# PORT OF LOS ANGELES BACTERIA STUDY

Source: POLA 2004a

**Prepared For:**

**Los Angeles Regional Water Quality Control Board**
**320 W. 4th St., Suite 200**
**Los Angeles, California 90013**
**And**
**Southern California Coastal Water Research Project**
**7171 Fenwick Lane**
**Westminster, California 92683**

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# INTRODUCTION

During February and March 2004, MEC Analytical Systems (MEC) conducted bacteriological sampling within the Port of Los Angeles in support of the Los Angeles County Regional Water Quality Control Board's (RWQCB) TMDL program.

The Port of Los Angeles (Port) is one of the world's largest commercial ports, covering approximately 7500 acres of land and water along its 43 miles of waterfront. The Port is comprised of 27 major cargo terminals, including facilities to handle automobiles, containers, dry bulk products and liquid bulk products (Port 2004b).

The Port is the terminus of two major channels. Dominguez Channel (303(d) listed for bacteria) and Cerritos Channel both empty into the Port's East Basin. Other drainage areas of interest are the Machado Lake Basin and the Gaffey Channel, which both drain into the Port's West Basin.

Areas within the Port are on the 303(d) List of Impaired Water Bodies for high coliform bacteria counts. Both Cabrillo Beach and the Los Angeles Harbor Main Channel are listed.

# METHODS

On February 5, 2004 a field reconnaissance survey was conducted within the Port of Los Angeles to identify potential sampling locations. Representatives from the Los Angeles Regional Water Quality Control Board and the Port of Los Angeles accompanied MEC Analytical Systems, Inc. (MEC) field scientists. The reconnaissance team initially surveyed locations from the shore to determine drainage areas and identify suitable sampling locations. Following the land-based survey the team finished the site reconnaissance by boat within the harbor. It was determined that the land-based sampling locations were too far upstream from the outlets to be representative of discharges to the harbor. The team decided samples collected from the outlets discharging directly into the harbor waters, and samples collected directly from the harbor were of more interest.

Twenty-seven locations were selected as primary sampling locations along with four alternate sites to be sampled if a primary site did not provide an adequate volume of water to collect a sample. Figure 1 presents the sampling locations. A total of twenty-eight site samples and one Quality Assurance/Quality Control (QA/QC) sample were collected during each sampling event. Sampling was conducted during the outgoing tide to ensure that crews were sampling outgoing flow from the storm drain outlets. Appendix A presents the tide charts for the corresponding sampling days.

The majority of the sampling locations were chosen to be paired samples. A storm drain outfall or drainage channel was selected based on its drainage characteristics; sites that had a larger drainage area were selected over smaller drainage area sites. An open-channel paired sampling location was identified as being 25-yards offshore of the drainage outlets. Sites 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, and 14 were paired sampling locations. A suitable drainage outlet could not be identified for Site 10. At this site only an open-channel sample was collected and an alternate site was to be added during the sampling events in place of the paired sample. Alternate Sites A, B, C, and D also consisted of open-channel sampling only. Site C was identified, but never sampled since sufficient primary sampling locations were available.


**Figure 1. Sampling locations.**

Sampling occurred during two dry weather events (a minimum of 72-hours antecedent dry weather) and one wet weather event. The wet weather event was also defined as having a 72-hour antecedent dry period and a minimum of 0.25-inches of rainfall.

On February 10, 2004, field scientists from MEC conducted the first round of dry-weather sampling. Twenty-five primary sites were sampled along with three alternate sites. On March 2, 2004 the wet-weather sampling event was conducted. Crews collected samples at all twenty-seven primary sites and one alternate site. On March 8, 2004 crews completed the final dry-weather round of sampling. Twenty-six primary sites and two alternate sites were sampled.

Field crews documented site visits with photographs. A photo of each sampling location was taken and is included in Appendix B. Field observations and measurements were recorded on field logsheets and are included in Appendix C. Observations included weather conditions, physical description of each site (location, type and size of pipe, GPS coordinates), visual water quality, flow estimation, field measurements, and comments. For conveyances with low flows, flow was estimated by timing how long it took to fill a container of known volume. If this method was not an option, flow was estimated using the area velocity method. Flow within a channel was measured using a Marsh McBirney Flo-Mate Model 2000 Portable Flow Meter.

Field measurements were taken for pH, temperature, conductivity and salinity using a YSI 6600 Multi-Parameter Water Quality Meter. All field instruments were calibrated before each sampling event. If sufficient flow was present, measurements were taken from the horizontal and vertical center of flow. If low flow conditions existed, a clean HDPE sample container was used to collect the sample for measurement.

During all sampling operations extreme care was taken to minimize exposure of the samples to human, atmospheric, and other sources of contamination. Bacteriological samples were collected using pre-sterilized, EPA approved sample bottles containing sodium thiosulfate. When sampling, sterile, powder-free latex gloves were worn at all times and were changed between each site. In addition, field crews cleaned their hands using an antibacterial hand wash between samples. Upon sampling, bottles were closed tightly and kept in separate, sealed, zip-lock bags. Bags were placed in coolers on ice and samples were delivered to the laboratory at 4° C. In addition to keeping samples cool, sample containers were also kept in coolers to minimize exposure to sunlight. Chains of custody were filled out completely and accurately and were signed by the sampling and receiving technicians. To ensure holding times were met, technicians delivered samples to the laboratory throughout the day while field crews continued sampling.

All sample analyses were initiated within sample holding times for total coliform, fecal coliform, *E. coli*, and enterococcus at MEC's microbiology laboratory in Carlsbad, California. Laboratory methods for each parameter are listed in Table 1. A field blank was collected during each sampling event as part of the QA/QC program. The results are listed as Site LA-1 and are presented along with the sampling data in Table 1.

**Table 1. Summary of Field Observations and Chemical Analyses.**

| Site | Visit | Date | Time | Total Coliforms MPN/100 mL | Fecal Coliforms MPN/100mL | E. Coli MPN/100 mL | Enterococci MPN/100mL | Flow (cf/s) | Temperature (°C) | pH | Conductivity (mS/cm) | Salinity (ppt) | Odor | Color | Clarity | Floatables | Vegetation | Biology |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1A | Dry 1 | 02/10/04 | 1341 | NA | NA | NA | NA | NA | NA | NA | NA | NA | None | NA | NA | None | None | Other |
| 1A | Wet | 03/02/04 | 1104 | 13,000 | 500 | 318 | 3,325 | 0.0003 | 14.9 | 7.72 | 40.120 | 25.66 | None | Brown | Cloudy | None | Limited | Other |
| 1A | Dry 2 | 03/08/04 | 1206 | >16,000,000 | 90,000 | 3,448 | 1,565 | 0.0001 | 18.8 | 8.65 | 0.179 | 0.08 | Rotten Egg | Brown | Cloudy | Bubbles | Limited | Algae/Other |
| 1B | Dry 1 | 02/10/04 | 1344 | <20 | <20 | <10 | <10 | NA | 14.4 | 7.74 | 50.470 | 33.09 | None | None | Clear | None | None | None |
| 1B | Wet | 03/02/04 | 1104 | 17,000 | 3,902 | 2,400 | 1,918 | NA | 14.3 | 7.71 | 37.730 | 24.08 | None | Green | Cloudy | Trash | None | None |
| 1B | Dry 2 | 03/08/04 | 1206 | 500 | <20 | <10 | 10 | NA | 15.6 | 7.80 | 49.310 | 32.27 | None | Green | Clear | None | None | None |
| 2A | Dry 1 | 02/10/04 | 1745 | 50,000 | 3,000 | 5,475 | 3,873 | 0.3 | 15.3 | 8.17 | 3.832 | 2.03 | None | None | Clear | None | None | Other |
| 2A | Wet | 03/02/04 | 1123 | 500,000 | 140,000 | 43,517 | 29,093 | 0.35 | 15.6 | 7.80 | 30.290 | 18.84 | None | Brown | Cloudy | Trash | Limited | Algae/Other |
| 2A | Dry 2 | 03/08/04 | 1550 | 1,400,000 | 17,000 | 3,873 | 4,500 | 0.5 | 17.5 | 8.13 | 5.489 | 2.98 | None | None | Clear | None | Limited | Other |
| 2B | Dry 1 | 02/10/04 | 1745 | 70 | <20 | 10 | 20 | NA | 14.0 | 7.77 | 50.610 | 33.18 | None | None | Clear | None | None | None |
| 2B | Wet | 03/02/04 | 1123 | 28,000 | 5,000 | 1,553 | 1,201 | NA | 15.1 | 7.77 | 34.980 | 22.26 | None | Green | Cloudy | Trash | None | None |
| 2B | Dry 2 | 03/08/04 | 1550 | 800 | 300 | 122 | 20 | NA | 14.9 | 7.85 | 49.620 | 32.48 | None | Green | Clear | None | None | None |
| 3A | Dry 1 | 02/10/04 | 1410 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | None | None | Other |
| 3A | Wet | 03/02/04 | 1150 | 270 | 130 | 75 | 306 | Trickle | 15.9 | 7.72 | 27.210 | 16.76 | None | Brown | Cloudy | None | None | Other |
| 3A | Dry 2 | 03/08/04 | 1234 | NA | NA | NA | NA | NA | NA | NA | NA | NA | None | None | na | None | Limited | Algae/Other |
| 3B | Dry 1 | 02/10/04 | 1409 | <20 | <20 | 10 | <10 | NA | 14.6 | 7.74 | 50.330 | 33.00 | None | None | Clear | None | None | None |
| 3B | Wet | 03/02/04 | 1150 | 50,000 | 1,300 | 1,616 | 958 | NA | 15.8 | 7.70 | 29.920 | 18.58 | None | Brown | Cloudy | Trash | None | None |
| 3B | Dry 2 | 03/08/04 | 1234 | <20 | <20 | <10 | 10 | NA | 18.5 | 7.84 | 49.350 | 32.32 | None | Green | Clear | None | None | None |
| 4A | Dry 1 | 02/10/04 | 1430 | 13,000 | 2,300 | 573 | 908 | 48.4 | 14.5 | 7.57 | 48.820 | 31.86 | None | None | Clear | Oily/Scum | None | Other |
| 4A | Wet | 03/02/04 | 1220 | 110,000 | 110,000 | 19,683 | 8,823 | 13.5 | 16.2 | 7.81 | 22.690 | 13.75 | None | Brown | Cloudy | Trash | None | Other |
| 4A | Dry 2 | 03/08/04 | 1255 | 170,000 | 22,000 | 1,968 | 1,670 | 31.5 | 17.7 | 7.70 | 16.820 | 10.52 | None | Green | Clear | None | None | Other |
| 4B | Dry 1 | 02/10/04 | 1437 | 1,300 | 1,300 | 108 | 446 | NA | 15.1 | 7.75 | 49.620 | 32.46 | None | None | Clear | None | None | None |
| 4B | Wet | 03/02/04 | 1220 | 80,000 | 80,000 | 26,125 | 7,665 | NA | 15.6 | 7.80 | 23.570 | 14.27 | None | Brown | Cloudy | None | None | None |
| 4B | Dry 2 | 03/08/04 | 1255 | 2,300 | 270 | 246 | 226 | NA | 16.7 | 7.58 | 47.780 | 30.81 | None | Green | Clear | None | None | None |
| 5A | Dry 1 | 02/10/04 | 1455 | 90 | <20 | <10 | 20 | 0.0003 | 15.1 | 7.49 | 49.520 | 32.41 | None | None | Clear | None | None | Other |
| 5A | Wet | 03/02/04 | 1250 | 3,000 | 500 | 408 | 1,017 | 0.003 | 15.1 | 7.60 | 21.810 | 13.10 | None | Brown | Cloudy | Trash | None | Other |
| 5A | Dry 2 | 03/08/04 | 1320 | 500 | 20 | <10 | 52 | 0.0003 | 19.0 | 7.51 | 0.453 | 0.21 | None | None | Clear | None | None | Other |
| 5B | Dry 1 | 02/10/04 | 1455 | <20 | <20 | 20 | <10 | NA | 14.6 | 7.73 | 50.590 | 33.18 | None | None | Clear | None | None | None |
| 5B | Wet | 03/02/04 | 1250 | 50,000 | 7,000 | 1,246 | 2,359 | NA | 15.6 | 7.61 | 28.200 | 17.40 | None | Green | Cloudy | Trash | None | None |
| 5B | Dry 2 | 03/08/04 | 1320 | 20 | <20 | <10 | 41 | NA | 18.2 | 7.79 | 49.490 | 32.43 | None | Green | Clear | None | None | None |
| 6A | Dry 1 | 02/10/04 | 1505 | 80 | <20 | <10 | 20 | 7.2 | 14.6 | 7.71 | 49.880 | 32.67 | None | None | Clear | None | None | Other |
| 6A | Wet | 03/02/04 | 1305 | 30,000 | 2,300 | 2,400 | 2,851 | 1.6 | 15.0 | 7.62 | 8.570 | 4.80 | None | Brown | Cloudy | Trash | Limited | Other |
| 6A | Dry 2 | 03/08/04 | 1330 | 500 | <20 | 10 | 1,989 | 8.5 | 16.0 | 7.89 | 31.800 | 19.88 | None | None | Clear | Bubbles | None | Other |
| 6B | Dry 1 | 02/10/04 | 1509 | <20 | <20 | <10 | <10 | NA | 15.0 | 7.72 | 50.500 | 33.17 | None | None | Clear | None | None | None |
| 6B | Wet | 03/02/04 | 1305 | 50,000 | 1,400 | 1,421 | 1,597 | NA | 16.3 | 7.50 | 22.130 | 13.32 | None | Brown | Cloudy | None | None | None |
| 6B | Dry 2 | 03/08/04 | 1330 | 700 | <20 | <10 | 2,142 | NA | 16.5 | 7.77 | 47.920 | 31.62 | None | None | Clear | None | None | None |
| 7A | Dry 1 | 02/10/04 | 1517 | 130 | <20 | <10 | 10 | 48 | 14.5 | 7.73 | 48.590 | 31.97 | None | None | Clear | None | None | Other |
| 7A | Wet | 03/02/04 | 1350 | 80,000 | 7,000 | 2,976 | 2,603 | 156 | 16.4 | 7.28 | 24.070 | 14.61 | None | Brown | Cloudy | None | None | Other |
| 7A | Dry 2 | 03/08/04 | 1340 | <20 | <20 | <10 | <10 | 48 | 19.7 | 7.84 | 39.550 | 25.26 | None | None | Clear | Trash | None | Other |
| 7B | Dry 1 | 02/10/04 | 1520 | <20 | <20 | <10 | <10 | NA | 15.0 | 7.74 | 50.630 | 33.22 | None | None | Clear | None | None | None |
| 7B | Wet | 03/02/04 | 1350 | 17,000 | 2,300 | 1,201 | 1,782 | NA | 15.1 | 7.03 | 15.130 | 15.73 | None | Brown | Cloudy | None | None | None |
| 7B | Dry 2 | 03/08/04 | 1340 | <20 | <20 | <10 | 10 | NA | 18.5 | 7.79 | 49.460 | 32.43 | None | None | Clear | None | None | None |
| 8A | Dry 1 | 02/10/04 | 1528 | <20 | <20 | <10 | <10 | 0.0001 | 14.5 | 7.82 | 51.150 | 33.59 | None | None | Clear | None | None | Other |
| 8A | Wet | 03/02/04 | 1340 | 23,000 | 5,000 | 4,611 | 4,352 | 0.003 | 17.2 | 7.74 | 33.730 | 21.21 | None | Brown | Cloudy | Trash | None | Algae/Other |
| 8A | Dry 2 | 03/08/04 | 1400 | 800 | 300 | 20 | 52 | 0.0003 | 18.5 | 7.83 | 25.640 | 15.68 | None | None | Clear | None | Limited | Other |
| 8B | Dry 1 | 02/10/04 | 1530 | <20 | <20 | <10 | <10 | NA | 14.8 | 7.76 | 50.470 | 33.10 | None | None | Clear | None | None | None |
| 8B | Wet | 03/02/04 | 1340 | 17,000 | 2,300 | 1,301 | 985 | NA | 16.3 | 7.50 | 24.650 | 21.87 | None | Green | Cloudy | Trash | None | None |
| 8B | Dry 2 | 03/08/04 | 1400 | <20 | <20 | <10 | <10 | NA | 17.7 | 7.81 | 49.410 | 32.37 | None | Green | Clear | None | None | None |

**Table 1. Summary of Field Observations and Chemical Analyses.**

| Site | Visit | Date | Time | Total Coliforms MPN/100 mL | Fecal Coliforms MPN/100mL | E. Coli MPN/100 mL | Enterococci MPN/100mL | Flow (cf/s) | Temperature (°C) | pH | Conductivity (mS/cm) | Salinity (ppt) | Odor | Color | Clarity | Floatables | Vegetation | Biology |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9A | Dry 1 | 02/10/04 | 1700 | 59,427 | 5,000 | 6,131 | 15,286 | 0 | 15.0 | 7.74 | 43.790 | 28.26 | None | None | Clear | None | None | Other |
| 9A | Wet | 03/02/04 | 1430 | 130,000 | 5,000 | 1,063 | 1,236 | 0 | 15.6 | 7.81 | 28.980 | 17.95 | Chemical | Brown | Cloudy | Oily/Trash | None | Other |
| 9A | Dry 2 | 03/08/04 | 1425 | 13000 | 70 | 20 | 984 | 0.5 | 17.7 | 7.70 | 38.580 | 24.58 | None | None | Clear | Trash | None | Other |
| 9B | Dry 1 | 02/10/04 | 1759 | 5,000 | 500 | 218 | 884 | NA | 14.4 | 7.77 | 50.190 | 32.88 | None | None | Clear | None | None | None |
| 9B | Wet | 03/02/04 | 1430 | 300,000 | 2,300 | 1,918 | 842 | NA | 15.5 | 7.80 | 29.330 | 18.21 | None | Brn/Grn | Cloudy | Trash | Limited | None |
| 9B | Dry 2 | 03/08/04 | 1425 | 80 | <20 | <10 | <10 | NA | 17.5 | 7.75 | 48.600 | 31.78 | None | Green | Clear | None | None | None |
| 10 | Dry 1 | 02/10/04 | 1331 | <20 | <20 | <10 | <10 | NA | 14.0 | 7.71 | 50.700 | 33.25 | None | Green | Clear | None | None | None |
| 10 | Wet | 03/02/04 | 1610 | 17,000 | 300 | 216 | 10 | NA | 15.9 | 7.78 | 41.640 | 26.74 | None | Green | Clear | None | None | None |
| 10 | Dry 2 | 03/08/04 | 1600 | <20 | <20 | <10 | <10 | NA | 15.4 | 7.90 | 49.580 | 32.49 | None | None | Clear | Trash | None | None |
| 11A | Dry 1 | 02/10/04 | 1630 | 3,500 | 20 | 85 | 197 | 30.2 | 14.6 | 7.59 | 46.230 | 30.02 | None | None | Clear | Trash | None | Other |
| 11A | Wet | 03/02/04 | 1500 | 300,000 | 13,000 | 3,873 | 11,776 | 52.48 | 13.9 | 8.04 | 10.710 | 6.46 | None | Brown | Cloudy | Trash | None | Other |
| 11A | Dry 2 | 03/08/04 | 1440 | 50,000 | 8,000 | 158 | 298 | 81.6 | 16.8 | 7.56 | 44.320 | 28.67 | None | None | Clear | Trash | Extensive | Other |
| 11B | Dry 1 | 02/10/04 | 1632 | 175 | 20 | 52 | <10 | NA | 14.5 | 7.70 | 46.330 | 30.09 | None | None | Clear | Trash | None | None |
| 11B | Wet | 03/02/04 | 1500 | 230,000 | 13,000 | 5,794 | 8,664 | NA | 14.1 | 7.98 | 8.290 | 4.62 | None | Green | Clear | None | None | None |
| 11B | Dry 2 | 03/08/04 | 1440 | 800 | <20 | <10 | <10 | NA | 15.6 | 7.66 | 46.020 | 29.88 | None | None | Clear | Trash | None | None |
| 12A | Dry 1 | 02/10/04 | 1715 | 40 | <20 | <10 | 98 | 0 | 14.8 | 7.68 | 48.700 | 31.81 | None | None | Clear | None | None | Other |
| 12A | Wet | 03/02/04 | 1525 | 70,000 | 2,200 | 884 | 2,559 | 0 | 14.7 | 7.99 | 14.380 | 8.38 | None | Brown | Cloudy | Trash | None | Other |
| 12A | Dry 2 | 03/08/04 | 1515 | 358 | 20 | 10 | 31 | NA | 16.0 | 7.75 | 54.350 | 29.41 | None | None | Clear | None | None | Other |
| 12B | Dry 1 | 02/10/04 | 1712 | 20 | <20 | <10 | <10 | NA | 14.1 | 7.77 | 50.370 | 33.01 | None | None | Clear | None | None | None |
| 12B | Wet | 03/02/04 | 1525 | 230,000 | 5,000 | 2,700 | 3,448 | NA | 14.7 | 14.80 | 24.530 | 7.83 | None | Green | Cloudy | None | None | None |
| 12B | Dry 2 | 03/08/04 | 1515 | 40 | <20 | 10 | <10 | NA | 15.5 | 7.76 | 48.480 | 31.68 | None | Green | Clear | None | None | None |
| 13A | Dry 1 | 02/10/04 | 1740 | 20 | <20 | 221 | 97 | NA | 16.1 | 7.64 | 49.310 | 32.28 | None | None | Clear | None | None | Other |
| 13A | Wet | 03/02/04 | 1555 | 130,000 | 1,300 | 637 | 85 | 0 | 16.4 | 7.75 | 33.670 | 21.17 | None | Brown | Cloudy | Trash | None | Other |
| 13A | Dry 2 | 03/08/04 | 1535 | 170 | 40 | <10 | 10 | NA | 16.3 | 7.80 | 49.300 | 32.28 | None | None | Clear | None | None | Other |
| 13B | Dry 1 | 02/10/04 | 1734 | <20 | <20 | 10 | <10 | NA | 14.2 | 7.76 | 50.580 | 33.17 | None | None | Clear | None | None | None |
| 13B | Wet | 03/02/04 | 1555 | 170,000 | 1,100 | 676 | 73 | NA | 16.2 | 7.72 | 36.250 | 22.93 | None | Green | Clear | None | None | None |
| 13B | Dry 2 | 03/08/04 | 1535 | <20 | <20 | 10 | <10 | NA | 15.5 | 7.81 | 49.310 | 32.27 | None | Green | Clear | None | None | None |
| 14A | Dry 1 | 02/10/04 | 1315 | >1,600,000 | 500,000 | >24,196 | >24,196 | 0.003 | 19.9 | 7.02 | 4.358 | 2.33 | Rotten Egg | Yellow | Clear | None | None | None |
| 14A | Wet | 03/02/04 | 1040 | 300,000 | 130,000 | 155,312 | 241,957 | 0.003 | 16.3 | 8.05 | 2.012 | 1.03 | None | None | Clear | Oily/Trash | None | None |
| 14A | Dry 2 | 03/08/04 | 1142 | 16,000,000 | 130,000 | 51,721 | 5,172 | 0.003 | 19.9 | 7.60 | 4.105 | 2.29 | Musty | None | Clear | None | None | None |
| 14B | Dry 1 | 02/10/04 | 1320 | 3,000 | 1,300 | 480 | <10 | NA | 13.9 | 7.29 | 50.700 | 33.25 | None | Green | Clear | trash | None | Other |
| 14B | Wet | 03/02/04 | 1040 | 2,200 | 220 | 504 | 464 | NA | 13.8 | 7.77 | 45.700 | 29.61 | None | None | Clear | Oily/Trash | None | None |
| 14B | Dry 2 | 03/08/04 | 1142 | 2,300 | 2,300 | 211 | <10 | NA | 15.1 | 7.62 | 49.420 | 32.32 | None | None | Clear | trash | None | None |
| A | Dry 1 | 02/10/04 | 1655 | <20 | <20 | 10 | <10 | NA | 14.5 | 7.75 | 49.940 | 32.21 | None | None | Clear | None | None | None |
| B | Dry 1 | 02/10/04 | 1730 | <20 | <20 | <10 | <10 | NA | 14.3 | 7.76 | 50.410 | 33.04 | None | None | Clear | None | None | None |
| B | Dry2 | 03/08/04 | 1520 | 20 | <20 | <10 | <10 | NA | 16.7 | 7.77 | 49.140 | 32.17 | None | None | Clear | Trash | None | None |
| D | Dry 1 | 02/10/04 | 1800 | 20 | <20 | <10 | <10 | NA | 14.0 | 7.80 | 50.700 | 33.24 | None | None | Clear | None | None | None |
| D | Wet | 03/02/04 | 1620 | 30,000 | 300 | 313 | 235 | NA | 15.1 | 7.80 | 44.390 | 28.77 | None | None | Clear | None | None | None |
| D | Dry 2 | 03/08/04 | 1615 | 40 | <20 | <10 | <10 | NA | 15.1 | 7.91 | 39.660 | 32.51 | None | None | Clear | None | None | None |
| LA-1 | Dry 1 | 02/10/04 | 1405 | <20 | <20 | <10 | <10 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| LA-1 | Wet | 03/02/04 | 1615 | <20 | <20 | <10 | <10 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| LA-1 | Dry 2 | 03/08/04 | 1615 | <20 | <20 | <10 | <10 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

Blue indicates open channel samples
Red inidactes open channel samples above AB411 criteria
NA = Not Applicable

## RESULTS

Table 1 presents the results from all three sampling events. Site numbers highlighted in blue indicate open-channel samples. The remaining sites are storm drain samples. Results that are highlighted in red indicate the open-channel result was above AB 411 criteria.

Results from the paired samples are plotted in Figures 2 through 4. As a reference, open-water sample results are compared to AB411 water quality criteria. The AB411 standards were developed as part of the California Health and Safety Code and provide a reference point for comparison of open-channel results. No criteria are presented for *E. coli*.

Open-channel total coliform counts remained below AB411 criteria during both dry weather sampling events (Figure 2). However, during the wet-weather sampling event all sites, except Site 14, were above AB411 criteria for total coliform. Outfall samples taken at Sites 2 and 14 were consistently higher for total coliform bacteria than other sites.

Figure 3 shows that open-channel samples from Site 4 were consistently higher than the other sites for fecal coliform, and were above AB411 criteria during two of the three events. Site 4 had the highest fecal coliform counts during the wet-weather event; and recorded within the top three highest counts for both dry-weather events. Fecal coliform counts measured at Site 14 were above AB411 criteria during both dry-weather events, but counts actually dropped during the wet-weather event. Sites 2, 4, and 14 were consistently higher than the other outfall sites for fecal coliform. All sites except Site 14 were above AB411 fecal coliform criteria during the wet-weather sampling event.

Site 4 open-channel enterococcus counts were above AB411 criteria during all three sampling events (Figure 4). During the wet-weather sampling event all sites, except Site 13, were above AB411 enterococcus criteria. Outfall samples from Sites 2 and 14 were consistently higher than other sites.

## DISCUSSION

With the exception of a single outlier for each indicator species, all open-channel sites exceeded AB411 criteria during the wet-weather sampling event. The storm event that preceded sampling on March 2, 2004 produced 0.92-inches of rainfall as recorded at the Long Beach Airport (NOAA 2004).

During the first dry-weather monitoring event Sites 4, 9, and 14 were higher than the other sites for the majority of indicator bacteria. The results were not as consistent during the second dry-weather sampling event, but Sites 4 and 14 again stood out as being higher than other sites.

Overall, Sites 2, 4, 9 and 14 were consistently higher than the other sites. Bacteria levels for all indicators from the outlet at Site 2 were consistently among the highest counts recorded compared with other sites. However, open-channel samples from Site 2 only exceeded AB411 criteria during the wet-weather event.

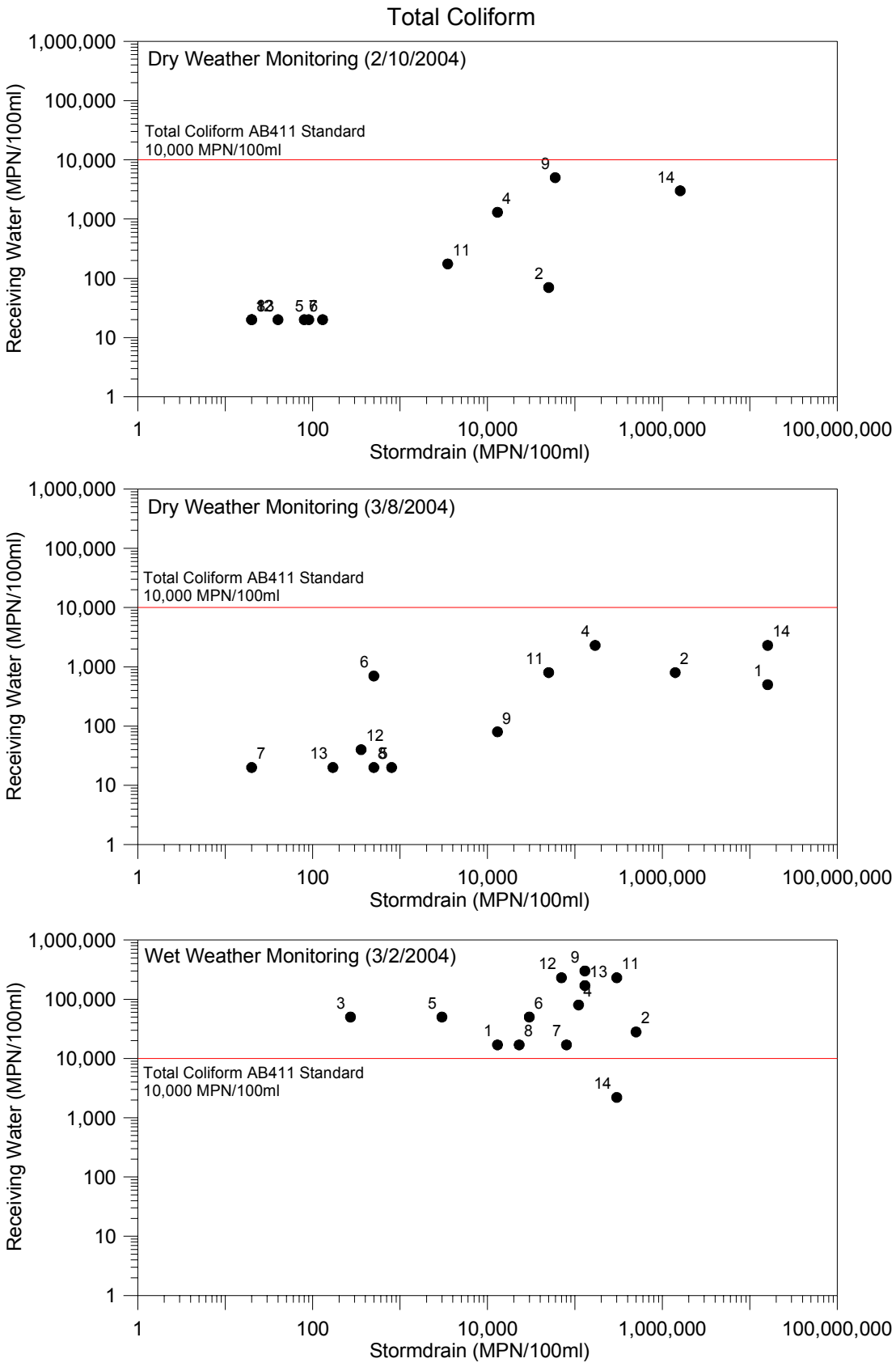


**Figure 2. Total coliform results.**

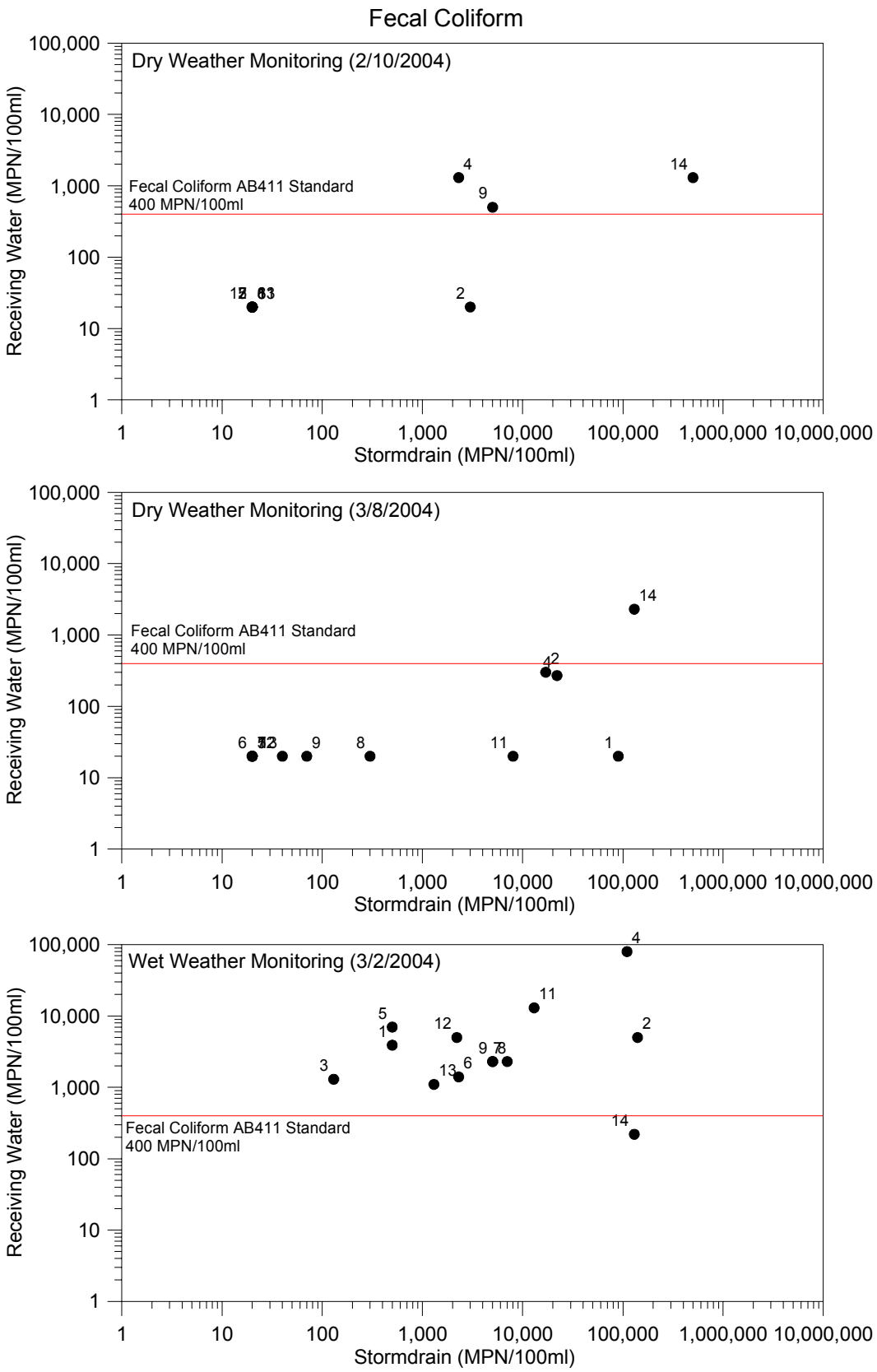


**Figure 3. Fecal coliform results.**

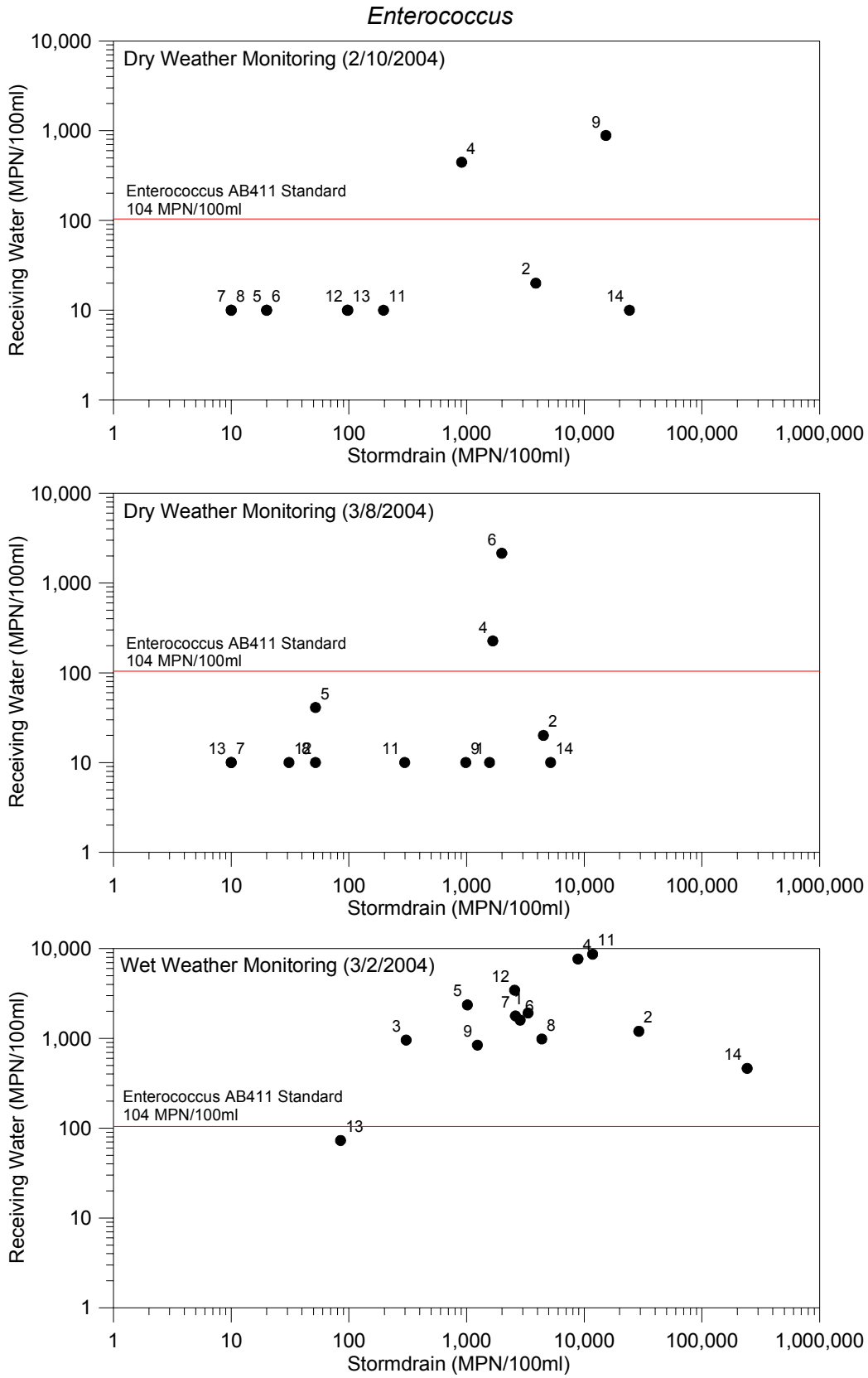


**Figure 4. Enterococcus results.**

Bacteria counts from the outlet at Site 4 were consistently higher than other sites. Open-channel fecal coliform and enterococcus counts at Site 4 were above AB411 criteria during all events (fecal coliform counts during the second dry-weather event were slightly below AB411 criteria).

Open-channel bacteria counts for all indicator bacteria were above AB411 criteria at Site 9 during the wet-weather event. During the first dry-weather monitoring event open-channel fecal coliform and enterococcus counts were above AB411 criteria. Bacteria counts recorded at the Site 9 outlet were higher when compared with other sites.

Bacteria counts for all indicators from Site 14 were consistently the highest when compared to other sites. Fecal coliform counts from the open-channel samples at Site 14 exceeded AB411 criteria during both dry-weather events and the enterococcus counts exceeded criteria during the wet-weather event.

## CONCLUSION

The elevated levels of bacteria found during both dry-weather sampling events is of concern. Bacteria levels at some sites may indicate the presence of sanitary wastewater entering the storm water conveyance system. While most of the Port is used for industrial and commercial purposes, there are some areas where there is human contact with the receiving water for commercial and recreational purposes. Site 9 is located in the same slip as an oceaneering college where divers are trained. Additionally, Cabrillo Beach and the boat launch are located outside the Port's Main Channel. While most of the bacterial contamination is limited to the piers, recreational users such as personal watercraft operators, kayakers, windsurfers, and swimmers have the potential to come in contact with waters affected by elevated levels of bacteria emanating from the Harbor Channel.

It is very challenging to gain a full understanding of the bacteriological conditions at an individual site by collecting only a limited number of samples. Within areas of concern, a more in-depth source tracking could be performed to better clarify the sources of bacterial contamination in highly polluted areas. Recent developments have allowed for various levels of source tracking according to budget and interest. For example, simple, rapid methods exist that would allow for determination between human versus non-human sources. Alternatively, for a more complex analysis, library methods exist that would provide identification down to individual species. Accurately performing such a study would involve substantial planning, beginning with an extensive field survey of the contaminated areas (i.e. animals, farms, housing, industry, etc. in the entire area of a given sample site).

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