SANTA MONICA BAY SHORELINE MONITORING
MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4) REPORT
(July 1, 2007 – June 30, 2008)
Monitoring and Assessment by the City of Los Angeles Environmental Monitoring Division

I. INTRODUCTION

Santa Monica Bay (SMB) plays a very important part in Southern California's recreation, tourism, and commercial economy. The City of Los Angeles (CLA) has been monitoring Santa Monica Bay shoreline water quality parameters since the late 1940's. Water quality monitoring data indicate that discharge from the Hyperion Treatment Plant (HTP) does not have a discernible impact on the water quality of the SMB shoreline (CLA, EMD 2005). In the interest of protecting public health and preserving the natural environment, recreation, and other beneficial uses of Santa Monica Bay, the City of Los Angeles continues to implement measures to improve the Bay's water quality. Pro-active and regulation-driven measures include Low-Flow Diversion systems to direct flows from storm drains and urban runoff to HTP during dry-weather; the Santa Monica Urban Runoff Recycling Facility (SMURRF), on which the City of Los Angeles collaborated; additional ongoing institutional and structural Best Management Practices (BMPs), and scientific studies. The monitoring data shows steady improvement in water quality, suggesting these efforts are achieving success.

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 exceedances of AB 411 standards, respectively. Compliance was to 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 up to seventeen exceedances annually, must be met within eighteen years. Implementation of the Coordinated Shoreline Monitoring Plan began in November 2004. With 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.

Additionally, in July 2005, the following changes became effective:

- Monitoring frequency for nine stations was reduced to 5 days per week.
- 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 2007-2008 (July 1, 2007 to June 30, 2008). The bacteriological data consists of 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 currently is one of the most efficient means of predicting the presence of pathogens 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 then are reported to the Los Angeles County Department of Public Health (LACDPH). Subsequently, LACDPH takes steps (such as posting health hazard warning signs for beach users) to notify beach goers when an exceedance of bacterial standards occurs.

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

Table 1. AB411 Bathing Standards

Current indicator bacterial quantification methods depend on incubation and growth of bacteria in the laboratory. Results presently are obtained approximately 18 to 24 hours after sample collection, thus preventing early notification of potential public health risks and contamination source identifications. Since November 2004, the chromogenic substrate method has been used for all SMB shoreline indicator bacterial quantifications, including enterococcus, which previously had 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

For the MS4 program, EMD monitors 18 SMB shoreline stations ranging from Surfrider Beach (S1, Malibu Lagoon) in Malibu southward to Malaga Cove (S18, Palos Verdes Estates; Figure 1). On November 1, 2004, the City of Los Angeles began participating in 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, S8, 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, S9, S10, and S16, was changed from seven to five days per week. All shoreline stations since November 1, 2006 have been 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.

B. SAMPLE ANALYSIS

Total coliform and *E. coli* bacterial densities were determined by the chromogenic substrate method following Standard Methods section 9223 (APHA 1998), and *Enterococcus* density was determined by Enterolert™, per manufacturer's instructions.

Visual field observations for shoreline stations were made along a 20-foot stretch of shoreline to the north and south of each station. This area around each station was observed for the presence of materials of sewage and non-sewage origin, any unusual odors of sewage and non-sewage origin, plankton color, and the presence of flow and flow rate (visual rating only) from storm drains. Storm drain flow data and Low-Flow-Diversion operation is available upon request. Materials of sewage origin included plastic goods, rubber goods, and grease particles. Non-sewage origin materials included ocean debris, seaweed, refuse, tar, and dead marine animals. Station S08 was used as the shoreline weather station for observations of air and water temperature, weather conditions, wind speed and direction, wave height, and sea conditions. Observations of rubber and plastic goods are included herein.

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 include 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 taken. 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 Public Health (CSDPH) as part of its Environmental Laboratory Accreditation Program (ELAP); CSDPH biennially certifies EMD.

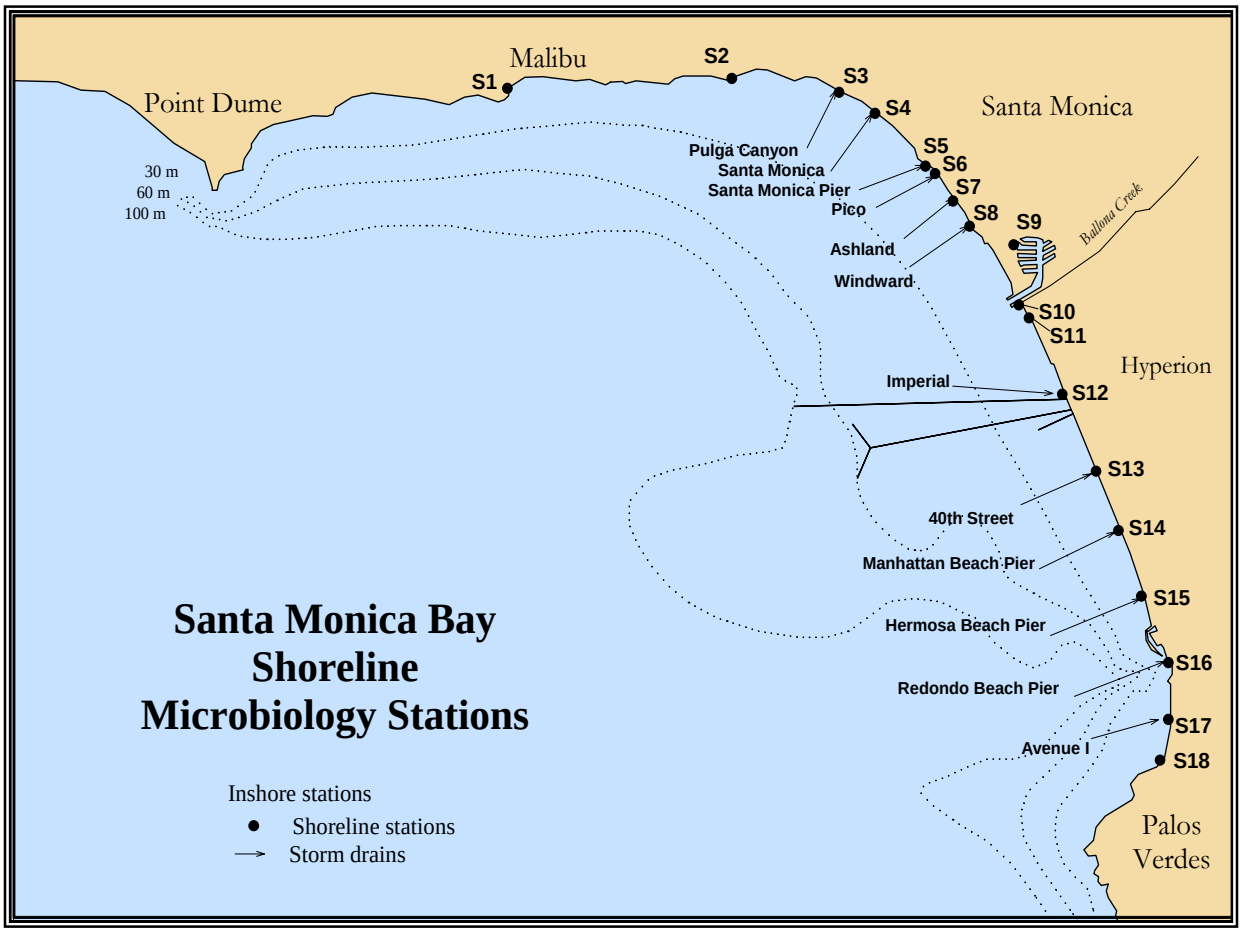

Figure 1. Location of Santa Monica Bay shoreline monitoring stations, storm drains, and piers.

C. DATA ANALYSIS

The results obtained from microbiological samples do not generally follow a normally distribution. 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

Measurable rainfall was recorded during Fiscal Year 2007-2008 for a total 13.52 inches, substantially greater than the total rainfall, 3.2 inches, for the Fiscal Year 2006-2007. The majority of this total, approximately 8 inches, was recorded in January 2008. No rain was recorded for July and August 2007, very little was recorded in May 2008 (0.11 inches), and no rain to trace amounts was detected in March, April, and June 2008 (Figure 2).

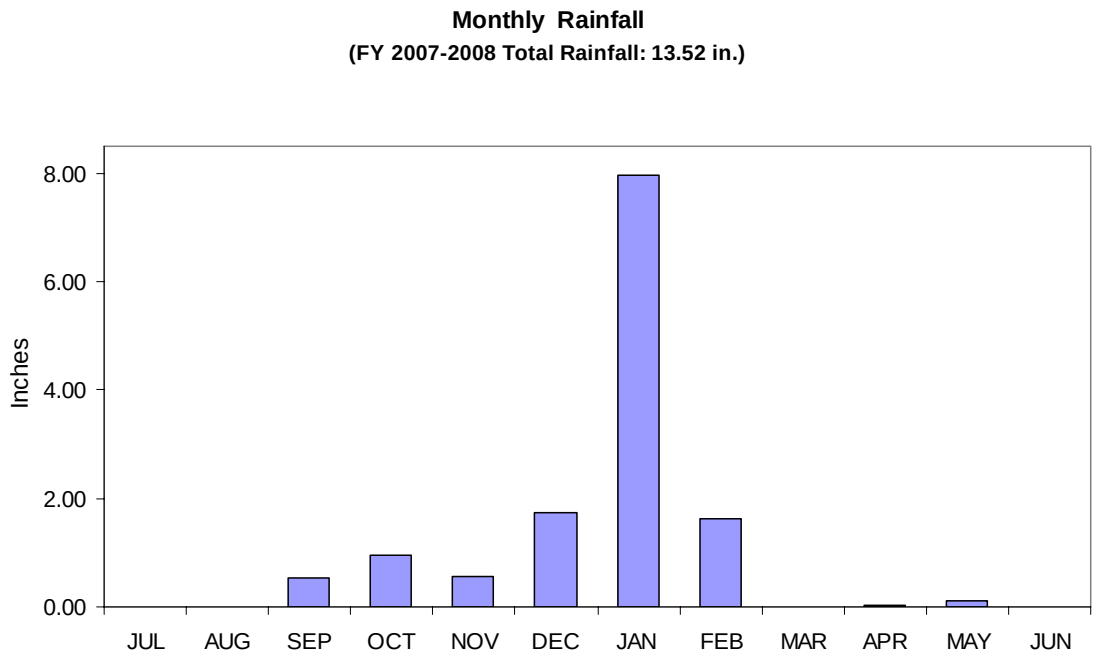

Figure 2. Monthly rainfall amounts at Downtown Los Angeles, USC, July 2007-June 2008.

Shoreline Stations

Annual geometric means for Fiscal Year 2007-2008 revealed higher bacterial densities for all three fecal indicator bacteria during the wet-weather periods compared to dry-weather periods for Santa Monica Bay monitoring stations (Figure 3). One notable exception was the geometric mean for *E. coli* at station S5 (Santa Monica Pier), it was higher during dry-weather than wet-weather. Total coliform and enterococcus densities were higher at S5 during wet-weather.

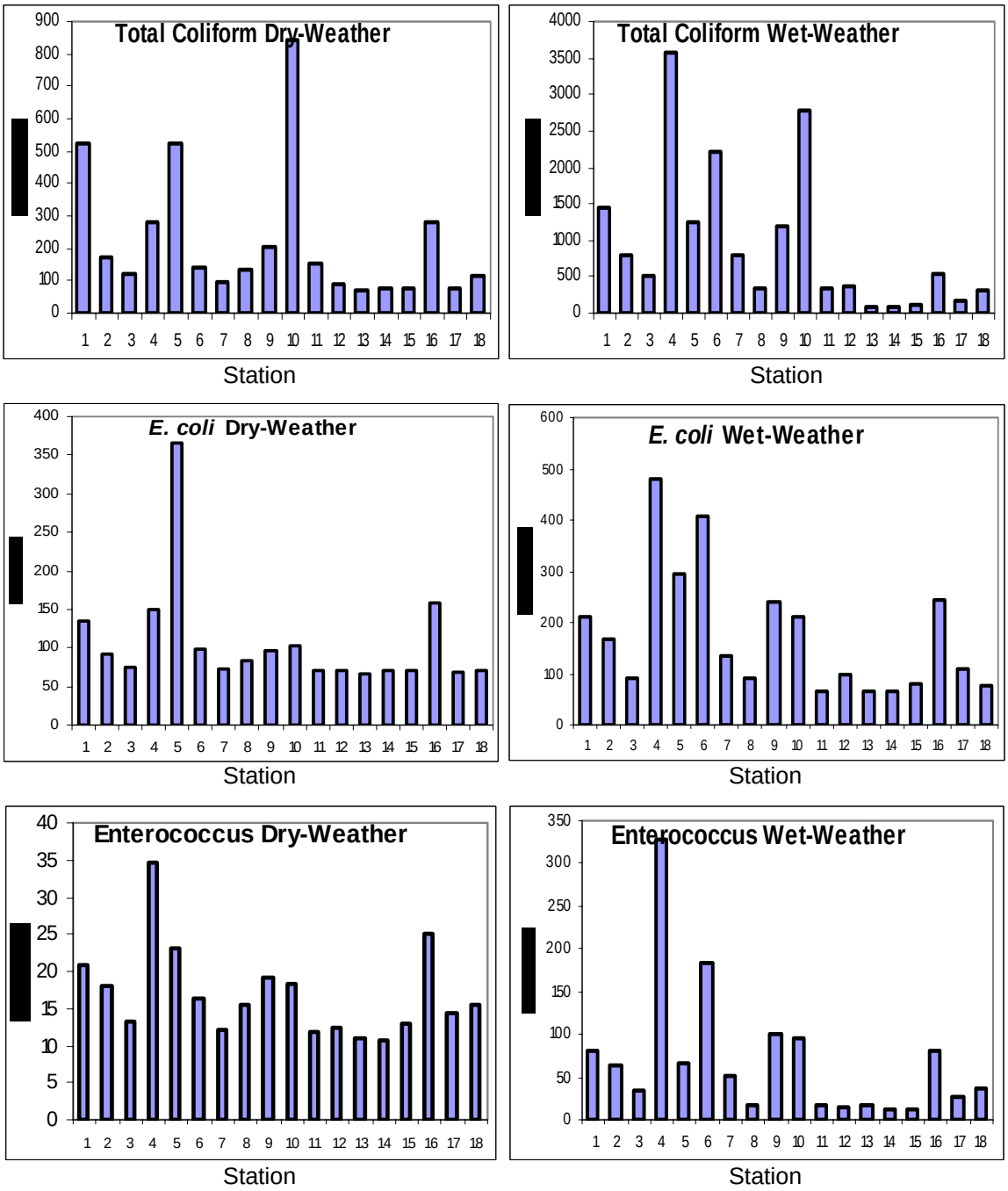

Figure 3. Annual dry- and –wet weather geometric means for fecal indicator bacteria at each compliance monitoring station in Santa Monica Bay for the 2007-2008 Fiscal Year.

The 18 compliance monitoring stations, S1-S18, in Santa Monica Bay are divided into northern stations, from S1 (Malibu Lagoon) in Malibu to S9 (Mother's Beach) in Marina Del Rey, and southern stations, S10 (Ballona Creek) to S18 (Malaga Cove) in Palos Verdes Estates. Stations S1, S4 (Santa Monica Storm Drain), and S5 (Santa Monica Pier) were the northern stations with the highest geometric means for all indicators during dry-weather. During wet-weather, the

northern stations with the highest bacterial densities for the three indicators were S4 and S6 (Pico-Kenter Storm Drain). During wet-weather, S9 was high for *E. coli* and enterococcus and S5 for *E. coli*.

The monitoring stations in the southern bay with the highest bacterial densities for all indicator bacteria during both dry- and wet-weather periods were S10 and S16 (Redondo Beach Pier). The remaining stations in the south had relatively lower densities.

Water Quality Standards Compliance

The purpose of collecting shoreline samples and reporting bacterial results is to assess water quality and the impact it may have on public health. Percent compliance for all AB411 bathing water quality standards for Santa Monica Bay shoreline stations are listed Table 2. Percent compliance represents the percentage of samples that met each of the four water quality standards listed in AB411. Monitoring stations S4, S5, S1, S16 and S10 had the lowest percent compliance for water quality standards.

Station	Number Of samples	(1)total coliform	(2)*E. coli*	(3)enterococcus	(4)EC:TC Ratio
S01	224	90	**81**	93	**84**
S02	224	100	94	**89**	93
S03*	46	100	98	98	98
S04*	225	97	**77**	**71**	**76**
S05*	225	98	**50**	92	**72**
S06*	225	97	94	92	96
S07*	225	99	99	98	99
S08*	48	96	94	98	98
S09	224	100	95	92	95
S10	225	**85**	92	94	95
S11*	44	100	100	100	100
S12*	45	100	100	96	100
S13	44	100	100	100	100
S14	44	100	100	100	100
S15	44	100	100	100	100
S16	225	99	**81**	**87**	**88**
S17*	45	100	100	98	100
S18	44	100	100	95	98

(1) total coliform 10,000 MPN/100mL
(2) fecal coliform 400 MPN/100mL
(3) enterococcus 104 MPN/100mL
(4) total coliform 1000 MPN/100mL, if the ratio of fecal-total coliform exceeds 0.1
(*) These locations are equipped with Low-Flow Diversion devices implemented by the City of Los Angeles, City of Santa Monica, and County of Los Angeles.

Table 2. Percent compliance of bacterial densities at EMD Santa Monica Bay Shoreline stations with California AB411 bathing water standards during dry weather (includes summer and winter dry seasons) from July 2007 to June 2008 (Samples less than 90% compliance are in bold).

The two stations with lowest compliance, S4 and S5, are located in northern Santa Monica Bay. No stations in the northern bay met 100% compliance for the four water quality standards listed by AB411. Three northern stations, however, did have very high percent compliance, stations S3, S7, and S8. Four southern bay stations, S11, S13, S14, and S15 met 100% compliance for all standards. Although they did not meet complete compliance, stations S12, S17, and S18 had very high percent compliance.

Table 3 lists the number of exceedances of AB411 standards during both summer and winter dry-weather for Fiscal Year 2007-2008. The highest total number of exceedances was for *E. coli* limits followed by the fecal:total coliform ratio and enterococcus limits; total coliform exceedances were the fewest of the four limits. Station S5 at Santa Monica Pier had 4 exceedances for total coliforms which translates to 98% compliance; however, *E. coli* limits for S5 were exceeded 113 times, a value that represents 50% compliance for this limit.

Station	**S01**	S02	S03*	**S04***	**S05***	S06*	S07*	S08*	S09	**S10**	S11*	S12*	S13	S14	S15	**S16**	S17*	S18
TC Exceedances	23	1	0	7	4	7	2	2	1	33	0	0	0	0	0	3	0	0
EC Exceedances	43	14	1	51	113	13	2	3	12	19	0	0	0	0	0	42	0	0
ENT Exceedances	15	24	1	65	19	19	4	1	17	14	0	2	0	0	0	30	1	2
EC/TC Exceedances	35	16	1	54	63	8	2	1	12	12	0	0	0	0	0	26	0	1
Total Exceedances	**116**	55	3	**177**	**199**	47	10	7	42	**78**	0	2	0	0	0	**101**	1	3

Table 3. Number of dry-weather (includes summer and winter dry seasons) exceedances of AB411 standards at SMB shoreline stations from July 2007 to June 2008.
(*) These locations are equipped with Low-Flow Diversion devices implemented by the City of Los Angeles, City of Santa Monica, and County of Los Angeles.

Field Observations

Field observations are recorded for each sampling location which include the presence of materials of sewage origin (MOSOs) and non-sewage origin, any unusual odors of sewage and non-sewage origin, and the presence of flow and flow rate (visual rating only) from storm drains. Storm drain flow data and Low-Flow-Diversion operation is available upon request. Table 4 summarizes field observations of MOSOs, such as, plastic goods (tampon inserts), rubber goods (prophylactic rings), and grease particles during Fiscal Year 2007-2008. One observation of rubber goods was recorded at S10. Of the 18 monitoring stations, this was only one incidence of observed MOSO for the entire fiscal year in Santa Monica Bay.

Materials of Sewage Origin							
Station	PG*	RG*	GO*	Station	PG*	RG*	GO*
S01	0	0	0	S10	0	1	0
S02	0	0	0	S11	0	0	0
S03	0	0	0	S12	0	0	0
S04	0	0	0	S13	0	0	0
S05	0	0	0	S14	0	0	0
S06	0	0	0	S15	0	0	0
S07	0	0	0	S16	0	0	0
S08	0	0	0	S17	0	0	0
S09	0	0	0	S18	0	0	0

*Legend: PG=Plastic Goods; RG=Rubber Goods; GP=Grease Particles

Table 4. Number of visual observations of material of sewage origin at shoreline stations during Fiscal Year 2007-2008.

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. Annual geometric means for all three indicator bacteria during dry-weather (includes summer and winter dry periods) identify for the third straight year stations S1, S4, S5, S10, and S16 as having the highest bacterial densities of all MS4 monitoring stations. Bacterial data used to assess percent compliance and tabulate the number of instances AB411 water quality standards were exceeded also identify these five stations as the most contaminated.

The geographic locations of S1, S4, and S10 at the outlet of large sub-watersheds predispose these locations to greater non-point source bacterial loading. Station S1 is located at Surfrider Beach at the outlet of the Malibu Creek watershed and is mainly affected by flows from Malibu Lagoon. This watershed covers a wide area, approximately 105 square miles. There is considerable local activity at the beach, and the lagoon serves as a habitat for numerous bird species; an added source of bacteria at this monitoring site. Surfrider Beach has previously been identified as one of the most polluted beaches in Santa Monica Bay (CLA, EMD 2003). Station S4 is located on a beach with considerable local activity and at the outlet of a large sub-watershed, Santa Monica Canyon. Santa Monica Canyon, which is adjacent to the Santa Monica Mountains, contains horse corrals, a golf course, and some houses on septic systems. In addition, large numbers of birds have been observed to congregate at the beach. Station S10 is at the mouth of Ballona Creek, across from the Marina Del Rey channel, and inside the breakwater that protects both channels. Ballona Creek is the largest freshwater body to drain into the Bay. It is a channel with year-round flow and a drainage area equal to approximately 89 square miles. High bacteria concentrations from the creek may contribute to bacteria detected at S10.

Stations S5 and S16 are adjacent to heavily used piers, which are most likely significant contributors to the high bacterial counts measured at these stations. Santa Monica Pier (S5) houses several food concession stands, restroom and parking facilities, as well as a small marine aquarium, and attracts thousands of local visitors and tourists. Station S16, located near the far end of the southern portion of the Bay, is adjacent to the Redondo Beach Pier. This site is subject to bacterial contamination by way of the pier. This pier contains large restaurants, food concessions, restroom and parking facilities, and has a large visitor population.

The City and County of Los Angeles are both operating several storm water low-flow diversion structures to improve water quality. They both have a program geared toward increasing the number of dry-weather storm drain flows diverted to sanitary sewers. Water quality within the Santa Monica Bay has shown improvement in recent years due to the efforts of these Low-Flow Diversion Programs 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). Plans to reduce storm water pollution and urban runoff, which include structural BMPs and educational programs geared toward the general public, businesses, and City employees, are projected to continue improving and protecting water quality along the Santa Monica Bay shoreline.

V. LITERATURE CITED

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