CHAPTER 3. MICROBIOLOGY WATER QUALITY SHORELINE AND INSHORE

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I. INTRODUCTION

Since July 1994, the focus of bacteriological monitoring in Santa Monica Bay has shifted from monitoring the possible impact of Hyperion's effluent on shoreline and inshore waters to a comprehensive regional monitoring program to address public health concerns and assess impacts from storm drains. Santa Monica Bay is economically important due to coastal tourism and recreational uses, such as swimming, surfing, diving, sport fishing, and boating. Ensuring that Santa Monica Bay is safe for recreational use is an important public health concern. For this reason, shoreline-monitoring stations are now close to storm drains and inshore monitoring stations are close to popular diving locations. These efforts have the support and participation of regulatory agencies, and environmental groups.

Point and nonpoint sources of pollution to Santa Monica Bay include urban runoff through storm drains, treated wastewater discharges, leaking septic tanks, sewage spills, boat discharges, fecal wastes from marine birds and mammals, and swimmers. Epidemiological studies have established that exposure to polluted bodies of water during recreational use is associated with disease (Cabelli et al. 1982, Dadswell 1993, Van Asperen et al. 1995, SMBRP 1996). The Hyperion Treatment Plant discharges approximately 317 million gallons per day (MGD) of full secondary-treated wastewater into the Bay. State and Federal regulatory agencies require wastewater dischargers to monitor receiving waters to assess any impact their discharge may have on water quality. To meet these requirements, bacteriological monitoring of Santa Monica Bay's shoreline and inshore waters has been conducted on a regular basis since the mid-1950's to assess water quality in areas used for water-contact recreation and where shellfish may be harvested for human consumption. Extensive past monitoring has shown that the Hyperion wastewater plume does not reach the shoreline or inshore waters of Santa Monica Bay (CLA, EMD 1989-2001). Through a joint effort involving City of Los Angeles, Heal the Bay, and the Los Angeles Regional Quality Control Board, in 1995, 18 shoreline stations were relocated close to storm drains.

Urban runoff is now the largest nonpoint source of pollution to Santa Monica Bay. Urban runoff has two major origins: rainfall and street runoff. Street runoff can result from domestic activities, irrigation water, and commercial or industrial discharges. Runoff reaches Santa Monica Bay through approximately 70 storm drains that empty directly into the Bay or flow onto the beach and then into the Bay. This untreated runoff carries with it high concentrations of heavy metals, human and animal wastes, and a variety of petroleum- and automobile-based pollutants. Runoff may occur daily in some storm drains; 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 are more dilute, but the mass loading is much larger due to wash-down effects of the rain on the surrounding urban environment. The construction of facilities geared towards diverting runoff flows from storm drains has been an ongoing effort in mitigating this problem. In December 2000, the Santa Monica Urban Runoff Recycling Facility (SMURRF) was completed and began treating on average 500,000 gallons of urban runoff during the dry-weather season (April through October) from Santa Monica's two largest flows, the Santa Monica Pier and the Pico-Kenter storm drains. These two storm drains alone cover approximately 5,100 acres of the cities of Santa Monica and Los Angeles' storm drain system. The facility utilizes an advance water treatment system and kills pathogens by way of ultraviolet radiation. The City of Los Angeles Watershed Protection Division have embarked on pollution-abatement measures by developing and constructing low-flow diversion structures to divert urban runoff from problematic areas in the City to the Hyperion Treatment Plant during the dry season.

Santa Monica Bay (shoreline and inshore waters), Ballona Creek, and major storm drains are sampled on a routine basis throughout the year to monitor the influence of urban runoff on the bacteriological water quality of Santa Monica Bay. Bacteriological data and field observations collected from January 1, 2001 through December 31, 2002 at these sampling locations are summarized herein.

Bacterial counts for the indicator organisms (total coliform, fecal coliform and *E. coli*, and enterococcus) are submitted in reports on a monthly and annual basis to the Regional Water Quality Control Board and the United States Environmental Protection Agency. On December 2001, the Los Angeles County Municipal Separate Stormwater Sewer System (MS4) permit was promulgated, which approved the use of either the Membrane Filtration (MF) method or the Idexx Chromogenic Substrate (CS) method for analysis of bacterial indicators. During 2001-2002, the City of Los Angeles Environmental Monitoring Division (CLA EMD) conducted a study assessing the comparability of these two methods on receiving waters. In comparing the two methods, MF tests for total coliform, fecal coliform and enterococcus, whereas CS tests for total coliform, *E. coli* instead of fecal coliform, and enterococcus. In terms of procedural advantages, the CS method is much easier and less cumbersome than MF and requires fewer supplies and preparation work. In addition, the former allows for a faster turnaround time in getting the samples processed and as a result, leads to earlier data submission to the Department of Health Services (DHS). Total coliform and *E. coli* results can be made available to the DHS within 18 hours instead of 24 hours, thereby, providing the public with earlier notification on the water quality of their beaches.

Because the CS method tests for *E. coli* instead of fecal coliforms, one of the three bacterial indicators noted in the AB411 standards, issues regarding the validity of using this indicator over the other arose. This matter was addressed in the CLA EMD study explaining that *E. coli*, a subset of fecal coliform that also includes the genera *Enterobacter*, *Citrobacter*, and *Escherichia*, should not compromise public health due to the fact that *E. coli* is the predominant organism found in this group of bacterial indicators.

The two methods were deemed to be highly comparable showing a strong linear correlation for total coliform and fecal coliform/*E. coli*. A report of the study was submitted to the RWQCB requesting that the City be granted approval to switch methodologies from MF to CS and allow *E. coli* to substitute for fecal coliform.

Approval was granted by the RWQCB to the CLA in November 2002 and, in December of that year, the CS method was implemented for analyzing indicator bacteria total coliform and *E. coli* on shoreline samples only. During 2002, enterococcus was not analyzed using the CS method. Parallel testing on this indicator was conducted using both MF and CS, which continued through 2002; data assessment will follow pending completion of the study. The study will also investigate the rate of false positives that are observed using CS for enterococcus analysis and its role in the increased number of exceedences for this indicator. The Hyperion Treatment Plant effluent and SMB inshore samples were not affected by this switch of methodologies which involved only the shoreline samples. The effluent and inshore samples continued to be analyzed by the MF method.

II. MATERIALS AND METHODS

A. SAMPLING LOCATIONS

Water samples from 18 Santa Monica Bay shoreline locations were collected daily. Shoreline locations ranged southward from Surfrider Beach in Malibu to Malaga Cove in Palos Verdes (Figure 3-1). All samples were collected during daylight hours. Samples from 11 inshore stations were collected five times a month. Ten of these inshore stations are located offshore at either the 30-foot (10-meter) isobath or the edge of a kelp bed and the samples were collected from the monitoring vessel *La Mer* or *Marine Surveyor* (Figure 3-1). The eleventh inshore station, IS11, is located at King Harbor in Redondo Beach and was collected off the pier. Surface and depth samples were taken at each of these inshore stations. Surface samples were collected 0.5 meters below the water's surface and depth samples were collected two meters above the ocean floor.

The Hyperion Treatment Plant effluent was collected and analyzed five times a month for indicator bacteria on rotating days of the week in compliance with Hyperion's National Pollutant Discharge Elimination System (NPDES) permit. The sampling location was at a site where the effluent is discharged to the 5-Mile effluent pipe. Sampling occurred during daytime peak plant flow.

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

B. METHODOLOGY

Water samples were collected and analyzed according to Standard Methods (APHA 1992). Total coliform, fecal coliform, and enterococcus bacterial densities were determined by the membrane filtration method as recommended in sections 9222B, 9222D, and 9230C, respectively. In December of 2002, following approval by the RWQCB, the CLA began using the chromogenic substrate method for analyzing total coliform and *E. coli* on all shoreline samples. Inshore samples and plant effluent were exempt from this and the MF method continued to be used.

Shoreline samples were tested daily for total and fecal coliforms/*E.coli* and five times a month for enterococcus bacteria. Inshore and plant effluent samples were collected five times a month and tested for all three indicator bacteria. Inshore samples collected at sea were filtered and initially

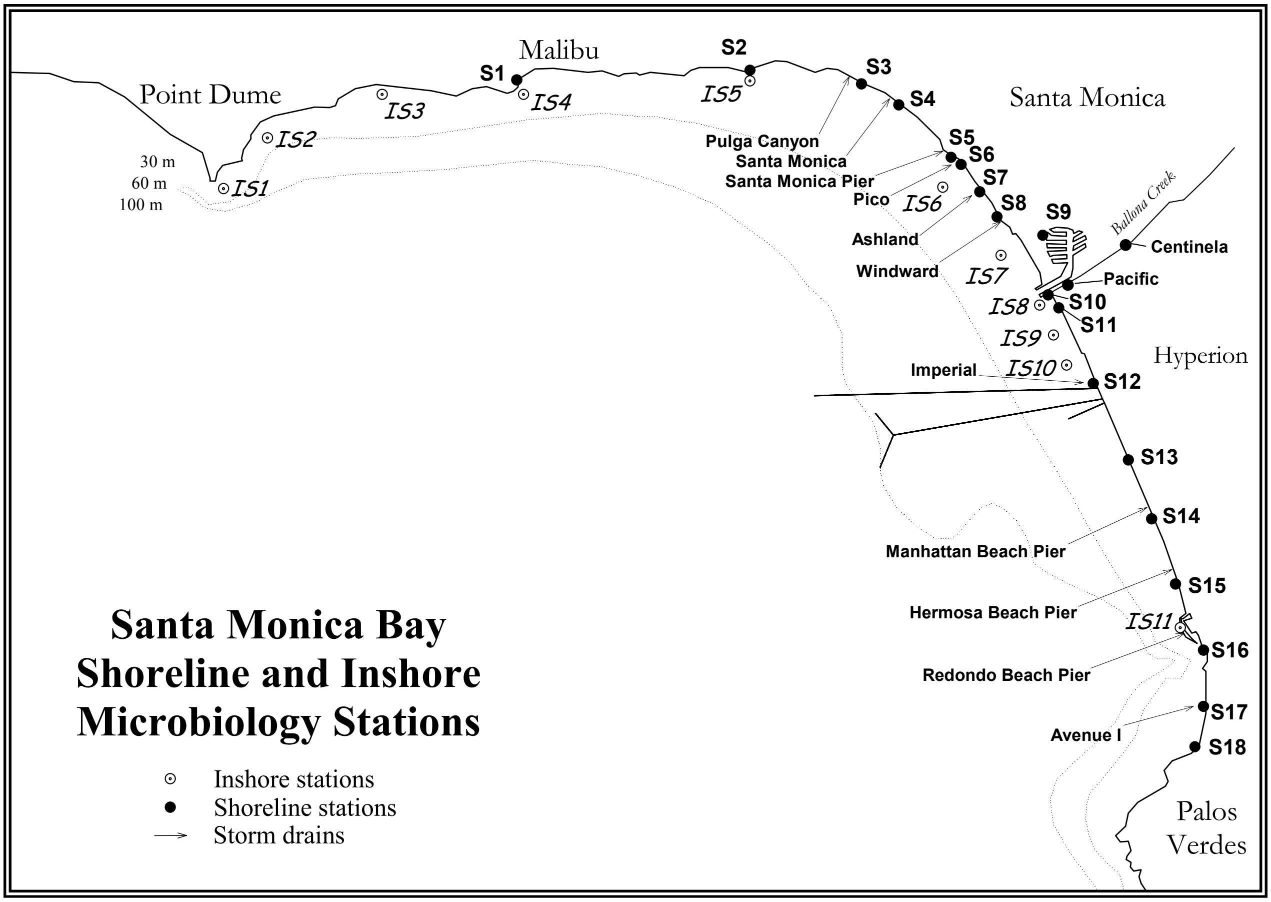

Figure 3-1. Shoreline and inshore microbiology stations in Santa Monica Bay.

incubated aboard the monitoring vessel *La Mer* or *Marine Surveyor*. After the vessel docked, agar plates were transferred to the Microbiology laboratory incubators for the remainder of their incubation period. Ballona Creek samples were tested for total and fecal coliforms/*E. coli* only.

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 nonsewage origin, any unusual odors of sewage and nonsewage origin, plankton color, and the presence of flow from storm drains. 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.

Inshore stations were observed for water color, clarity, and the presence of floatable items and materials of sewage and nonsewage origin at the time of sample collection. Weather conditions were recorded every four hours while at sea. Daily rainfall data were obtained from the weather station at the Los Angeles Civic Center.

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. In addition, duplicate analyses 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. The Microbiology Unit participates in the performance evaluation program managed by the California State Department of Health Services (CSDHS) annually. CSDHS, as part of their Environmental Laboratory Accreditation Program (ELAP), biennially certifies the Microbiology Unit.

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 and inshore data while monthly geometric means were calculated for Ballona Creek and the Hyperion Treatment Plant's effluent data.

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 the following two days. In accordance with Hyperion's NPDES permit, data within 72 hours of a rain event are not included in calculations for compliance of indicator bacterial counts for NPDES bacterial water quality limits.

III. RESULTS

A. SANTA MONICA BAY SHORELINE

1. Rainfall

There were seven months with rainfall during 2001, with February receiving the most rain – approximately one half of the rainfall for the year (Figure 3-2). There were five dry months in 2001 (May-September), with slight rain on October, measuring in at 0.06 inches. The total amount of rainfall in 2002 was 67% less than 2001. There were eight months with measurable rainfall amounts in 2002. The wettest month was December (receiving almost half of the rainfall for the year); February, which received the most rain in 2001, was a dry month in 2002, as were July, August, and September.

Most of the rainfall in 2001 was more evenly spread over the rainy season ranging from 1.38 inches per month to a high of 9.99 inches. Although there was significantly less rain in 2002, ranging from 0.01 inches to 3.32 inches, the rainfall followed almost the same pattern as 2001, with most of the rainfall occurring during the rainy season with the occasional rain during the dry season months

April, May, June and October, at 0.09, 0.05, 0.01, and 0.05 inches, respectively. The total yearly rainfall amount for 2001 (21.13 inches) was well over the annual average of 15 inches for Los Angeles, while the rainfall amount for 2002 (7.00 inches) was well below the average.

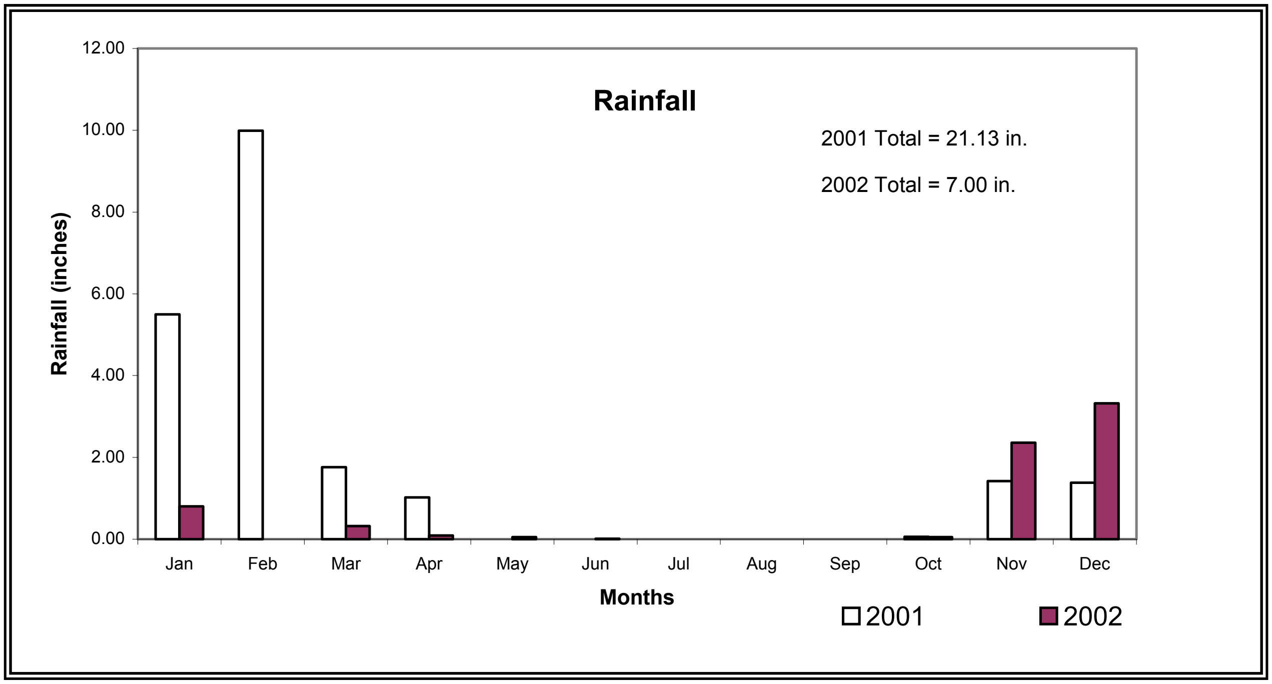

Figure 3-2. Monthly rainfall amounts at Los Angeles Civic Center, 2001-2002

2. Shoreline Stations

During 2001 and 2002, 365 shoreline samples per year were collected and analyzed for bacterial indicators at each station. The annual geometric means for all indicator bacteria during wet weather, generally, were higher at more stations in 2001 than in 2002 (Figure 3-3). During dry weather, the opposite was observed where the densities of all indicator bacteria, with the exception of enterococcus, were higher at more stations in 2002. Among all of the SMB stations, the lowest indicator bacterial counts for both years regardless of weather were found along the southern section of the SMB, in particular stations S13, S14, S15, S17, and S18. Counts at station S16 (Redondo Beach Pier) were the highest for all indicator bacteria among the southern SMB stations in both the 2001 and 2002 dry-weather seasons and the highest fecal coliform counts during the wet-weather season in 2002. The highest total coliform count during the wet-weather season of 2001-2002 and the highest enterococcus count in south SMB in 2002 were measured at station S10 (50 yards south of Ballona Creek).

Northern Santa Monica Bay typically had higher bacterial geometric means than the southern section of the Bay for all indicator bacteria. At station S01 (Surfrider Beach), the wet-weather geometric means for total coliform, fecal coliform/*E. coli*, and enterococcus were much higher in 2001 when compared to the geometric means in 2002.

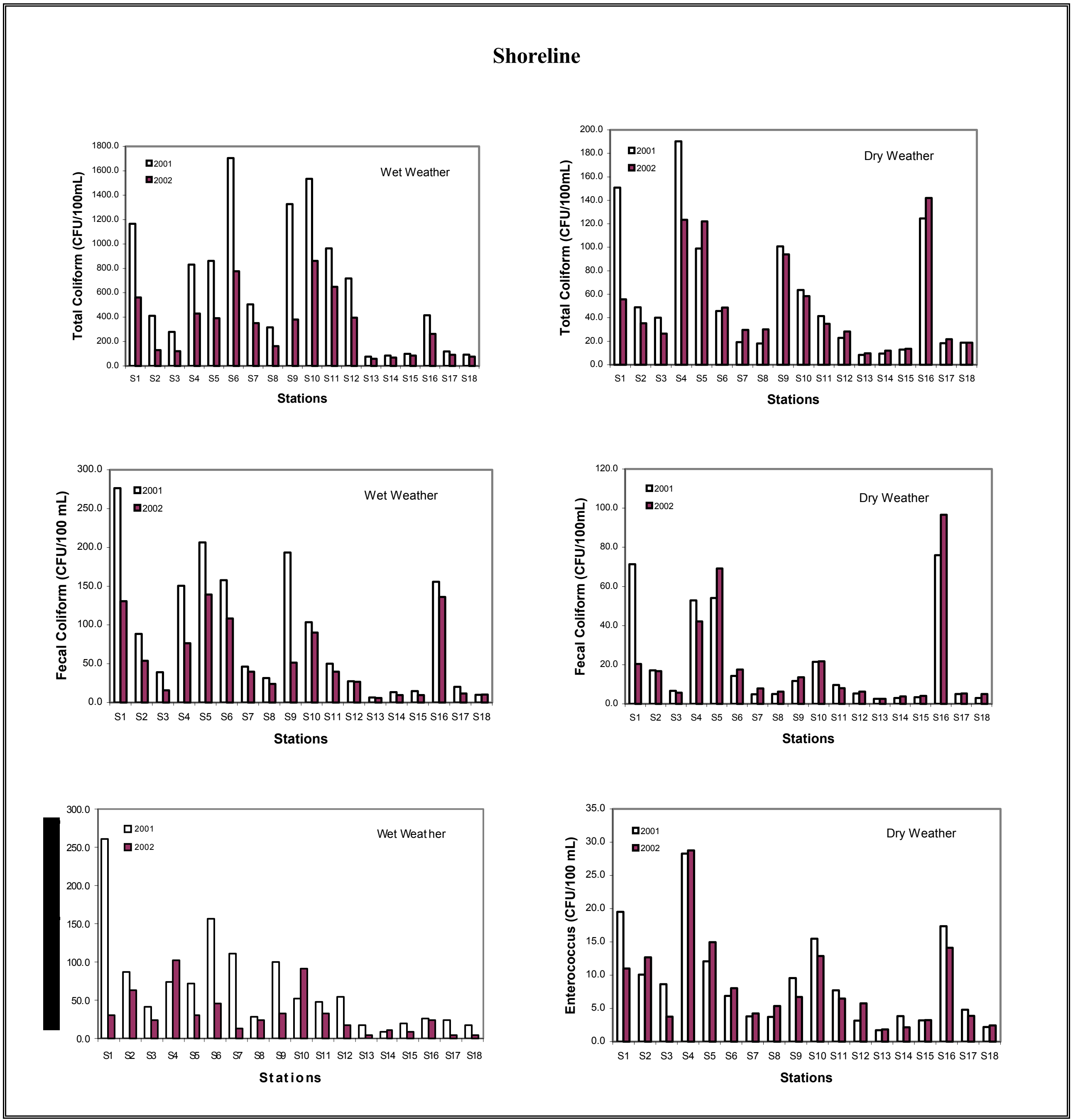

Figure 3-3. Annual geometric means for indicator bacteria at shoreline stations in Santa Monica Bay, 2001-2002.

The stations with consistently high geometric means for 2001 and/or 2002 for all three bacterial indicators during dry weather were S01, S04, and S05 in the northern section and S16 in the southern section of the Bay. This was also true for total coliforms and enterococci at station S10 (50 yards south of Ballona Creek) during 2001 and 2002.

3. Ballona Creek

The monthly geometric means for the two Ballona Creek sampling locations, Centinela and Pacific, were higher than the annual geometric means at the nearest shoreline stations (S10 and S11) for total and fecal coliforms (Figures 3-3, 3-4). These means were calculated using all sampling data, regardless of weather conditions. The geometric means for total coliform at the Centinela station were mostly higher in 2002 than for 2001. The highest total coliform geometric monthly mean occurred in February for 2001 and December for 2002. Conversely, the lowest geometric monthly means were on December of 2001 and January of 2002. The geometric means for fecal coliforms/*E. coli* were found also to be higher in 2002 as opposed to 2001. The geometric monthly means for fecal coliforms/*E. coli* were highest in August for both years. The lowest geometric means for fecal coliforms/*E. coli* were in December of 2001 and February of 2002.

At the Pacific sampling station, total coliforms were highest in November of 2001 and December of 2002 (Figure 3-4); fecal coliforms in years 2001 and 2002 were highest in November and September, respectively. Counts were lowest during the summer months for both years, particularly in July. The bacterial indicator geometric means at Pacific on November 2001 were significantly higher than what was observed at the Centinela station. The Pacific station is located downstream from Centinela and is closer to the mouth of Ballona Creek.

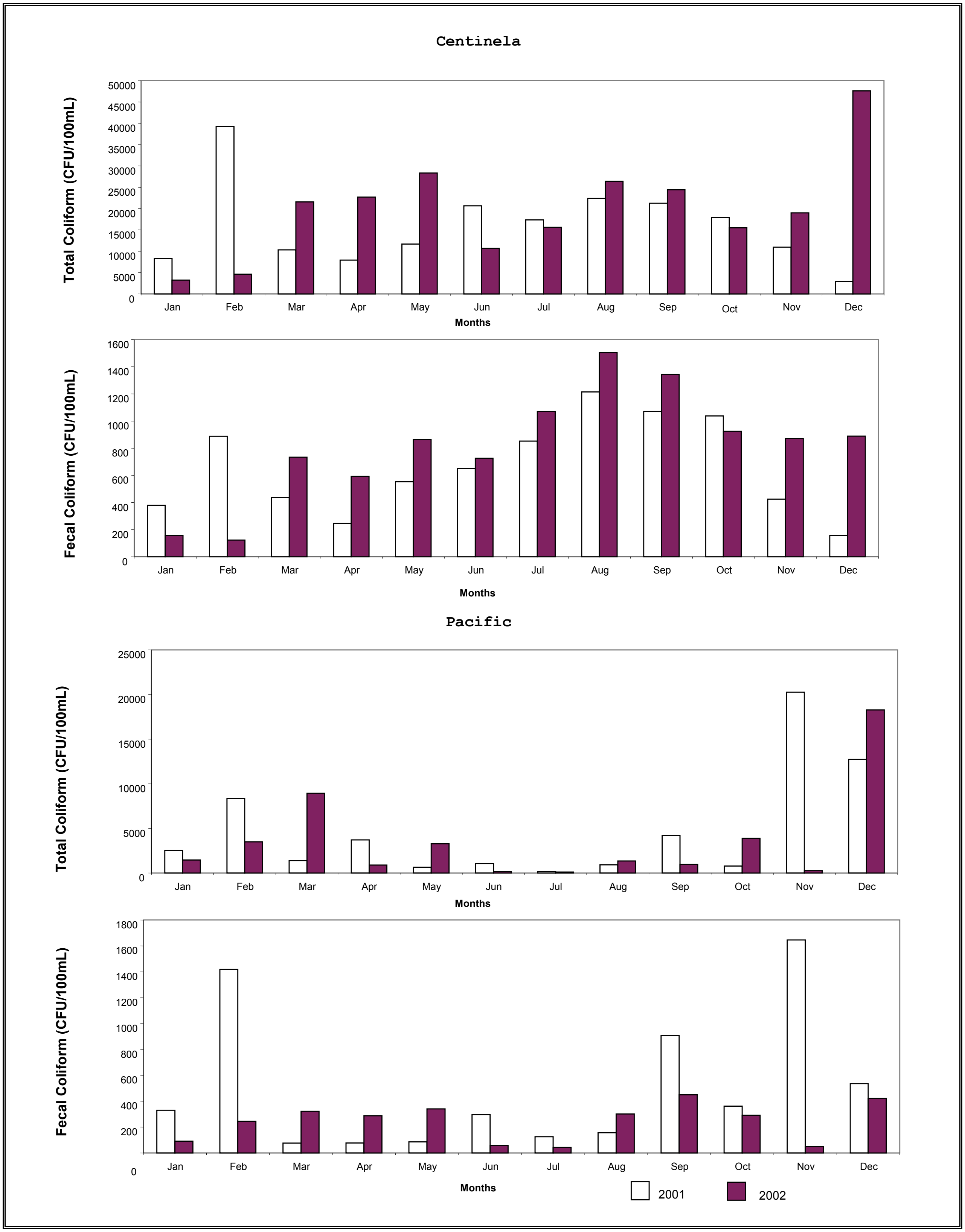

Figure 3-4. Monthly geometric means for indicator bacteria at Ballona Creek stations, 2001-2002. Wet and dry weather combined.

4. Hyperion Treatment Plant Effluent

The bacterial geometric means for the 5-mile effluent at the Hyperion Treatment Plant were greater in 2002 than 2001 (Figure 3-5). The counts were relatively the same magnitude throughout the seasons, with slightly higher counts during the dry-weather months, notably in June and August of 2002.

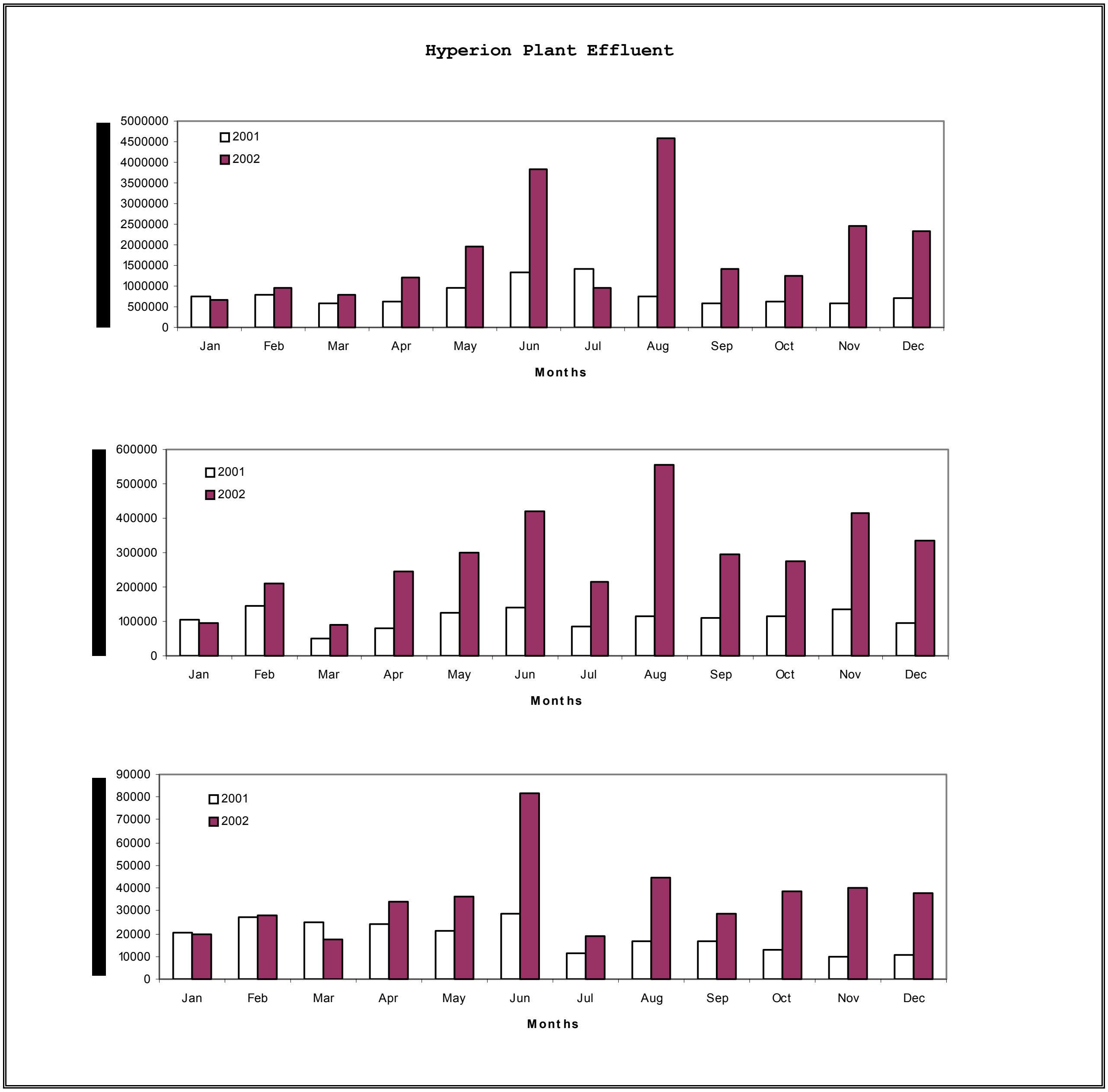

Figure 3-5. Monthly geometric means for indicator bacteria for the Hyperion Treatment Plant Effluent, 2001-2002.

Following the conversion to full secondary treatment in 1998, the bacterial composition of the Hyperion effluent improved significantly as observed by the decline in bacterial indicator densities. From 1998 to 1999, the effluent experienced a one-log reduction in the total coliforms, fecal coliforms and enterococci. Continued reduction in bacterial counts was observed in 1999 to 2001 (CLA EMD 1999, 2001, present report).

5. Water Quality Standards

The water-contact and shellfish-harvesting bacteriological standards for recreational waters are listed in Table 3-1. The standards were taken from various sources: total and fecal coliform water-contact and shellfish-harvesting standards obtained from the Hyperion NPDES permit are utilized to assess water quality and compliance for SMB shoreline and inshore samples. Enterococci standards are only recommended limits per the USEPA and Sanitary Survey and, consequently, are not used for water quality assessment.

Table 3-1. Summary of bacteriological standards for recreational waters from various sources. Values listed are CFU/100mL.

Standard	Period	Total Coliform	Fecal Coliform	Enterococcus
Water-Contact	Single Sample	10,000[1] (Unless repeat sample within 48 hours is <10,000)	-	104[2]
	30-Day	1,000[1] (>20% of samples shall not exceed 1,000)	200[1] (Geometric mean of at least 5 samples)	24[3] 35[2]
	60-Day	-	400[1] (>10% of samples shall not exceed 400)	-
Shellfish Harvesting	6-Month median	70[1]	-	12[3]
	6-Month	230[1] (>10% of samples shall not exceed 230)	-	-

[1]NPDES Permit No.CA109991
[2]USEPA Recommended Limit
[3]Sanitary Survey Limit

A summary of the percent of NPDES bacteriological limit compliance for total and fecal coliform standards showed only six shoreline stations not exceeding any of the recreational water bacteriological standards during 2001 and 2002 (Table 3-2). Of these stations, S03 (Pulga storm drain) is the only one located in the northern section of the Bay. The remaining five, S11, S13, S14, S15, and S18 are all located in the south. All other shoreline stations exceeded at least one of the standards during 2001 and 2002. In 2001, only one standard, the 30-day water contact total coliform limit, was met by all shoreline stations and therefore, were in full compliance. In

>20% exceeding 30-day water contact standards for total coliform (columns 1, 3, and 4, Table 3-2). The lowest percentages of bacteriological standards compliance were for the two shellfish harvesting total coliform standards (columns 2 and 5, Table 3-2). Shoreline stations S01 (Surfrider Beach), S02 (Topanga State Beach), S04 (Santa Monica storm drain), S05 (Santa Monica Pier), S06 (Pico-Kenter storm drain), S09 (Mother's Beach, Marina del Rey), and S16 (Redondo Beach Pier) were not in 100% compliance for both these standards during 2001 and 2002.

Table 3-2. Percent of NPDES bacteriological standards limits compliance with total coliform standards (1-5) and fecal coliform standards (6-7) at shoreline stations, 2001-2002.

	Percent Compliance													
	(1)		(2)		(3)		(4)		(5)		(6)		(7)	
Sta	'01	'02	'01	'02	'01	'02	'01	'02	'01	'02	'01	'02	'01	'02
S01	100	100	25	58	100	100	100	100	0	33	58	83	33	58
S02	100	100	67	92	100	100	100	100	50	50	100	100	100	100
S03	100	100	100	100	100	100	100	100	100	100	100	100	100	100
S04	100	100	0	0	92	100	100	100	0	0	92	100	83	100
S05	100	100	0	0	100	100	100	100	0	0	100	100	50	50
S06	100	100	58	67	100	100	100	100	33	50	100	100	100	100
S07	100	100	100	100	100	100	100	100	75	67	100	100	100	100
S08	100	100	100	100	100	100	100	100	100	92	100	100	100	100
S09	100	100	42	50	100	100	100	100	17	25	100	100	83	100
S10	100	100	100	67	100	100	100	100	42	67	100	100	100	100
S11	100	100	100	100	100	100	100	100	100	100	100	100	100	100
S12	100	100	100	100	100	100	100	100	100	83	100	100	100	100
S13	100	100	100	100	100	100	100	100	100	100	100	100	100	100
S14	100	100	100	100	100	100	100	100	100	100	100	100	100	100
S15	100	100	100	100	100	100	100	100	100	100	100	100	100	100
S16	100	100	0	0	100	100	100	100	0	0	92	92	83	75
S17	100	100	100	100	100	100	100	100	100	67	100	100	100	100
S18	100	100	100	100	100	100	100	100	100	100	100	100	100	100

*LEGEND

(1) Total coliform >10,000 CFU/100mL when verified within 48 hours - Water Contact Std.

(2) Total coliform six month median >70 CFU/100mL - Shellfish Harvesting Std.

(3) Total coliform monthly median >1,000 CFU/100mL Water - Contact Std.

(4) >20% Total coliform exceeding 1000CFU/100mL in 30 days - Water Contact Std.

(5) >10% Total coliform exceeding 230CFU/100mL in six months - Shellfish Harvesting Std.

(6) Fecal coliform log-mean exceeding 200 CFU/100mL in 30 days - Water Contact Std.

(7) Fecal coliform >10% exceeding 400 CFU/100mL in 60 days - Water Contact Std.

In April 2001 at the start of the dry weather season, the Santa Monica Urban Runoff Recycling Facility (SMURRF) began treating an average of 500,000 gallons per day of dry-weather urban runoff diverted from the City of LA and the City of Santa Monica's two main storm drains, Santa Monica Pier and Pico-Kenter, which are associated with shoreline stations S05 and S06, respectively. An assessment was made to determine if the water quality of these affected beaches improved as a result of the diversion. The assessment was based on percent compliance of the NPDES bacteriological standards going back to 1997 to observe if any trending can be established and if the percentages of compliance with those standards indicate improvements in water quality. In 2001 and 2002, station S05 demonstrated an improvement in one of the seven standards and for the first time, was 100% compliant for one of the fecal coliform water contact standards (column 6, Table 3-2). Station S06 also improved in one of the water contact fecal coliform standards (column 5, Table 3-2); from 1997 to 1999, the station was not in compliance with this standard but by 2000, 2001 and 2002, the percent compliance exhibited an upward trend of 8%, 33%, and 50%, respectively (CLA EMD 1999, 2001, present report).

Of all the stations sampled, S01 had the most noncompliances for both years. Overall, the number of stations that demonstrated an improvement in percent compliance or remained at 100% compliance increased from 2001 to 2002.

6. Field Observations

There were more occurrences of plastic goods and rubber goods along the shoreline in 2002 than in 2001 (Table 3-3). The greatest number of visual observations in 2001 and 2002 were at the shoreline stations located south of Ballona Creek (stations S10 – S18). There were no incidents of grease particles at any of the shoreline stations in 2001 and 2002.

Table 3-3. Number of visual observations of material of sewage origin at shoreline stations, 2001-2002.

Materials of Sewage Origin													
	PG*		RG*		GP*			PG*		RG*		GP*	
Sta.	'01	'02	'01	'02	'01	'02	Sta.	'01	'02	'01	'02	'01	'02
S01	0	0	0	1	0	0	S10	2	2	3	2	0	0
S02	0	0	0	0	0	0	S11	1	0	2	1	0	0
S03	0	0	0	0	0	0	S12	2	0	1	3	0	0
S04	1	1	0	1	0	0	S13	2	0	1	3	0	0
S05	1	3	0	1	0	0	S14	1	0	1	3	0	0
S06	0	5	3	5	0	0	S15	1	0	1	1	0	0
S07	0	4	0	1	0	0	S16	1	0	4	3	0	0
S08	0	2	0	1	0	0	S17	2	0	4	1	0	0
S09	0	2	1	1	0	0	S18	1	0	2	1	0	0

*LEGEND
PG - Plastic goods
RG - Rubber goods
GP - Grease particles

B. INSHORE

The annual geometric means for all three indicator bacteria were greater in 2001 as compared to their counterparts in 2002 (Figure 3-6), with the exception of inshore stations IS07 and IS11 (annual geometric means for fecal coliform-depth, enterococcus-surface, and enterococcus-depth at station IS11 and enterococcus-depth at station IS07 were higher in 2002 than 2001). As in past years, inshore stations IS08 (the mouth of Ballona Creek) and IS11 (King Harbor, Redondo Beach) for surface and depth had the highest counts.

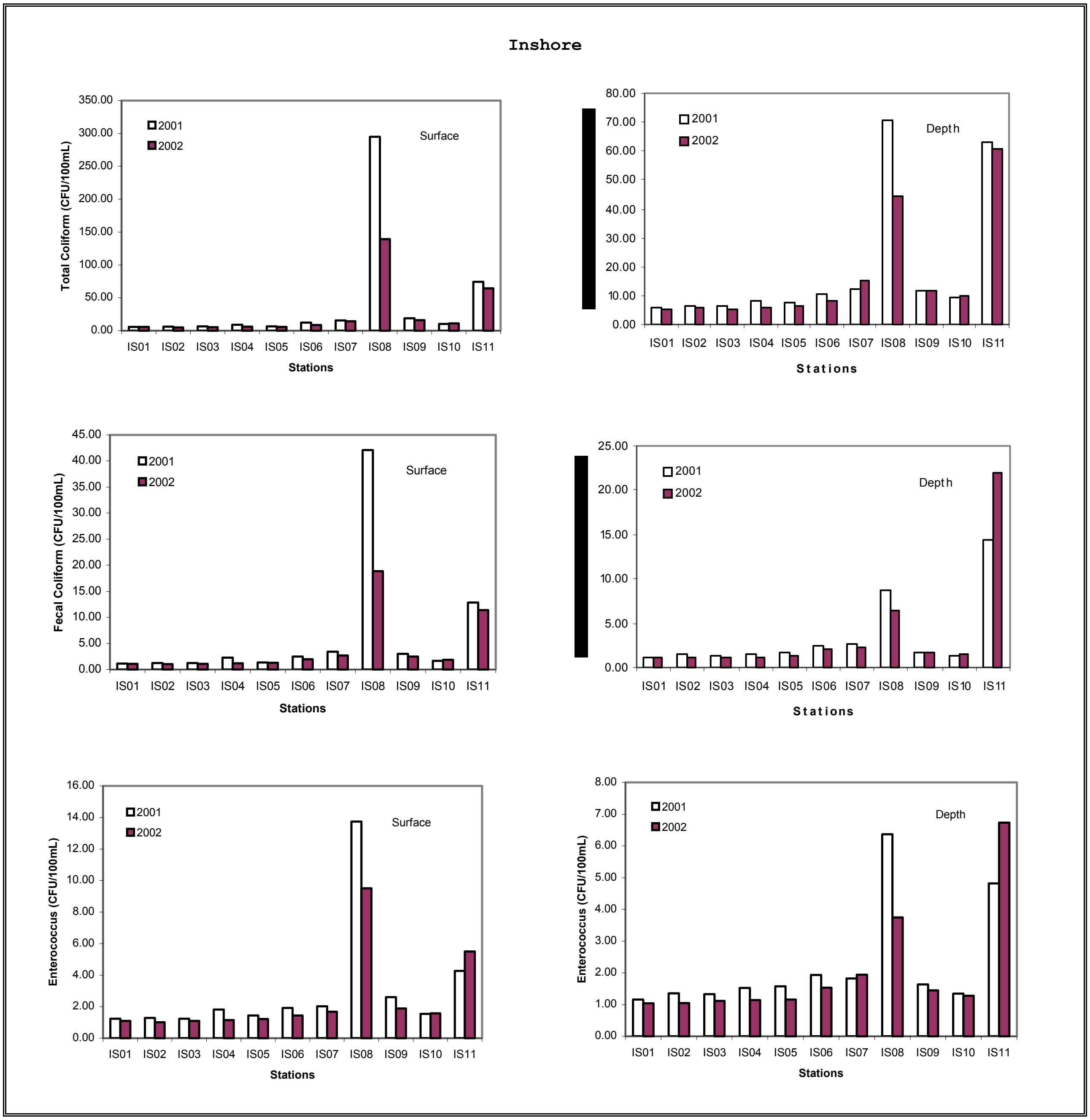

Figure 3-6. Annual geometric means for indicator bacteria at inshore (surface and depth) stations in Santa Monica Bay, 2001-2002.

Table 3-4. Percent of NPDES bacteriological limits compliance with total coliform standards (1-5) and fecal coliform standards (6-7) at inshore (surface and depth) stations in Santa Monica Bay, 2001-2002.

Percent Compliance														
	(1)		(2)		(3)		(4)		(5)		(6)		(7)	
Inshore Surface														
Sta	‘01	‘02	‘01	‘02	‘01	‘02	‘01	‘02	‘01	‘02	‘01	‘02	‘01	‘02
IS01	100	100	100	100	100	100	100	100	100	100	100	100	100	100
IS02	100	100	100	100	100	100	100	100	100	100	100	100	100	100
IS03	100	100	100	100	100	100	100	100	100	100	100	100	100	100
IS04	100	100	100	100	100	100	100	100	100	100	100	100	100	100
IS05	100	100	100	100	100	100	100	100	100	100	100	100	100	100
IS06	100	100	100	100	100	100	100	100	100	100	100	100	100	100
IS07	100	100	100	100	100	100	100	100	100	100	100	100	100	100
IS08	100	100	92	100	83	100	92	100	0	58	100	100	0	50
IS09	100	100	100	100	100	100	100	100	100	100	100	100	100	100
IS10	100	100	100	100	100	100	100	100	100	100	100	100	100	100
IS11	100	100	75	58	100	100	100	100	100	67	100	100	92	100
Inshore Depth														
IS01	100	100	100	100	100	100	100	100	100	100	100	100	100	100
IS02	100	100	100	100	100	100	100	100	100	100	100	100	100	100
IS03	100	100	100	100	100	100	100	100	100	100	100	100	100	100
IS04	100	100	100	100	100	100	100	100	100	100	100	100	100	100
IS05	100	100	100	100	100	100	100	100	100	100	100	100	100	100
IS06	100	100	100	100	100	100	100	100	100	100	100	100	100	100
IS07	100	100	100	100	100	100	100	100	100	100	100	100	100	100
IS08	100	100	100	100	100	100	100	100	100	83	100	100	100	100
IS09	100	100	100	100	100	100	100	100	100	100	100	100	100	100
IS10	100	100	100	100	100	100	100	100	100	100	100	100	100	100
IS11	100	100	100	75	100	100	100	100	100	75	100	100	92	100

*LEGEND

(1) Total coliform >10,000 CFU/100mL when verified within 48 hours - Water Contact Std.

(2) Total coliform six month median >70 CFU/100mL - Shellfish Harvesting Std.

(3) Total coliform monthly median >1,000 CFU/100mL - Water Contact Std.

(4) >20% Total coliform exceeding 1000CFU/100mL in 30 days - Water Contact Std.

(5) >10% Total coliform exceeding 230CFU/100mL in six months - Shellfish Harvesting Std.

(6) Fecal coliform log-mean exceeding 200 CFU/100mL in 30 days - Water Contact Std.

(7) Fecal coliform >10% exceeding 400 CFU/100mL in 60 days - Water Contact Std.

Inshore stations showed 100% compliance for NPDES water quality limits in 2001 and 2002 with the exception of stations IS08 and IS11 (Table 3-4). In 2001, inshore station IS08 (surface) exceeded the bacterial limits for five of the seven water contact and shell-harvesting standards, and at depth level, exceeded one of the seven. In 2002, the water quality at station IS08 improved at both the surface and depth level as observed by the decline in the number of standards exceeded; at surface level, only two of seven were exceeded and at depth level, station IS08 was 100% compliant. Inshore IS11 (surface and depth) exceeded two of the standards for both years. The shellfish-harvesting total coliform bacteriological six-month standard (Column 5, Table 3-4) was exceeded the most of any standards.

IV. DISCUSSION

With the advent of full secondary treatment at the Hyperion Treatment Plant, the bacterial pollution from this point source has been reduced ten-fold by the year 2002 (CLA, HTP 1998-2002). In addition, floatable materials, namely plastic and rubber goods, have declined in numbers following the conversion to secondary treatment. During periods of dry and wet weather, the influence of urban runoff on the water quality of the Santa Monica Bay can be observed by the increase in the annual geometric means for indicator bacteria at shoreline waters adjacent to flowing storm drains. Shoreline stations located in the southern section of Santa Monica Bay were found to be of better quality, based on degree of exceedances and percent compliance of NPDES bacteriological standards. The inshore waters of the Bay appear to be impacted by runoff from King Harbor and Ballona Creek.

The City of Los Angeles has increased stormwater management by selectively diverting storm drains along Santa Monica Bay's most heavily contaminated beaches. This effort has resulted in completion of the SMURRF in December 2000. The cities of Santa Monica and Los Angeles formed a joint venture to produce one of the first dry-weather urban water recycling plants in the U.S. The facility is expected to reduce the bacterial counts at the Santa Monica Pier and Pico-Kenter storm drains. The City's Watershed Protection Division (WPD) is leading the low-flow diversion projects along the Bay. Since 2002, WPD has developed 11 projects to divert urban runoff from storm drains to receive treatment at the Hyperion Plant during the dry-weather season.

A. SHORELINE

Improvements to wastewater treatment processes and industrial waste pretreatment programs have resulted in measurable improvements to the water quality of receiving waters affected by these point source discharges (CLA, EMD 1989-present report). The current challenge is to control nonpoint sources of pollution from urban runoff. Recent estimates by EPA indicate that nonpoint sources are the leading cause of impairment to surface water quality nationwide (Perciasepe 1995). Urban runoff, consisting of stormwater and dry-weather runoff, is the major nonpoint source of untreated pollution to Santa Monica Bay. The negative impact of this transient and perennial runoff on bacterial water quality limits the recreational use and aesthetic enjoyment of the Bay.

1. Rainfall

The rainy season in Southern California normally occurs during the seven-month period from October to April. In 2001 and 2002, the rain events occurred during the typical rainy months with the most rainfall occurring in February of 2001 and December of 2002.

Extensive past monitoring has shown that stormwater runoff significantly impacts the bacteriological water quality of Santa Monica Bay's shoreline (CLA, EMD 1989-present report). Annual geometric means for indicator bacteria (total coliform, fecal coliform/*E. coli*, and enterococcus) at all shoreline stations were the highest in 2001 and 2002 during wet weather due to contaminants in stormwater runoff following rain events (Figure 3-3).

During the dry-weather months, the bacterial densities were in general higher in 2002 than 2001. In wet-weather months, however, the bacterial counts were significantly higher for 2001 over 2002, mainly as a result of more intense rain events and the effects of coliform-bearing contaminants (e.g., animal feces, soil, and plant debris) flushing through the storm drain collection system.

Because Southern California has a reputation of year-round sunny and warm weather, activities involving beach use and water contact is common throughout the year, rain or shine. Attempting to control and treat stormwater runoff is a challenge due to the variability in rainfall and the inability to control runoff from entering the Bay due to the myriad of storm drains throughout the Los Angeles area. Southern California's wettest months are usually January and February, but significant storms may occur from October through April and contribute over 95% of the total annual rainfall. The inherent variability of rainfall can be seen in the amounts and distribution of rainfall for 2001 and 2002 (Figure 3-2).

2. Shoreline Stations

As with stormwater runoff, past monitoring has shown that dry-weather runoff significantly impacts the bacteriological water quality of Santa Monica Bay's shoreline (CLA, EMD 1989-present report). The contribution of dry-weather flow to the total volume of runoff into Santa Monica Bay is about 30% (NCR, COWT 1984). This impact on the bacteriological water quality of the Santa Monica Bay shoreline is reflected by the increase in indicator bacterial geometric means during dry weather when storm drains are flowing. In general, the highest geometric means for dry weather were at stations associated with flowing storm drains and lagoons in the northern part of Santa Monica Bay (Figure 3-1). Only one station in the southern part of the Bay, S16, which is located south of Redondo Beach Pier, had high dry-weather bacterial counts (Figure 3-3).

Stations S01 and S02 are located near lagoons created and fed by natural creeks that flow into the ocean when breached. The flow from these lagoons is classified as storm drain runoff. Station S01 (Surfrider Beach) is located at the outlet of the entire Malibu Creek watershed, which has a drainage area equal to approximately 105 square miles (LACDPW 1996). When the lagoon is breached, it brings with it a heavy discharge of pollutants into the surf zone, thereby elevating the bacterial densities which enter the Bay. In doing so, this station is likely to exceed AB411 limits when a breach on the lagoon has occurred. Station S01 has been designated as one of the most polluted beaches in Santa Monica Bay as noted on Heal the Bay’s Annual Report Card. At station S02

(Topanga Canyon) runoff from the adjacent lagoon is also the major contributor to increased bacterial densities at this station.

Station S03 is located approximately 0.03 miles west of the Pulga Canyon storm drain. While the storm drain flow may not always be apparent due to the occasional high tides that can obstruct visibility of the mouth of the drain, the samples taken at this station seldom yields high counts. In 2002, this station had the lowest geometric bacterial means for all stations that constitute the northern section of SMB. In addition, it is the only station in the North Bay to be in full compliance for all the NPDES bacteriological standards in 2001 and 2002. The Santa Monica storm drain (a partially enclosed storm drain), near station S04, in contrast has significant flow during dry weather. It drains a large watershed area that contains horse corrals, a golf course, and some houses on septic systems, all of which are sources for the increased bacterial densities at this station.

Stations S05 and S06 are located 50 yards south of the Santa Monica Pier and 50 yards south of the Pico-Kenter storm drain, respectively. Dry-weather urban runoff originating from these storm drains are now being diverted, beginning April 2001, to the SMURRF where it is being completely treated and recycled for landscaping and dual-plumbed systems. Although bacterial densities during the dry weather have not declined considerably following the diversion effort, the percent compliance with the NPDES bacteriological standards has improved at station S05 when comparing data from previous years. In particular, water quality at this station has shown an improvement on one of the water contact standards for fecal coliform. Moreover, the station was 100% compliant for 2001 and 2002 as opposed to years 1997 and 1998, which complied only 58% of the time for this specific standard and in 1999 and 2000, which complied just 75% and 92% of the time, respectively (CLA, EMD 1999, 2001).

Ashland storm drain, near station S07, periodically has drain flow. Gardening and/or restaurant waste may be the sources of the bacterial contamination at this station (Gorke 1996). In 2001, station S07 had the lowest geometric bacterial means of all the shoreline stations in the northern part of Santa Monica Bay. Shoreline station S08 is close to Brooks and Windward storm drains, and is only 0.03 miles west of the Venice Pavilion storm drain. Even though this station is close to three storm drains, the bacterial levels are among the lowest of the 18 stations sampled.

Station S09 is located at Mother's Beach in Marina del Rey. And as its name implies, Mother's Beach is popular among families due to its calm water and lack of waves, an ideal condition for young beachgoers. However, sources of bacterial contamination at this station is evident and comes from nonpoint discharges associated with the marina and from natural wastes deposited by numerous birds. Although monofilament lines were installed approximately ten feet off the ground and have been effective in keeping the birds away from the area, occasional high counts can be found at this location and may be attributed to the poor water circulation. Station S10, just 0.33 miles south of the Marina del Rey Channel and Ballona Creek opening, had the second highest geometric bacterial mean amongst all of the South Bay beaches in years 2001 and 2002, second only to S16 (Redondo Beach Pier). Stations S11 and S12 are located 50 yards south from their respective storm drains, in Culver Boulevard and Imperial Highway. Station S11, located several hundred yards south of S10, has slightly lower geometric means than that station. The Culver storm drain extends completely out into the ocean, which makes it difficult to visibly observe actual flow coming from the drain. The increase in indicator bacterial densities following storm events may be the result of an increase in the volume of runoff discharging out of the Culver drain and/or partially attributed to the Ballona Creek. Whichever the case, the geometric bacterial means for S11 are low and have fully complied with all NPDES standards in both 2001 and 2002.

Station S12 (Imperial Hwy), also exhibited low bacterial densities. Stations S12 through S17 are located in the southern portion of Santa Monica Bay, which has a small watershed and very few industrial dischargers. The geometric bacterial means for stations S13 (40th Street Extension), S14 (Manhattan Beach Pier) and S15 (Hermosa Beach) are consistently at low levels. Following storm events, these three stations including station S18, are generally low.

Station S16, associated with two storm drains and the Redondo Beach Pier, stands out among the stations in the southern part of the Bay because it had the highest bacterial means among the stations in this part of the Bay. The remaining shoreline stations S17 (Avenue I) and S18 (Arroyo Circle) are located near municipal piers or storm drains with little or no detectable flow, and as a result, they have lower bacterial geometric means.

3. Ballona Creek

Ballona Creek is a concrete channel with year-round flow and a drainage area equal to approximately 89 square miles (LACDPW 1996). The Centinela overpass 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, caused by ocean tides, was evidenced by the decreased geometric means for total and fecal coliform/*E. coli* bacteria at Pacific as compared to Centinela (Figure 3-4). However, this was not the case in November 2001, where bacterial geometric means were higher at Pacific than in Centinela. Tidal influence at Pacific may not have played a significant factor in further diluting the bacterial concentrations at this station over the far more distant Centinela; possibly attributed to low tides. Also, Pacific is not sampled as routinely as Centinela. Centinela has more data points per month than Pacific, with a wider range of bacterial densities. Because of this, counts at Pacific yielded an overall higher geometric mean for the month of November 2001. In comparison, shoreline stations S10 and S11, the stations closest to Ballona Creek, exhibited lower bacterial counts than Pacific and Centinela (Figure 3-3).

4. Hyperion Treatment Plant Effluent

The bacterial geometric means for the 5-mile effluent were constant during 2001 with no fluctuations. By 2002, the bacterial densities began to increase with two significant spikes in June and then again in August. The reason behind these spiking events is uncertain. Since there are no effluent NPDES limits, these spikes did not violate permit standards.

5. Water Quality Standards

The health impact of nonpoint source discharges into Santa Monica Bay is reflected in the number of times that water quality standards were exceeded at the various shoreline-monitoring stations. Only six shoreline stations did not exceed any of the recreational water standards and were at 100% compliance in 2001 and 2002 (Table 3-2). All but one of these stations is located in the southern part of the Bay, and four are not associated with dry-weather flowing storm drains. The shellfish harvesting standards for total coliforms were exceeded more than the water-contact standards and by a greater number of stations during both 2001 and 2002. Past data (CLA, EMD 1997-2000) were assessed to establish whether the percentage of compliance with these standards has improved among the shoreline stations sampled. In April 2001, two storm drains (Santa Monica Pier and Pico-Kenter) associated with routine shoreline stations were diverted to the SMURRF to treat dry-weather urban runoff. Thus far, following an evaluation of these two stations in particular, an improvement was observed. However, exceedences were not eliminated, suggesting other sources of bacterial contamination at the sampling sites.

6. Field Observations

Visual observations recorded at each shoreline station included the type and number of the various items observed. A predominant number of both plastic and rubber goods were found intermingled among seaweed and other ocean debris suggesting that they may have been washed ashore with the tides after being discharged from storm drains or the Hyperion 5-Mile Outfall. The majority of these occurrences were located at the shoreline station adjacent to Ballona Creek (station S10) and the Pico-Kenter storm drain (station S06) where storm water flow is continuous, and to the south (stations S11 to S18) where observed storm drain flows are minimal (Table 3-3). There were no occurrences of grease particles along the beach as in past years (CLA, EMD 1989-present report).

While they are not health concerns, plastic and rubber goods are aesthetically unpleasant and therefore are a public concern. Negative implications associated with the presence of plastic and rubber goods make these items an undesirable presence on the shoreline. With complete construction of the full-secondary facilities, the problem of these items on the shoreline has been reduced by six to seven-fold since November 1998 (CLA, HTP 1998-present report).

B. INSHORE

Inshore monitoring is conducted to assess compliance with water quality standards in the NPDES permit. Data presented herein concurs with past data (CLA, EMD 1993-2001) that the wastewater discharge of the Hyperion Treatment Plant does not impact the inshore waters of Santa Monica Bay and that water quality standards were met during 2001 and 2002. Stations adjacent to station IS08 had significantly lower geometric means for both surface and depth samples for all indicator bacteria. Higher geometric means at station IS08 can be attributed to flow from Ballona Creek. Similarly, high counts at station IS11 in King Harbor can reasonably be assumed to be a reflection of boat activity, birds, and harbor runoff and not the discharge from the Hyperion Treatment Plant. Station IS11 is the southernmost inshore station and the nearest station to the north of it, IS10, which is closer to the HTP discharge point, had lower bacterial geometric means.

There was little difference between the inshore indicator bacterial geometric means for surface and depth stations. The only exception was inshore station IS08. The indicator bacterial densities for depth samples for this station were approximately one-half to two-thirds of the surface geometric means.

As with the shoreline stations, the Hyperion NPDES permit requires visual observations and temperature readings to be taken at the time of sampling at all inshore stations. These visual observations are to ensure that no sewage-related materials impact the boundary between inshore stations and the shoreline. No materials of sewage origin were found in the inshore waters during this reporting period.

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