and S18, was reduced from seven days to one day per week. The monitoring frequency of the remaining nine stations, S1, S2, S4 through S7, S10, and S16, was changed from seven to five days per week. All shoreline stations were sampled at point zero, which is defined as the point at which the discharge from a storm drain or creek initially mixes with the receiving water. A station having no storm drain or creek associated with it is referred to as an open beach site. All samples were collected at ankle-depth level during daylight hours.

In addition to the above compliance samples, Ballona Creek was sampled daily from midbridge at Centinela Avenue and weekly from midbridge at Pacific Avenue.

B. SAMPLE ANALYSIS

Water samples from 18 stations were collected and analyzed according to Standard Methods (APHA 1998) for all bacterial indicators. Total coliform and *E. coli* bacterial densities were determined by the chromogenic substrate method following Standard Methods section 9223, and *Enterococcus* density was determined by Enterolert™, per manufacturer's instructions. For the Ballona Creek stations sampled at Centinela and Pacific Avenue, total coliform and *E. coli* were determined by chromogenic substrate and enterococcus by membrane filtration.

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 1998). These areas included sampling techniques, sample storage and holding time, facilities, personnel, equipment, supplies, media, and analytical test procedures. Duplicate analyses also were 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.

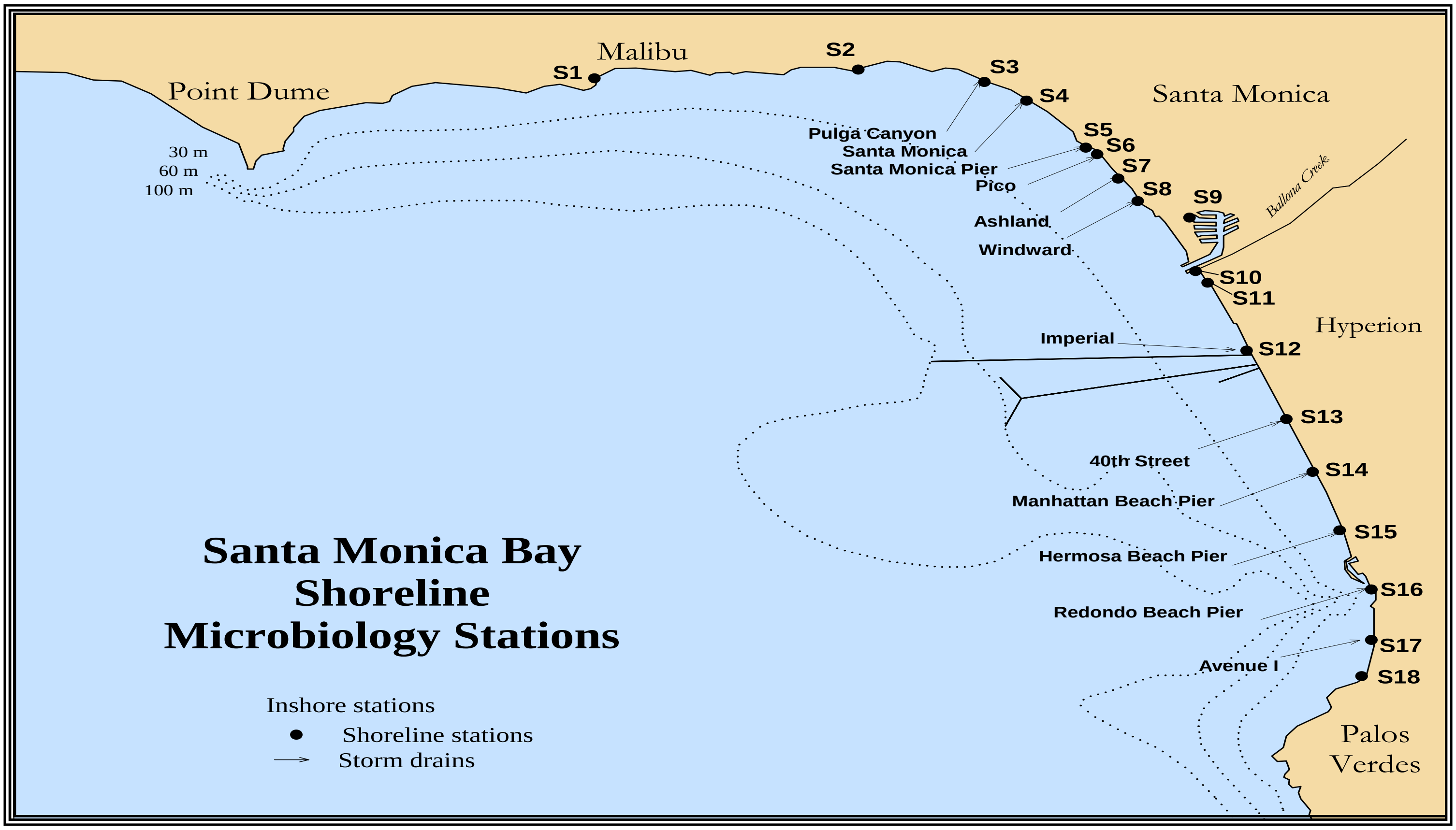

Figure 1. Location of Santa Monica Bay shoreline monitoring stations, stormdrains, and piers.

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 runoff from storm drains on indicator bacterial concentrations. The MS4 permit has defined wet weather as the day of rain plus three days following the rain event. Rain data were obtained from the National Weather Service's Downtown Los Angeles, University of Southern California (USC) records.

III. RESULTS

Rainfall

During the 2005-2006 fiscal year, measurable rainfall occurred over a nine-month period. The total rainfall for Fiscal Year 2005-2006 was 13 inches, which is less than the average rainfall of 15 inches for Los Angeles. March had the most rainfall with 2.87 inches. No rainfall was recorded for July and August 2005 for or June 2006 (Figure 2).

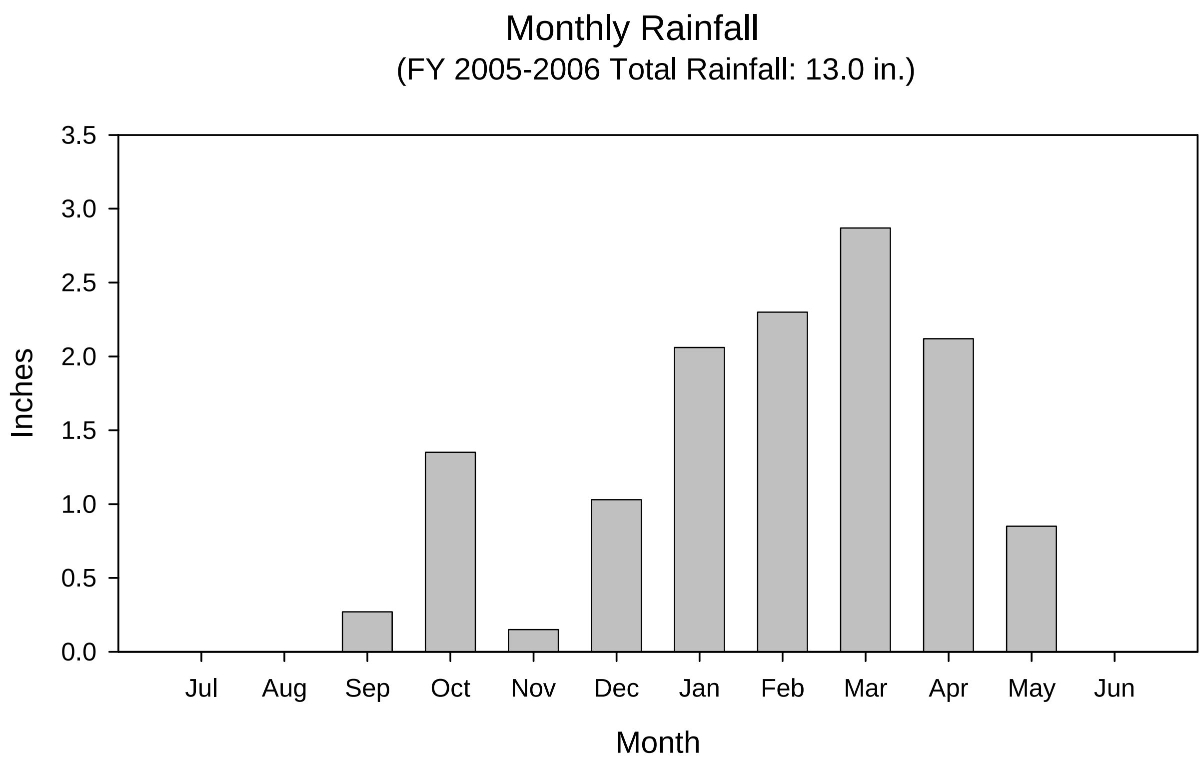

Figure 2. Monthly rainfall amounts at Downtown Los Angeles, USC, July 2005-June 2006.

Shoreline Stations

The annual geometric means for all indicator bacteria were higher during wet weather than 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.

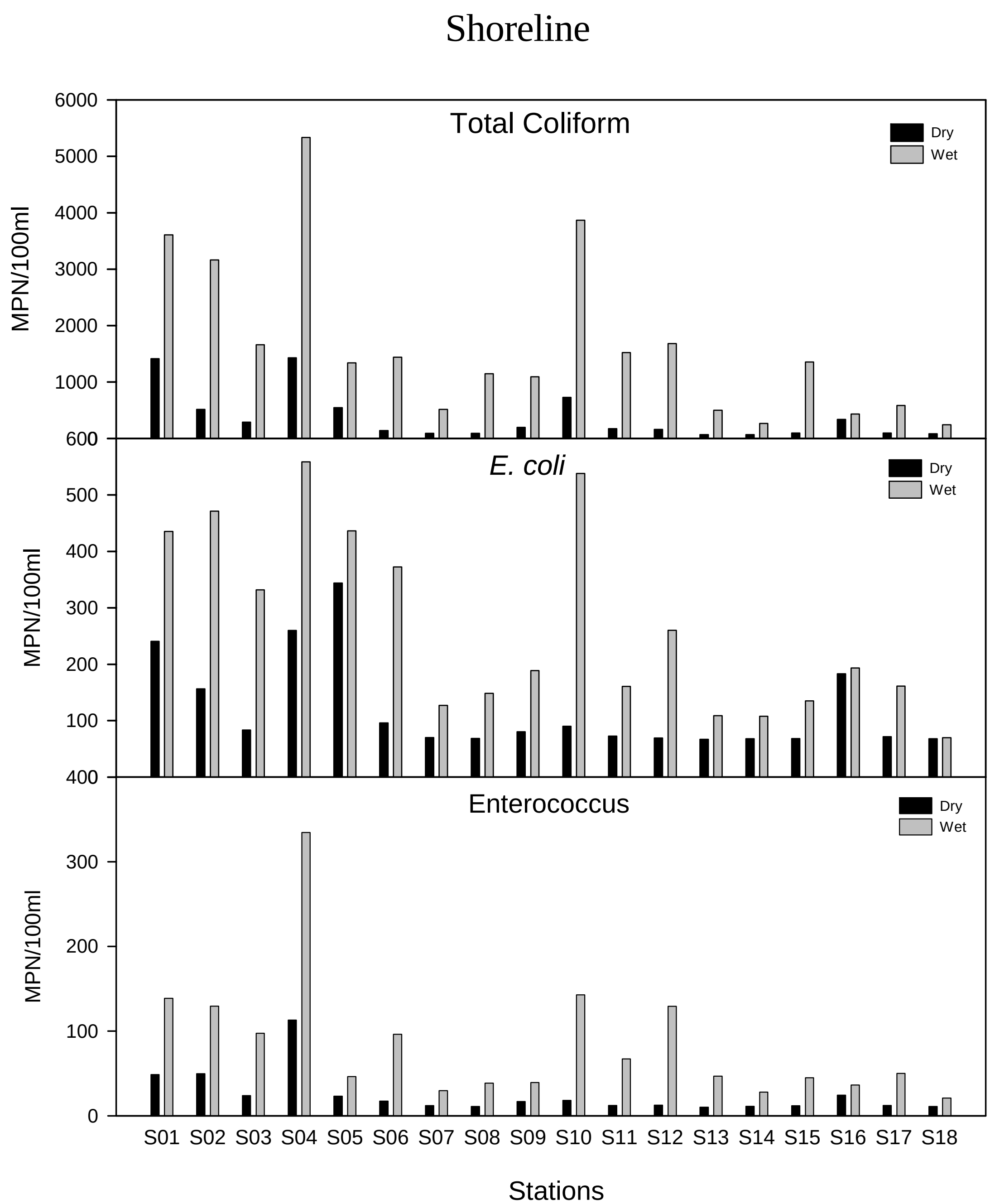

Figure 3. Annual geometric means for indicator bacteria at each shoreline station in Santa Monica Bay during Fiscal Year 2004-2005 wet and dry weather.

Northern Santa Monica Bay is comprised of stations from Malibu (S1, Malibu Lagoon) to Marina Del Rey (S9, Mother's Beach, Marina Del Rey). The northern SMB shoreline stations' annual bacterial geometric means generally were higher than those of the southern SMB shoreline stations for all indicator bacteria. Dry-weather geometric means for total coliform were highest at northern stations S4 (Santa Monica Canyon), S1, S5 (Santa Monica Pier), and S2 (Topanga Canyon). Highest *E.coli* geometric means were noted for stations S5, S4, and S1, and the enterococcus geometric mean was highest at station S4. As previously noted, wet-weather geometric means for all bacterial indicators were higher than those for dry-weather. Sampling locations with highest wet-weather bacterial densities for all three indicators were S4, S1, and S2.

Southern Santa Monica Bay includes all of the stations south of Ballona Creek, starting from station S10 (Ballona Creek) to station S18 (Malaga Cove, Palos Verdes Estates). The bacterial densities at the south SMB shoreline stations were typically lower than those in the north SMB, with the exception of station S10 for wet-weather geometric means. During the dry-weather period, station S10 had the highest total coliform geometric mean, while highest *E. coli* and enterococcus geometric means were at station S16 (Redondo Beach Pier). The highest total coliform, *E. coli,* and enterococcus wet-weather geometric means were at stations S10 and S12 (Imperial Hwy storm drain) (Figure 3). It is also interesting to note that there is little difference between wet and dry-weather geometric means at S16 for all three indicators.

Ballona Creek

The monthly geometric means for the two Ballona Creek sampling locations, Centinela and Pacific, were calculated using data of both weather periods combined. At the Centinela sampling station, the highest monthly geometric means for total coliform, *E. coli*, and enterococcus were in July, August, and September 2005, respectively (Figure 4). Note that there was not much difference between *E. coli* densities in August and September 2005. The lowest monthly geometric means for total coliforms, *E. coli,* and enterococcus were in February of 2006.

The Pacific station is located downstream from Centinela and is closer to the mouth of Ballona Creek. At this station, the total coliform geometric means were highest in July 2005 and March 2006. *E. coli* geometric means were highest in September 2005 and March 2006. Enterococcus geometric means were highest in January and March 2006 (Figure 4). Geometric means for total coliform were lowest in November and December of 2005, and April of 2006. Lowest *E. coli* geometric means were in November and December of 2005, and February and April of 2006. Enterococcus geometric means were lowest in July and November of 2005, and June of 2006. The bacterial indicator geometric means at Pacific were generally lower than at the Centinela station.

Ballona Creek

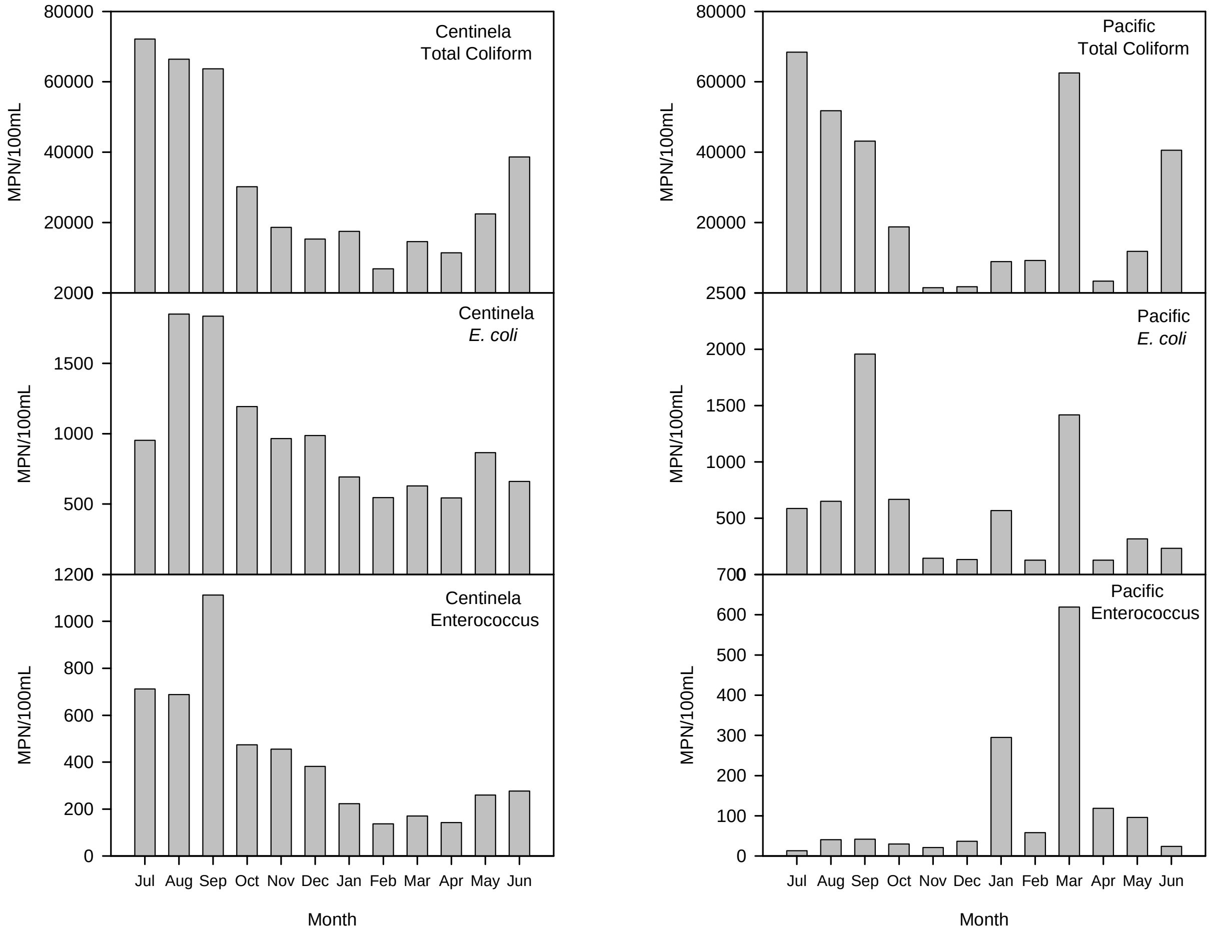

Figure 4. Monthly geometric means for indicator bacteria at Ballona Creek stations, dry- and wet-weather combined. Centinela and Pacific, July 2005 to June 2006.

Water Quality Standards Compliance

Table 2 lists the percent compliance of all AB411 bathing water quality standards for SMB shoreline stations during Fiscal Year 2005-2006. The percent compliances are based on dry-weather bacterial densities and reflect a measure of water quality for public health. Station S4 (Santa Monica Storm Drain) was the station with lowest percent compliance of water quality standards and highest number of standard exceedances. Next in order of lowest percent compliance were stations S1 (Malibu Lagoon) and S2 (Topanga Canyon). Station S5 (Santa Monica Pier) had the lowest percent compliance for *E. coli*. These four stations are in the northern part of the Santa Monica Bay.

Southern stations S12 (Imperial Hwy storm drain), S13 (40th Street, Manhattan Beach), S14 (Manhattan Beach Pier), S15 (Hermosa Beach Pier), S17 (Ave I, Redondo Beach) and S18

(Malaga Cove, Palos Verdes Estates) were 100% compliant for all standards, with the exception of station S17 with 97.4% compliance for EC:TC ratio. No northern SMB station achieved 100% compliance for all standards.

STATION	**TOTAL**[1]	***E. COLI*** [2]	**ENTERO**[3]	**EC:TC**[4] **RATIO**
S01	78.9	63.2	73.7	64.1
S02	96.2	80.4	64.1	70.8
S03	97.8	97.8	84.8	95.7
S04	78.0	59.3	43.5	71.3
S05	99.0	56.5	90.4	72.2
S06	97.6	93.8	90.9	95.7
S07	99.0	99.5	98.1	100
S08	98.0	100	95.9	100
S09	100	97.6	94.3	96.2
S10	88.5	93.8	94.7	98.6
S11	97.7	97.7	97.7	97.7
S12	100	100	100	100
S13	100	100	100	100
S14	100	100	100	100
S15	100	100	100	100
S16	99.5	72.6	90.4	86.1
S17	100	100	100	97.4
S18	100	100	100	100

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

Table 2. Percent compliance of bacterial densities at EMD Santa Monica Bay shoreline stations with California AB411 bathing water standards during dry weather from July 1, 2005 through June 30, 2006.

The frequency of exceedance of the AB411 standards during the dry-weather period only of Fiscal Year 2005-2006 is presented in Figure 5. As mentioned above, station S4, followed by stations S1 and S2 had the most exceedances. The southern part of the Bay had the most stations in compliance; the major exceptions being stations S16 (Redondo Beach Pier), which had a high exceedance frequency for *E. coli* and S10 for total coliform. Five out of nine southern stations were 100% compliant.

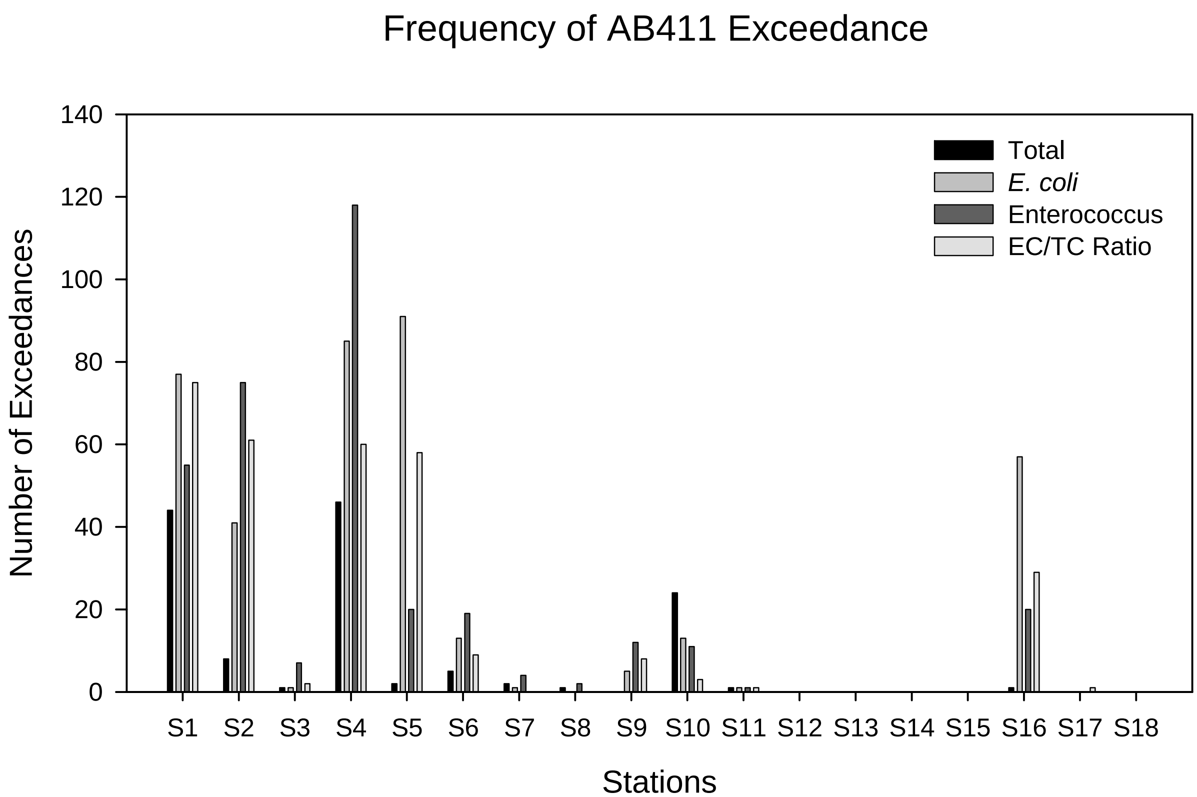

Figure 5. Frequency of exceedance of AB411 standards at SMB shoreline stations during dry weather from July 1, 2005 through June 30, 2006.

Field Observations

Table 3 provides a summary of field observations of plastic goods (tampon inserters), rubber goods (prophylactic rings), and grease particles. All are considered to be materials of sewage origin (MOSOs), which, when found, trigger an incidence of treatment plant non-compliance. No grease particles have been observed since 1998. The occurrence of plastic and rubber goods along the SMB shoreline decreased markedly from 1994 to 2004 (CLA, EMD, 2005). During Fiscal Year 2005-2006, none of the 18 stations had any incidences of plastic goods, rubber goods, or grease particles.

Materials of Sewage Origin (FY 05-06)							
Station	PG*	RG*	GP*	Station	PG*	RG*	GP*
S1	0	0	0	S10	0	0	0
S2	0	0	0	S11	0	0	0
S3	0	0	0	S12	0	0	0
S4	0	0	0	S13	0	0	0
S5	0	0	0	S14	0	0	0
S6	0	0	0	S15	0	0	0
S7	0	0	0	S16	0	0	0
S8	0	0	0	S17	0	0	0
S9	0	0	0	S18	0	0	0
***LEGEND** **PG-PLASTIC GOODS** **RG-RUBBER GOODS** **GP-GREASE PARTICLES**							

Table 3. Number of visual observations of material of sewage origin at shoreline stations, during Fiscal Year 2005-2006.

IV. DISCUSSION

Historic monitoring data of Santa Monica Bay has indicated that the wastewater discharge from the Hyperion Treatment Plant has no observable impact on water quality at CLA monitored shoreline stations. Urban runoff has been identified as one of the major contributors of bacterial contamination to Santa Monica Bay (RWQCB, 2005). The effects of urban runoff on impacted shorelines have been studied extensively by regulatory agencies, environmental organizations, and universities. Runoff flows over rooftops, freeways, parking lots, construction sites, industrial facilities, and other impervious and non-impervious surfaces, collect pollutants and transport them through open channels and underground pipes directly to the Bay. Even in dry-weather, ten to twenty-five million gallons of water flow daily through storm drains into Santa Monica Bay (Santa Monica Bay Restoration Commission, 2004).

Past water quality data has shown that sites with high bacterial densities were associated with either a storm drain (or a lagoon) and/or a large heavily used pier. Storm drain data suggests that the number of flow days, in conjunction with the rate of flow, also is predictive of high bacterial indicator densities (CLA, EMD 2005).[1] Southern stations S11 through S18, had the lower overall

[1] It is important to note that the position of the mouth of storm drain contributes to the observed number of flow days. Storm drain position (buried in sand, submerged, or extended too far in the surf) or the location of the mouth of the drain, may obscure vision or make the storm drain inaccessible. Flow observations are noted to the best of the observer’s ability, but due to safety concerns, observers are not allowed under piers or to venture far into the surf to improve visibility

counts than did the northern sites. It seems apparent that sites associated with storm drains with few flow days and low-flow rates contributed lower bacterial contamination overall, confirming that urban flow and runoff is the major contributor of pollutants to these shoreline receiving waters.

The northern part of the Bay has a number of consistently flowing storm drains. Stations S1, S2, and S4 are sites with high densities and each had both a high number of observed flow days and high average flow rates (Table 4). Stations S1 and S2 are located near lagoons created and fed by natural creeks that flow into the ocean when breached. Surfrider Beach (Station S1) has been designated as one of the most polluted beaches in Santa Monica Bay (CLA, EMD 2003). It is located at the outlet of the entire Malibu Creek watershed, which has a drainage area equal to approximately 105 square miles. When the lagoon is breached, it brings a heavy discharge of pollutants into the surf zone, resulting in increased bacterial densities in the Bay. Station S4 has a large watershed area that contains horse corrals, a golf course, and some houses on septic systems, all of which contributed to its having the highest bacterial densities of all stations.

In its efforts to improve water quality, the City of Los Angeles has employed storm water low-flow diversion structures. The CLA has a program geared toward increasing the number of dry-weather storm drain flows diverted to sanitary sewers. Stations S3 through S8, S12, and S17 are sites with low-flow diversion structures. With the exception of stations S4 and S5, data for Fiscal Year 2005-2006 exhibited a decrease in AB411 standard exceedances compared to the previous fiscal year.

Ballona Creek is a concrete channel with year-round flow and a drainage area equal to approximately 89 square miles. The Centinela station is under tidal influence when ocean tides exceed 3.5 feet. The Pacific station is located downstream of Centinela and is close to the shoreline. It is sampled to assess the effect that tidal dilution may have on the upstream bacterial levels. This dilution effect is suggested by the decreased geometric means for total coliform, fecal coliform/*E. coli*, and enterococcus at Pacific as compared to Centinela. However, this was not the case in March 2006, when the greatest amount of rainfall occurred, and bacterial geometric means were higher at Pacific than in Centinela. These high bacterial means suggest that high tides, near the mouth of Pacific station, might have hindered the storm water flow, whose volume was greater than usual, downward from Centinela, into the Bay. An additional contributor to this might have been the spill on March 19, 2006 entering Ballona Creek between Centinela and Pacific. As a result, Pacific yielded an overall higher geometric mean for the month of March 2006. Additionally, Pacific is sampled once per week; whereas, Centinela is sampled five times per week. The fewer samples at Pacific means a higher data point contributes relatively more to the geometric mean calculation.

Northern Stations	S1	S2	S3	S4	S5	S6	S7	S8	S9
Flow Days	230	173	46	199	12	42	12	1	0
Average Flow rate	3	3	2	3	0	3	2	2	0
Southern Stations	**S10**	**S11**	**S12**	**S13**	**S14**	**S15**	**S16**	**S17**	**S18**
Flow Days	247	0	12	2	1	4	0	8	0
Average Flow rate	3	0	1	2	1	1	0	2	0
***FLOW RATE** *1- Low* *2–Moderate* *3 - Heavy*									

Table 4. Storm drain flow occurrences, Fiscal Year 2005-2006

Studies have shown that urban runoff and storm drain flows leading into the Bay, not effluent discharged from Hyperion, are the major contributors of shoreline pollution. The largest source of stormwater pollution is the general public. They are contributors of trash containing fast-food wrappers, cigarette butts, Styrofoam containers, motor oil, antifreeze, pesticides, sewage overflow, and pet waste (CLA, EMD 2005). Plans to reduce stormwater pollution and urban runoff, which include structural best management practices (BMPs) and educational programs geared toward the general public, businesses, and City employees, are expected to contribute to improving and protecting water quality along the Santa Monica Bay shoreline.

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