Clean Charles 2005 Water Quality Report
1999 Core Monitoring Program
December 2000

Prepared By

US EPA
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1.0 EXECUTIVE SUMMARY

Purpose and Scope

In 1995, the Environmental Protection Agency - New England (EPA) established the Clean Charles 2005 Initiative to restore the Charles River Basin to a swimmable and fishable condition by Earth Day in the year 2005. The ongoing Initiative has a comprehensive approach for improving water quality through: Combined Sewer Overflow (CSO) controls, illicit sanitary connection removal, stormwater management planning and implementation, public outreach, education, monitoring, enforcement and technical assistance.

In 1998, EPA's Office of Environmental Measurement and Evaluation (OEME) initiated the Clean Charles 2005 Core Monitoring Program that will continue until 2005. The purpose of the program is to track water quality improvements in the Charles River Basin (defined as the section between the Watertown Dam and the New Charles River Dam) and to identify where further pollution reductions or remediation actions are necessary in order to meet the Clean Charles 2005 Initiative goals. The program is designed to sample during the summer months to coincide with peak recreational usage.

The program monitors twelve "Core" stations. Ten stations are located in the basin, one station is located on the upstream side of the Watertown Dam and another is located immediately downstream of the South Natick Dam (to establish upstream boundary conditions). This report presents the results of the 1999 sampling season.

Conclusions of the 1999 Core Monitoring Program

The summer of 1999 was a dry, hot summer and the flow at the Waltham gaging station was near the 7Q10 low flow condition from the end of July until mid September. Three dry and four wet weather events were sampled. With only two years worth of data, no definitive water quality trends were determined. However, in 1999, generally there were slightly lower fecal coliform and total phosphorus concentrations as well as improved clarity. Chlorophyll a (an indicator of algal biomass) was slightly higher this year, most likely caused by the lower flow conditions and warmer temperatures which promote algae growth. The improvements in water quality likely reflect the Clean Charles Initiative clean-up efforts and natural fluctuations associated with the weather and low river flows.

Water Clarity and Algae

Water clarity was directly measured using a Secchi disk. The greatest clarity was recorded between the Esplanade and the New Charles River Dam. Except for the July sampling event, Secchi disk readings met the four foot MA Department of Public Health's bathing beach visibility standard from the Esplanade to the New Charles River Dam. In both 1998 and 1999, water clarity improved closer to the mouth of the Basin. Based on EPA's apparent and true color results, which were other measures of water clarity, and data presented by USGS (Breault, 2000), it appears that part of the color was associated with particulate matter. This implies that controlling algae growth and preventing particulates from being discharged could enhance the clarity of the water and help achieve the bathing beach visibility standard. Chlorophyll a concentrations (an indicator of algal biomass) were highest between the Esplanade and the New Charles River Dam in August.

Bacteria

The fecal coliform concentrations were generally lower toward the mouth of the Basin. During dry weather conditions, approximately 8% of the core monitoring samples exceeded the fecal coliform swimming criteria of less than 200 colonies/100 ml[1]. During wet weather conditions approximately 50% of the fecal coliform core monitoring samples exceeded 200 colonies/100ml. At every core station, the dry weather fecal coliform geometric means[2] for 1998 and 1999 were less than 200 colonies/100ml. In 1999, the geometric means[2] were slightly lower than in 1998.

Dissolved Oxygen (DO) and pH
The continuous pH and DO monitoring data consistently met the Massachusetts class B water quality criteria. However, the data from manual measurements revealed twelve pH exceedences (approximately 8% of the all samples) and three DO exceedences (approximately 3% of all samples) of the MA class B water quality criteria.

Nutrients
Phosphorus was the most significant nutrient in this system. Elevated phosphorus concentrations at many of the sampling stations indicated highly eutrophic conditions. During the three dry weather sampling events, total phosphorus concentrations were highest at the South Natick Dam. These elevated concentrations may be caused by upstream wastewater treatment plants. In general, during rain events, total phosphorus concentrations throughout the Basin increased.

Metals
None of the metals exceeded the acute Ambient Water Quality Criteria (AWQC). Lead was the only metal that exceeded the chronic AWQC. There were more exceedences of the lead chronic criteria in September than any other month. This may have been caused by the more than nine inches of rain that occurred in September and the resultant increased storm water and flows from CSOs entering the River.

2.0 BACKGROUND

The Charles River watershed is located in eastern Massachusetts and drains 311 square miles from a total of 24 cities and towns. Designated as a Massachusetts class B water, the Charles is the longest river in the state and meanders 80 miles from its headwaters at Echo Lake in Hopkinton to its outlet in the Boston Harbor. From Echo Lake to the Watertown Dam, the River flows over many dams and drops approximately 340 feet. From the Watertown Dam to the New Charles River Dam in Boston, the River is primarily flat water (EPA 1997). This section, referred to as "the Basin", is the most urbanized part of the River and is used extensively by rowers, sailors and anglers. A Metropolitan District Commission (MDC) park encompasses the banks of the River and creates excellent outdoor recreational opportunities with its open space and bicycle paths.

The lower basin (defined as the section between the Boston University Bridge and the New Charles River Dam), once a tidal estuary, is now a large impoundment. During low flow conditions of the summer, the basin consists of fresh water overlying a wedge of saltwater. Sea walls define a major portion of the banks and shoreline of this section.

The Charles River shows the effects of pollution and physical alteration that has occurred over the past century. The water quality in the Basin is influenced by point sources, storm water runoff and CSOs. An EPA survey identified over 100 outfall pipes in the Basin (EPA 1996).

3.0 INTRODUCTION

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[1] The State fecal coliform swimming criteria of less than 200 colonies/100ml is actually based on a geometric mean of 5 samples or more.

[2] At some of the stations the geometric mean was calculated for less than 5 samples.

In 1995, EPA established the Clean Charles 2005 Initiative, with a taskforce and numerous subcommittees, to restore the Charles River to a swimmable and fishable condition by Earth Day in the year 2005. The Initiative's strategy was developed to provide a comprehensive approach for improving water quality through CSO controls, removal of illicit sanitary connections, stormwater management planning and implementation, public outreach, education, monitoring, enforcement and technical assistance.

In 1998, EPA's Office of Environmental Measurement and Evaluation (OEME) implemented a water quality monitoring program (Core Monitoring Program) in the Charles River that will continue until at least 2005. EPA and its partners on the Taskforce's water quality subcommittee developed a study design to track improvements in the Charles River Basin and to identify where further pollution reductions or remediation actions were necessary to meet the swimmable and fishable goals. Members of the subcommittee include EPA-New England, U.S. Geological Survey (USGS), U.S. Army Corps of Engineers - New England District (ACE), Massachusetts Executive Office of Environmental Affairs (EOEA), Massachusetts Department of Environmental Protection (DEP), Massachusetts Department of Environmental Management (DEM), Massachusetts Water Resources Authority (MWRA), Boston Water and Sewer Commission (BWS), Charles River Watershed Association (CRWA) and the MDC. In addition to the Core Monitoring Program, EPA and its partners continue to support other water quality studies in the Charles River to further identify impairment areas and to evaluate storm water management techniques.

OEME's Core Monitoring Program was designed to sample twelve stations during three dry weather periods and six (of the twelve) stations during three different wet weather events. The monitoring was focused in the Boston and Cambridge areas of the River during peak recreational usage in July, August and September. To establish a boundary conditions, one station was located immediately downstream from the South Natick Dam or 30.5 miles upstream from the Watertown Dam. One station was located above the Watertown Dam and the other ten stations were located in the Basin. Five of these ten sampling stations were located in priority resource areas (potential wading and swimming locations). The project map (Figure 1) shows the locations of the: dry and wet weather fixed sampling stations, priority resource areas, CSOs, and stormwater discharge pipes. Table 1 describes the stations monitored in 1999.

The 1998 monitoring program included measurements of dissolved oxygen (DO), temperature, pH, specific conductance, chlorophyll a, total organic carbon (TOC), total suspended solids (TSS), apparent color, clarity, turbidity, nutrients, bacteria and total metals. Chronic toxicity was also tested during dry weather conditions. In 1999, dissolved metals and true color were added to the analyte list. Dissolved metals were added to better assess the metals concentration in relationship to the AWQC, which are based on the dissolved metals fraction. True color was added to help determine the causes of reduced clarity. Four wet weather sampling events were conducted and one event was tested for ambient water acute toxicity. A fish toxics study was conducted in the fall to evaluate the human health risks and ecological risks associated with contaminated fish.

Figure 1: EPA Core Monitoring Locations and Priority Resource Areas

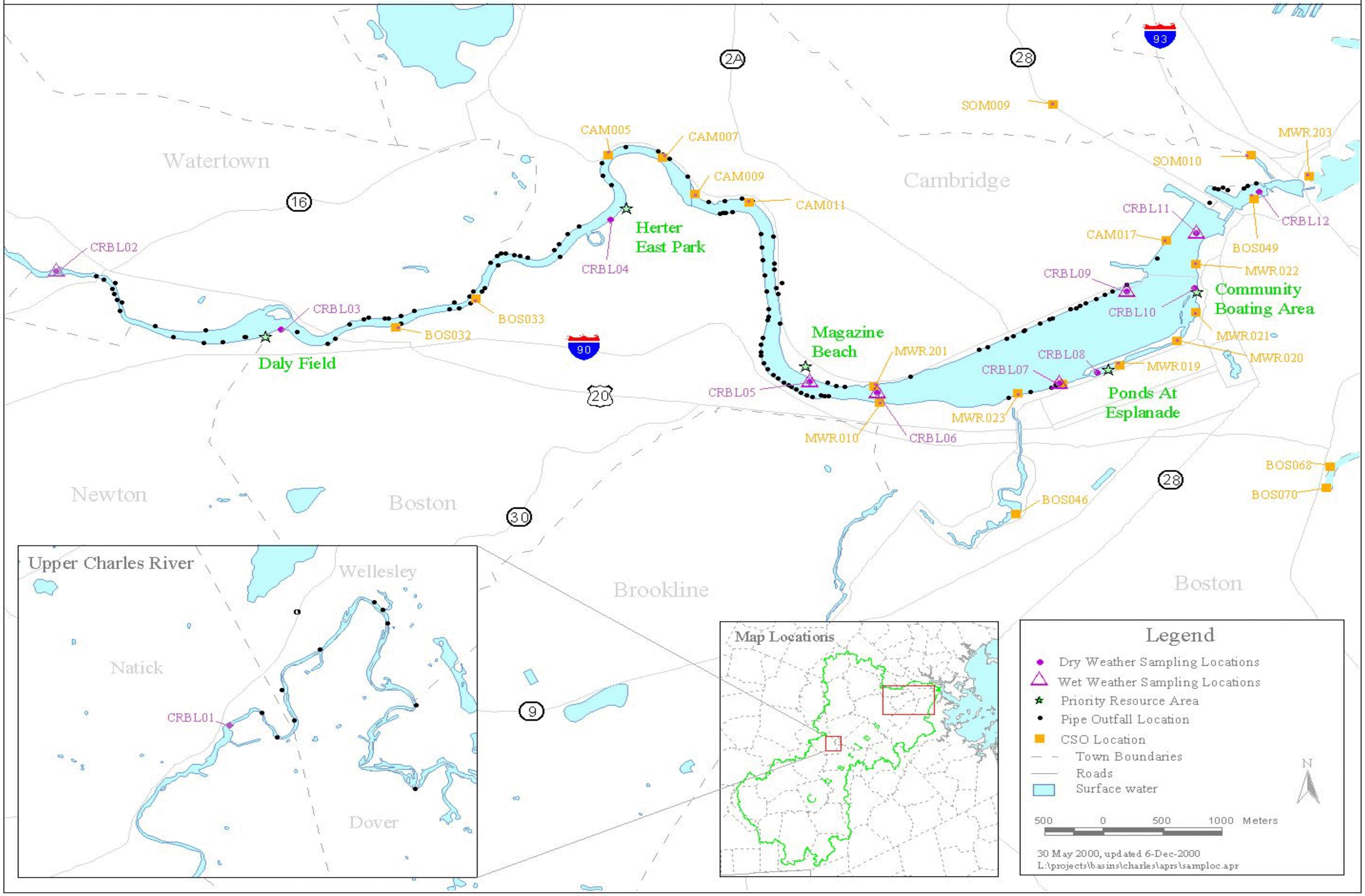

Table 1: Sampling Station Description

PRIMARY CORE MONITORING STATION DESCRIPTIONS	STATION #
Downstream of S. Natick Dam	CRBL01
Upstream of Watertown Dam	CRBL02 WW
Daly Field, 10 m off south bank	**CRBL03**
Herter East Park, 10 m off south bank	**CRBL04**
Magazine Beach, 10 m off north bank	**CRBL05 WW**
Downstream of BU Bridge, main stem	CRBL06 WW
Downstream of Stony Brook & Mass Ave, 10 m off S. shore	CRBL07 WW
Pond at Esplanade	**CRBL08**
Upstream of Longfellow Bridge, Cam. side	CRBL09 WW
Community boating area	**CRBL10**
Between Longfellow Bridge & Old Dam	CRBL11 WW
Upstream of railroad Bridge	CRBL12
Supplemental Sampling Stations Used	
Mouth of Laundry Brook	EPCT01
Mouth of Faneuil Brook	EPCT02
Mouth of Muddy River	MUDD01
Plume of Cottage Farm CSO - under the BU Bridge	BUDRID
200 m upstream of BU Bridge & 10 m off south bank	CRBL4S
100 m downstream of River St Bridge & 10 m off south bank	CRBL5S
Between Museum of Science and Longfellow Bridge 10m off south bank	CRBL11S

Bold = Priority resource area station
WW = Wet weather sampling station

4.0 PROJECT DESCRIPTION

Sampling was conducted during three dry weather periods and four wet weather events from July through October, 1999. In addition to monitoring the mouths of Laundry and Faneuil brooks for selected parameters during dry weather, the twelve core stations were monitored for all parameters. Dry weather sampling days were preplanned for the months of July, August, and September. The dry weather sampling occurred on the planned day if it was preceded by three days during which a total of less than 0.20 inches of rain had fallen. Dry weather sampling was conducted on July 13, August 10 and September 14.

The approach for each wet weather event was to sample six station during four storm periods; pre-storm, first flush, peak flow and post-storm. The pre-storm was sampled before the rain began. The first flush sampling began when the rain became steady and one hour after the measured stage in the Laundry Brook culvert increased by at least 0.5 inches. The peak flow sampling began when rain intensity peaked and the stage reading was greatest in the Laundry Brook culvert. Post-storm sampling occurred when the rain ceased and the flow at Laundry Brook returned to near pre-storm condition.

The first wet weather sampling event was initiated on August 20. Because the rain event produced less precipitation than was predicted (less than 0.25 inches of rain[1]), the sampling was terminated after the second sampling run. Only bacteria samples and field measurements were analyzed for this second sampling run.

The second wet weather sampling occurred from September 14 to September 20. The storm was associated with Hurricane Floyd and produced 4.5 inches of rain[1]. Since this storm lasted more than 24 hours, additional samples for bacteria and field measurements were collected between first flush and peak flow (Figure A-6).

The third wet weather sampling was conducted from September 29 to October 4. The storm on September 29 dumped 0.45 inches of rain in three hours[1]. Because this storm was brief, only one set of samples were collected during the storm. (Figure A-7).

A fourth wet weather sampling was initiated on October 18 after 1.8 inches of precipitation had fallen[1]. For this event, fecal coliform samples and field measurements were collected immediately after the rain had ceased at fourteen stations (Figure A-8).

Table 2: Parameters Analyzed During the 1999 Sampling Events

Field Measurements	Bacteria	Nutrients	Total Metals	Dissolved Metals	Other Parameters
dissolved oxygen, temperature, pH, specific conductance, turbidity, Secchi disk	fecal coliform *Enterococcus*	total phosphorus(TP), ortho-phosphorus(OP), nitrate+nitrite(NO_2+ NO_3), ammonia(NH_3)	Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Mg, Mn, Mo, Ni, Pb, Sb, Se, Tl, V, Zn, Hg	Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Mg, Mn, Mo, Ni, Pb, Sb, Se, Tl, V, Zn	TSS, chlorophyll a, TOC, apparent + true color

In addition to chemical and bacterial analyses (Table 2), forty-eight hour acute toxicity tests were performed on first flush, peak flow and post-storm samples from the September 14 through September 16 wet weather event. The August 21 and October 18 wet weather events were sampled only for fecal coliform and field measurements. *Enterococcus* was analyzed for the three dry weather events and during the post-storm sampling on September 20. *Enterococcus* samples were analyzed by MWRA and EPA. Chlorophyll a was not monitored during first flush and peak flow. Ammonia samples were analyzed by a contract laboratory. The EPA OEME's laboratory and field staff conducted toxicity testing and analyzed all other parameters.

5.0 DATA ANALYSIS

The monitoring results were significantly influenced by weather conditions and stream flow. The summer of 1999 was a dry hot summer and the flow at the Waltham gaging station was near the 7Q10 low flow (17.7 cfs) condition from the end of July until approximately mid September. In September, over nine inches of rain had fallen and the flow in the River increased substantially. In the 30 day prior to September 10 the average daily flow was 27 cfs, the following 30 days the average daily flow was 340 cfs. For most of the summer the flows were less than those recorded in 1998[2] (Figure A-5).

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[1]Precipitation data collected form Boston Water and Sewer (http://www.bwsc.org)

[2]Flow data was collected from USGS Waltham gaging station and is reported as preliminary data.

In 1999, some improvements were noted over 1998, however with only two years of data, no definitive water quality trends could be determined. Fecal coliform geometric mean and total phosphorus arithmetic mean were slightly lower in 1999 than in 1998. In 1999, overall water clarity improved. Chlorophyll a (an indicator of algal biomass) was slightly higher in 1999, most likely a result of lower flow conditions and warmer temperatures. The improvements in water quality maybe a result of the Clean Charles Initiative clean-up efforts and natural fluctuations associated with the weather and low river flows. Continued monitoring will help clarify these trends over the next several years.

5.1 Clarity, Apparent color, True color, TSS, Turbidity, TOC and Chlorophyll a

Secchi disk was used to measure visibility/clarity. The Massachusetts Department of Health has established minimum standards for bathing beaches (105 CMR 445.00) which require four feet of visibility.

Clarity could not be measured at the South Natick Dam (CRBL01) and Watertown Dam (CRBL02) because of the shallow water at these stations. Except for the July sampling event, Secchi disk readings from approximately the Longfellow Bridge (CRBL09) to the Railroad Bridge (CRBL12) met the four feet visibility criteria during all sampling events (Figure 2). In both 1998 and 1999, water clarity improves closer to the mouth of the Basin and the lowest clarity readings were measured in the pond at the Esplanade (CRBL08). Except for station CRBL08, the mean clarity at each station improved slightly in 1999 compared to 1998 (Figure 3).

Apparent color measures the color of the water which may contain suspended matter. Generally, apparent color was less during first flush and peak flow when compared to pre-storm and post-storm samples. Mean apparent color was slightly less in 1999 than in 1998. For unexplained reasons, the highest apparent and true color concentrations occurred during pre-storm, peak flow and post-storm samples associated with the September 30th storm.

True color measures the stain in the water after the suspended particulates have been removed by centrifuging. At each station the true color mean value was 25 to 50% lower than the apparent color mean value (Figure 4). Based on these data and USGS data (Breault, 2000), part of the color in the River was associated with particulate matter. This implies that reducing nutrients that stimulate algae growth and other sources of particulates and suspended matter could enhance the clarity of the water and help achieve Bathing Beach Standards. Other sources of particulates and suspended matter include non-point and point sources, such as storm water and CSOs and resuspended bottom sediments.

In general, TSS concentrations were lowest near the mouth of the Basin during wet and dry weather conditions. Except for one wet weather peak flow sample collected on September 16, upstream of Watertown Dam (CRBL02), all measured TSS concentrations were less than the Massachusetts water quality standard (Table3).

The highest turbidity concentrations occurred in Laundry Brook (EPCT01) and Fanueil Brook (EPCT02). Turbidity was generally elevated during first flush and peak flow when compared to the associated pre-storm and post-storm samples. Total Organic Carbon (TOC) concentrations were highest during the late September wet weather sampling than any other time. This was most likely caused by run-off containing organic matter.

Chlorophyll a was one of the parameters measured to assess eutrophication in the Basin. Because Massachusetts does not have numeric nutrient or chlorophyll a criteria for assessing lakes and rivers eutrophication, the total phosphorus and Chlorophyll a concentration were compared to the Connecticut's Lake Trophic Classifications - Water Quality Standards[1]. When measured concentrations were compared to these criteria, more than 50% of the samples collected in the Basin were considered highly eutrophic. The highest chlorophyll a concentrations occurred on August 10, between CRBL09 and CRBL12. These elevated levels coincided with increased turbidity. Chlorophyll a concentrations decreased considerably after the September 16 storm (4.5 inches of rainfall), probably due to the dilution and flushing in the River. As stated earlier, chlorophyll a was slightly higher this year than in 1998, most likely a result of lower flow conditions and warmer temperatures.

Table 3: Massachusetts Class B Surface Water Quality Standards and Guidelines for Warm Waters

Parameter	MA Surface Water Quality Standards (314 CMR 4.00) and Guidelines
Dissolved Oxygen	$\geq$ 5 mg/l and $\geq$ 60% (for class B warm water fisheries)
pH	Between 6.5 and 8.3 (for class B waters)
Fecal coliform	See Table 4
Solids	TSS $\leq$ 25.0 mg/l
Color and Turbidity	Narrative Standard
Nutrients	Narrative "Control of Eutrophication" Site Specific

5.2 Bacteria

Except for one wet weather peak flow sampling on September 30, fecal coliform concentrations were measured during each sampling event. *Enterococcus* bacteria were measured during the three dry weather events and during the September 20 post-storm sampling.

The Massachusetts Department of Public Health (DPH) Minimum Standards for Bathing Beaches and the DEP Surface Water Quality Standards (314 CMR 4.00) establish maximum allowable bacteria criteria. These are summarized in Table 4.

[1]The Connecticut Water Quality Lake Trophic Classification Criteria during mid summer conditions for chlorophyll a: Oligotrophic (0 - 2 ug/l), Mesotrophic (2 - 15 ug/l), Eutrophic (15 - 30 ug/l), and Highly Eutrophic (>30 ug/l).

Table 4: Massachusetts Freshwater Bacteria Criteria

Bacteria	MA DPH Minimum Criteria for Bathing Beaches (105 CMR 445.00)	MA DEP Surface Water Quality Standards (314 CMR 4.00) and water quality guidelines	
	Bathing beaches	Primary contact	Secondary contact
Total coliform (guideline)	≤1000 colonies/100ml	NA	NA
Fecal coliform	NA	a geometric mean ≤200 col/100ml for ≥5 samples ≤400/100ml for not more than 10 % of the samples	a geometric mean ≤1000 col/100ml for ≥5 samples ≤2000/100ml for not more than 10 % of the samples
		≤400 col/100ml for <5 samples	≤2000 col/100ml for <5 samples

Note: NA = not applicable

For the purpose of this report, the fecal coliform counts of individual samples were compared to the Massachusetts DEP geometric mean criteria of less than or equal to 200 colonies/100ml for primary contact recreation (swimming) and less than or equal to 1000 colonies/100ml for secondary contact recreation (boating). All dry weather fecal coliform counts collected at the twelve core monitoring stations were less than 1000 colonies/100ml and approximately 92% were less than the 200 colonies/100ml. Fecal coliform samples collected from supplemental station EPCT01 exceeded 200 colonies/100ml during all five sampling events and exceeded 1000 colonies/100ml on four sampling events. All the dry weather samples downstream from Stony Brook & Mass Ave (CRBL07) had fecal coliform counts less than the 200 colonies/100 ml criteria.

During wet weather conditions, approximately 50% of the samples at the core monitoring stations had fecal coliform concentrations less than the swimming standard. At the core monitoring stations, the dry weather fecal coliform geometric means[1] for 1998 and 1999 were less than 200 colonies/100ml. In 1998 and 1999, there were lower concentrations toward the mouth of the Basin. In 1999, the geometric means[1] were slightly less than in 1998 (Figure3).

5.3 Dissolved Oxygen and pH

Automated instruments continuously monitored DO and pH at a total of seven stations during select periods from June through September,1999 (Figure A-1 through A-4 and Table A-1 through A-4). The continuous pH and DO monitoring data consistently met the Massachusetts class B water quality criteria (Table 3).

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[1] At some of the stations the geometric mean was calculated for less than 5 samples.

Dissolved oxygen and pH were measured during each water quality sampling events. Of these, twelve pH (approximately 10 % of the total) and three DO (approximately 3 % of the total) measurements exceeded the MA class B water quality criteria. On August 10, each station from CRBL07 to CRBL12 exceeded the pH criteria. These measurements ranged from 8.6 to 9.1. On August 20, each station from Magazine Beach (CRBL05) to between Longfellow Bridge & Old Dam (CRBL11) exceeded the pH criteria. The measurements ranged from 8.4 to 8.8. On September 14, at station CRBL08 the pH was 8.4. The cause of these elevated values was unable to be determined but may be, in part, by the photosynthesis of algae and the uptake of carbon dioxide from the water. On August 21, during a first flush sampling the DO was 3.6 mg/l at station CRBL02. On September 14, at station CRBL01, the DO was 4.1 mg/l. On October 18, during a wet weather sampling the DO was 2.8 mg/l at the mouth of the Muddy River (MUDD01). This DO exceedence was caused by the flow from the Muddy River. The other low DO values were infrequent and could not be explained.

5.4 Nutrients

Nutrient analyses included measurements of total phosphorus, ortho-phosphorus, nitrate+nitrite and ammonia. During the dry weather sampling events, total phosphorus concentrations were highest at the South Natick Dam (CRBL01). This indicates that a significant amount of phosphorus was coming from sources upstream of the South Natick Dam. Upstream point sources include wastewater treatment plants operated by: Charles River Pollution Control District, the Massachusetts Correctional Institute (MCI) in Norfolk, Wrentham State School, and the towns of Medfield and Milford. At most stations, total phosphorus concentrations increased during wet weather.

Since Massachusetts uses a narrative site-specific water quality criteria for total phosphorus, measured concentrations were compared to Connecticut's numeric lakes trophic classifications. These classifications indicated that 80% of the dry weather and 100% of the wet weather total phosphorus concentrations were associated with highly eutrophic[1] waters. Figures 6 and 7 presents the total phosphorus concentrations during dry and wet weather, respectively. As with the total phosphorus concentration some of the highest dry weather ortho-phosphate concentrations were measured at station CRBL01. No spatial trends were observed for ortho-phosphate.

Nitrate+nitrite (the total nitrate and nitrite) concentrations ranged from 0.01 mg/l to 0.78 mg/l as nitrogen. Ammonia concentrations, as nitrogen, ranged from less than 0.075 mg/l (not detected) to 0.28 mg/l. Generally, higher concentrations of nitrate+nitrite and ammonia occurred during the September sampling events. This may be caused by nutrient cycling and seasonal plant die off and decomposition.

[1]The Connecticut Water Quality Lake Trophic Classification Criteria during the spring and summer conditions for total phosphorus are: Oligotrophic (0 - 0.010 mg/l), Mesotrophic (0.010 - 0.030 mg/l), Eutrophic (0.030 - 0.050 mg/l), and Highly Eutrophic (>0.050 mg/l).

5.5 Metals

Twenty metals were included in total recoverable and dissolved analyses. In addition, total recoverable mercury was analyzed. Ten of these are EPA priority metals and have associated Ambient Water Quality Criteria (AWQC)[1]. Seven of these AWQC's are dependent on the water hardness. Hardness dependent AWQC were calculated using the water's hardness at the time of sampling. Except for mercury, all AWQC's were based on the dissolved metals fraction. Because only total recoverable mercury was measured, the AWQC's for mercury were converted to a total recoverable criteria. The metals concentrations and the associated criteria are presented in Tables 5 and 6 for dry and wet weather, respectively. The concentrations of all the metals analyzed are presented in Appendix A.

None of the ten EPA priority metals exceeded the acute AWQC, and lead was the only metal that exceeded the chronic AWQC. During the dry weather sampling on July 13, August 10, August 20, and September 14, there were three exceedences of the lead chronic AWQC (8% of the total number of samples). There were 26 exceedences (72% of the total number of samples) of the lead chronic AWQC during the six wet weather sampling events that occurred in September and October. The increased number of lead exceedences in September and October may have been caused by the amount of rain and increased flows from storm water and CSOs. The increased rain water caused a reduction in the water hardness, which compounds the problem by reducing the calculated AWQC.

On September 14, station CRBL09 recorded a total recoverable copper concentration of 56.9 ug/l, while concentrations at other stations were in the single digits. For the same sampling event, the dissolved copper concentration, at CRBL09 was not elevated when compared to other stations. The cause for the elevated total recoverable copper concentration could not be determined with the available data.

5.6 Toxicity

Wet weather toxicity was evaluated using 48 hour ambient aquatic toxicity tests. Two test species were used, the Cladoceran, *Ceriodaphnia dubia* and the Fathead minnow, *Pimephales promelas.* The test was conducted during the September 16 storm event on first flush, peak flow, and post-storm samples. No toxicity was reported in any of the samples.

5.7 Data Usability

Quality control criteria were established for all data presented in this report. The criteria specifies holding times, sample preservation, and precision and accuracy limits. All samples were preserved and analyzed according to the plan requirements. The quality control requirements, for this project, were documented in the Project Work/QA Plan - Charles River Clean 2005 Water Quality Study June 2,1999.

Continuous monitoring data that partially met the established quality control criteria were reported as estimated data. Continuous monitoring data not meeting any of the quality control criteria was not presented in this report. Chemistry data that partially met laboratory quality control criteria or concentrations that were less than the associated reporting limit were presented as estimated data and identified with a swung dash (~) preceding the value.

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[1] EPA's Clean Water Act Section 304(a) Criteria for Priority Toxic Pollutants (40 CFR Part 131.36)

Field duplicate samples were collected to evaluate sampling and analytical precision. The overall sampling and laboratory precision were adequately evaluated using the duplicate sampling data. No duplicate samples were evaluated for the September 16 wet weather first flush event. This was the only sampling event (out of 13 events) where duplicate samples were not collected. Because all sampling events employ the same methods for sampling and analysis, the precision for September 16 wet weather first flush event was evaluated by looking at the overall project precision. Therefore, the use of the September 16 data were not limited for this project.

Twelve of the 83 duplicate samples (excluding metals) analyzed during the sampling events did not meet the precision quality control goal of less than 35 relative percent difference established in the Quality Assurance Project Plan. However, the project use of these data were not limited for the reason specified below. Four of the out of range duplicate analyses were associated with low concentrations near the reporting limit, where more analytical drift occurred. Eight of the twelve samples that did not meet the quality control goal for fecal coliform and *enterococcus* analyses. These variations among duplicate bacteria samples may have occurred because of the natural bacteria variability that exist in ambient water. All bacteria duplicate samples were within the same magnitude as the affiliated sample. Apparent color, ortho-phosphate, chlorophyll a and TSS analyses each had one duplicate sample with a relative percent difference above 35%. The review of the field and laboratory quality control data for each of the twelve duplicate samples that did not meet the precision goal, showed no abnormalities.

Eighteen of 338 duplicate samples for total and dissolved metals analyzed during nine sampling events did not meet the precision quality control goal of less than 35 relative percent difference. However, the use of these data was not limited for this project for the reason specified below. Seven of these duplicate analyses were associated with concentrations near the detection limit. The review of the field and laboratory quality control data, for the eleven remaining out of range duplicate samples showed no abnormalities.

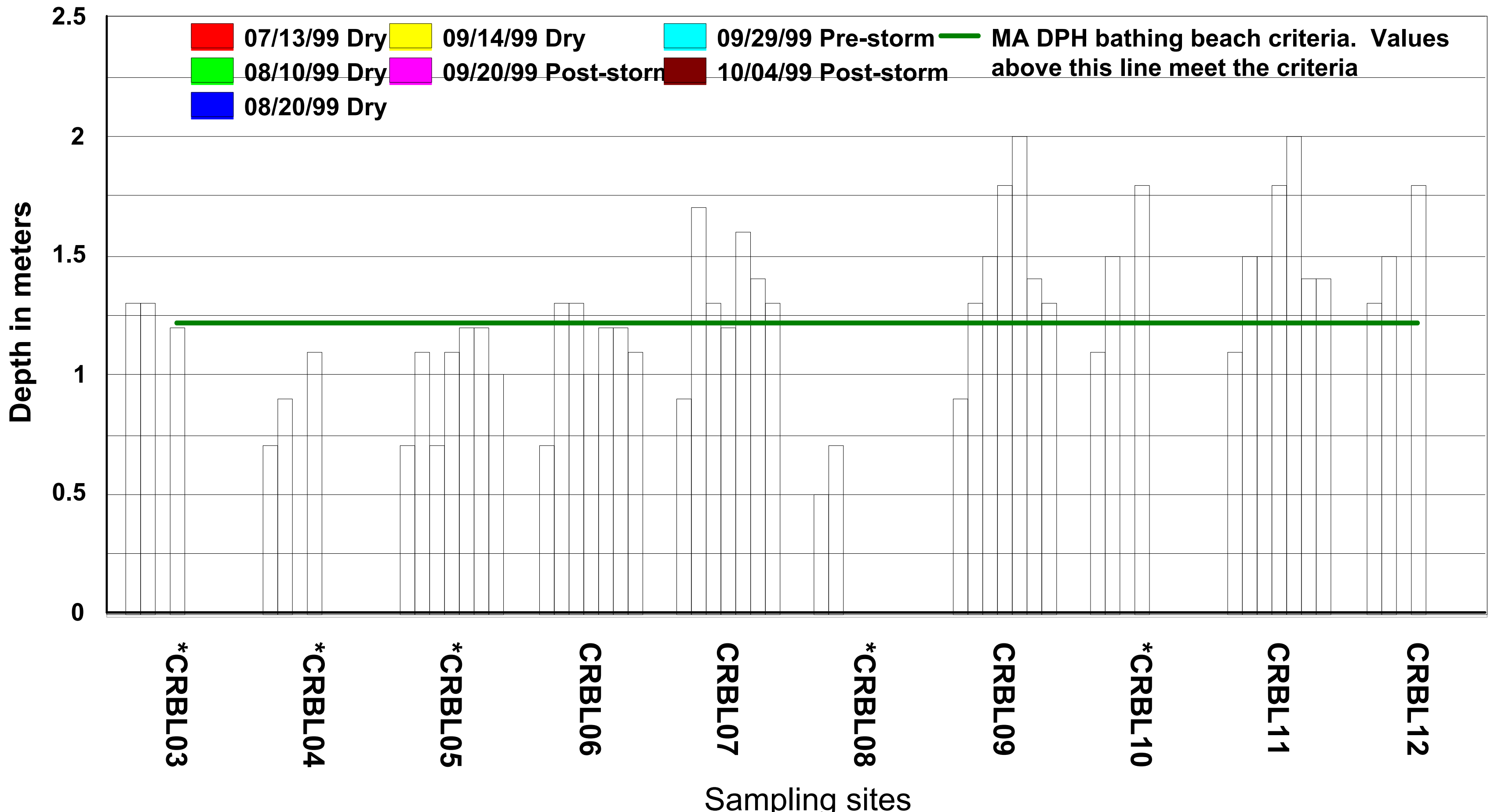
For the low level metals analyses, trip blanks were used to evaluate any contamination caused by the: sample preservation, sample container, sampling method, and/or transporting of the sample. The trip blank, a bottle of ultra pure water, was collected prior to sampling and brought on the sampling trip. Because of elevated trip blanks, some of the dissolved antimony, chromium, zinc and total zinc values were reported as maximum values. The Appendix contains all the validated data for this report.

6.0 2000 Study Design

In 2000, two additional studies will be added to the Clean Charles 2005 water monitoring program. In March, OEME will initiate a study to investigate the water color and reduced visibility in the Charles River. The purpose of this study is to determine the spatial and temporal variability of the color throughout the watershed. Monthly sampling will end in September of 2000. The results from this investigation will help identify the causes and sources of reduced visibility in the Basin.

In June of 2000, OEME will initiate a pilot study to evaluate the use of a filter curtain to achieve the Clean Charles 2005 swimmable goal. The vertical hanging filter curtain will enclose an area off shore of Magazine Beach. Water quality measurements will be collected inside and outside the enclosed area to evaluate the curtain's ability to improve water clarity and reduce bacteria. The filter curtain will be employed in June and August. The results from these projects will be presented in separate reports.

Figure 2: Clarity - Secchi Disk Measurements at Stations CRBL03 - CRBL12



*= Priority Resource Areas

Figure 3: 1998 and 1999 Arithmetic Mean Secchi Disk Measurements at Station CRBL03 - CRBL12

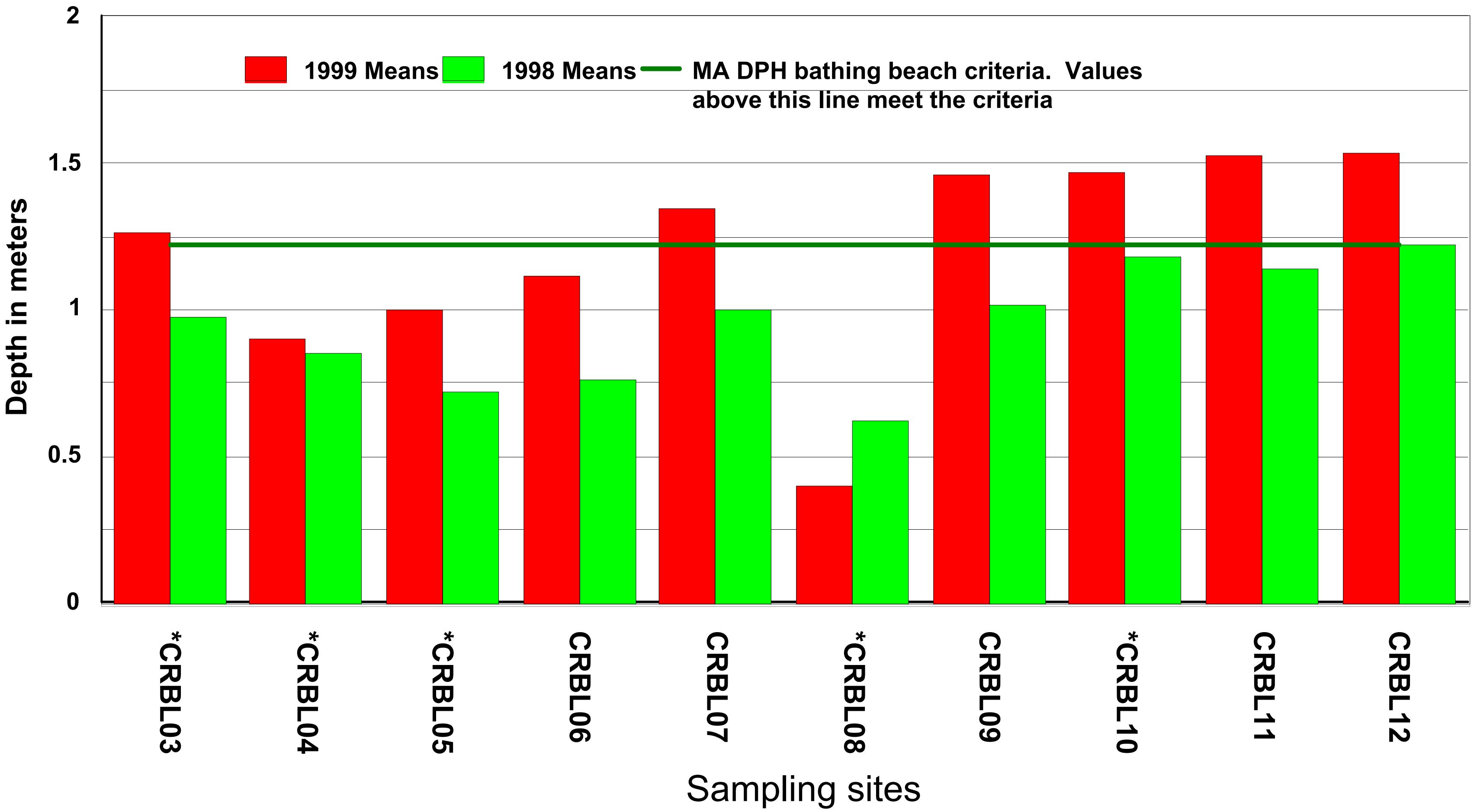


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Figure 4: 1998 and 1999 Dry Weather Arithmetic Means for Apparent & True Color

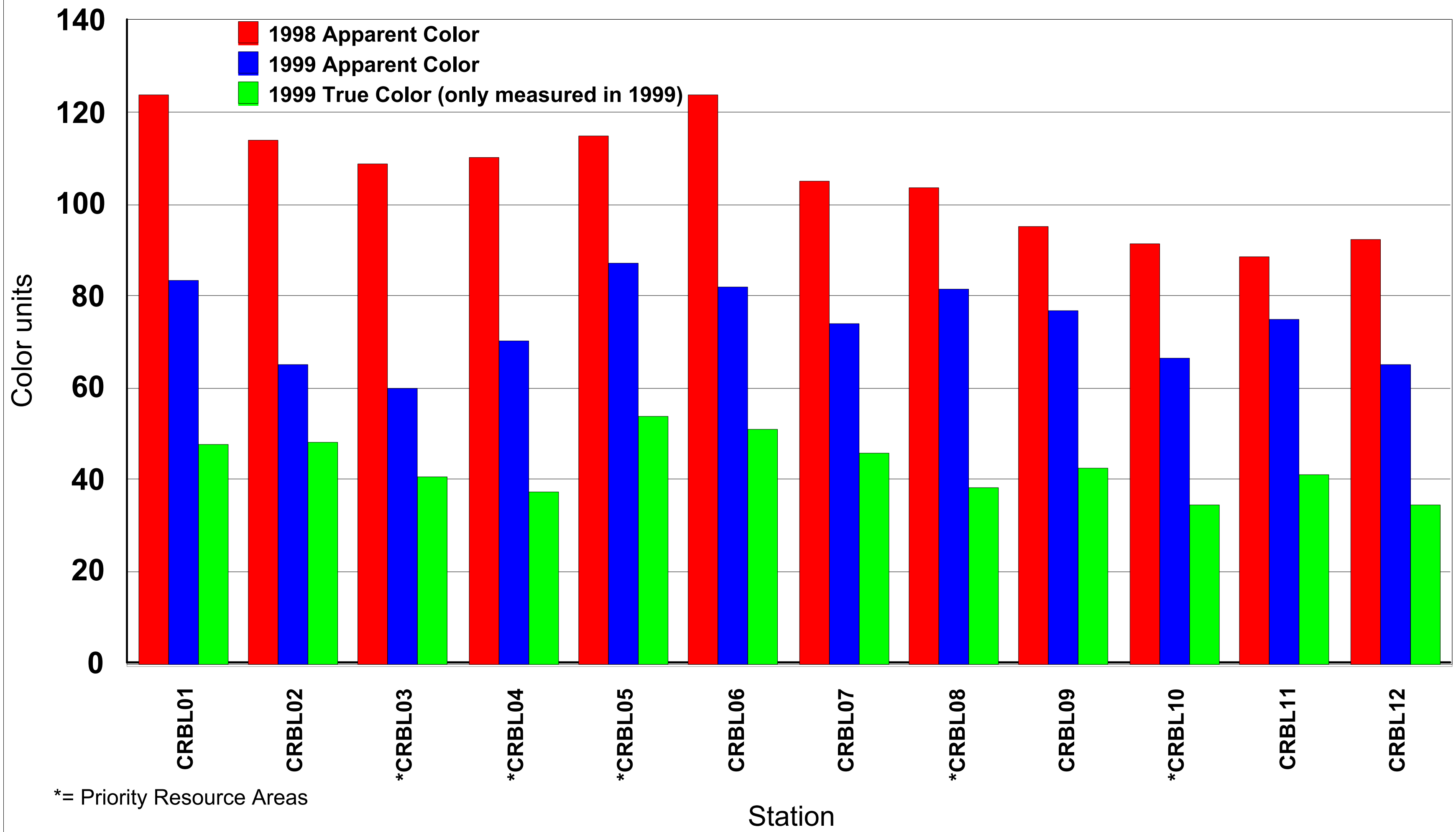

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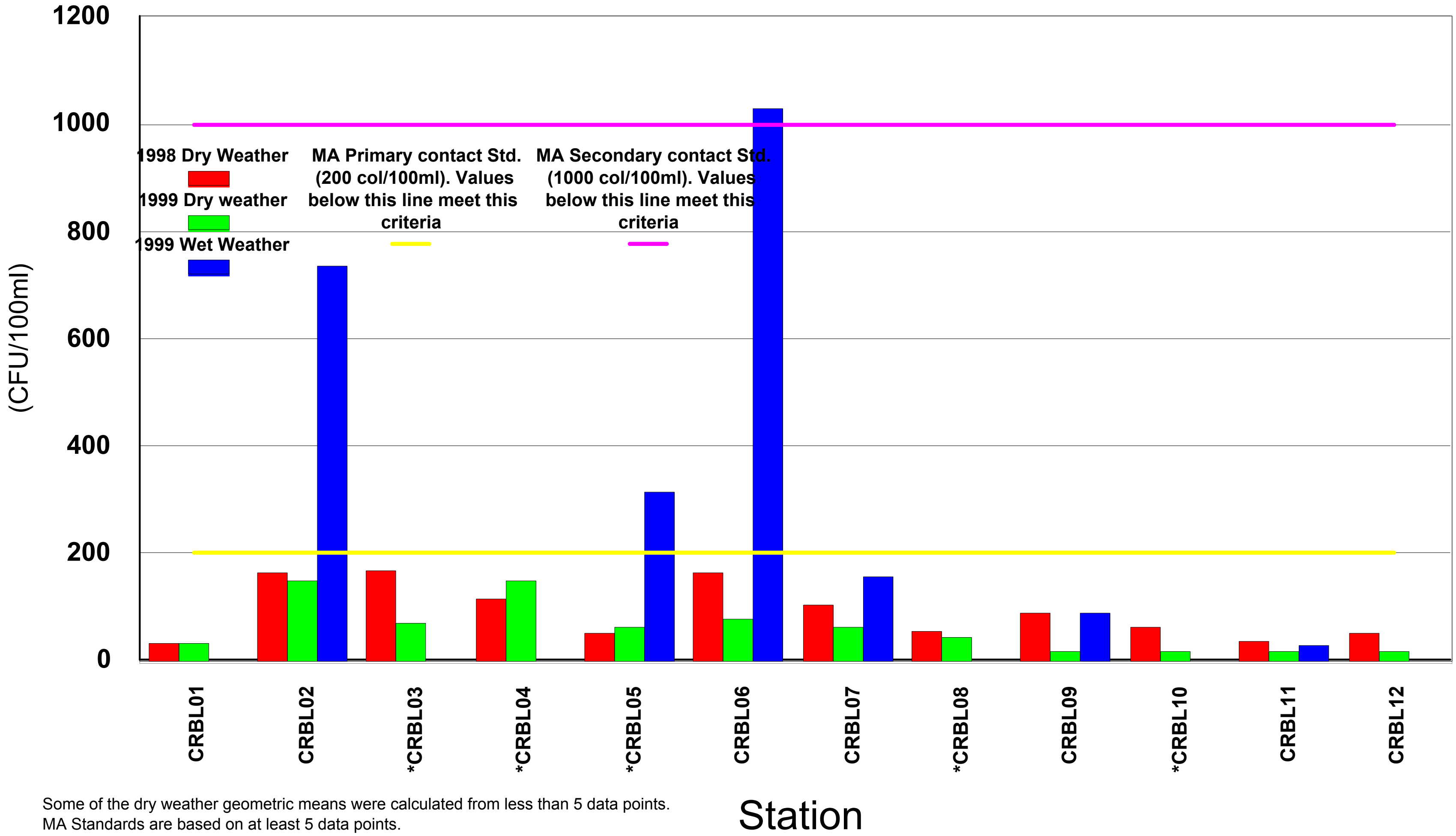
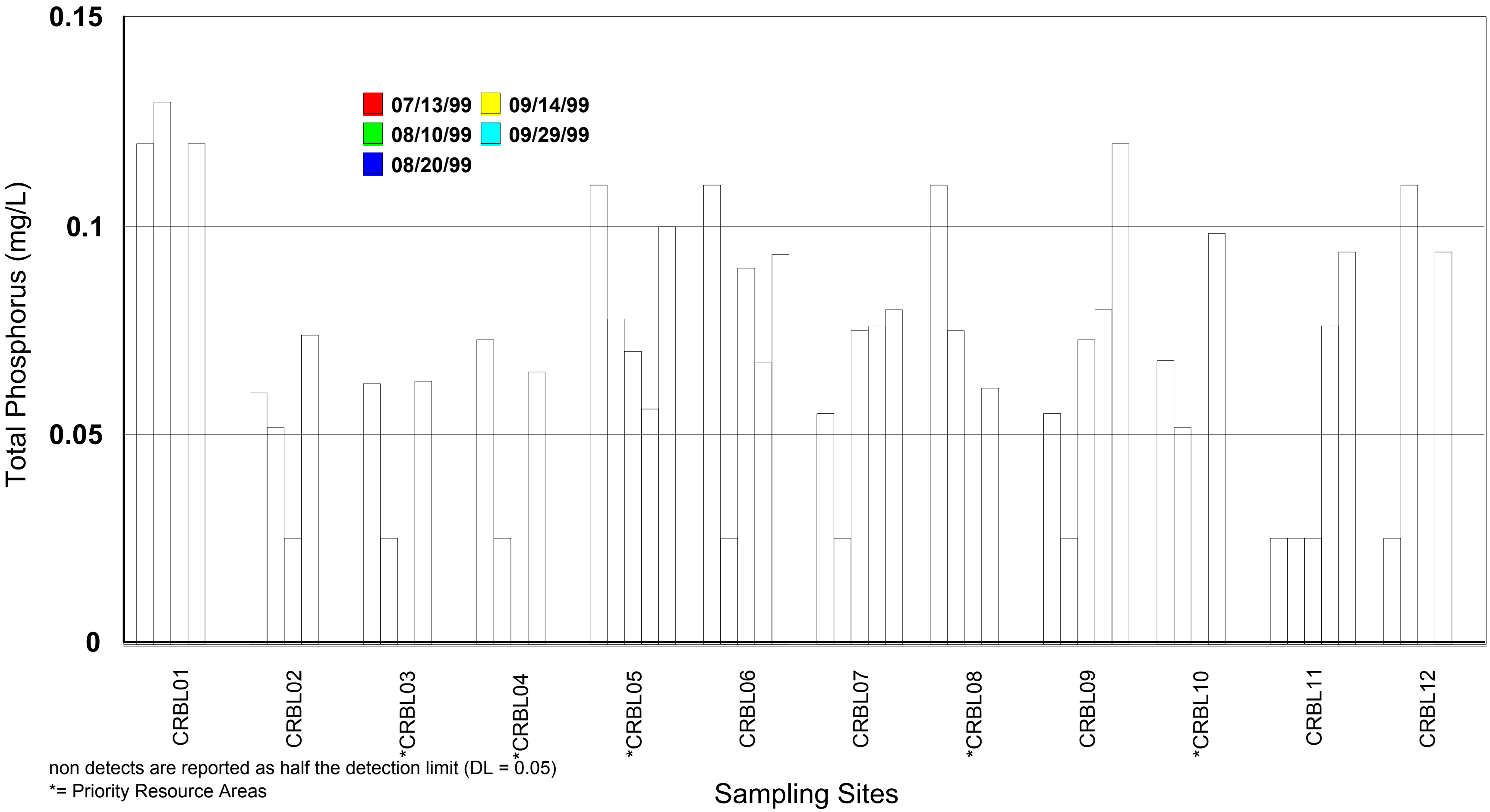
Figure 5: 1998 and 1999 Geometric Mean Fecal Coliform Counts



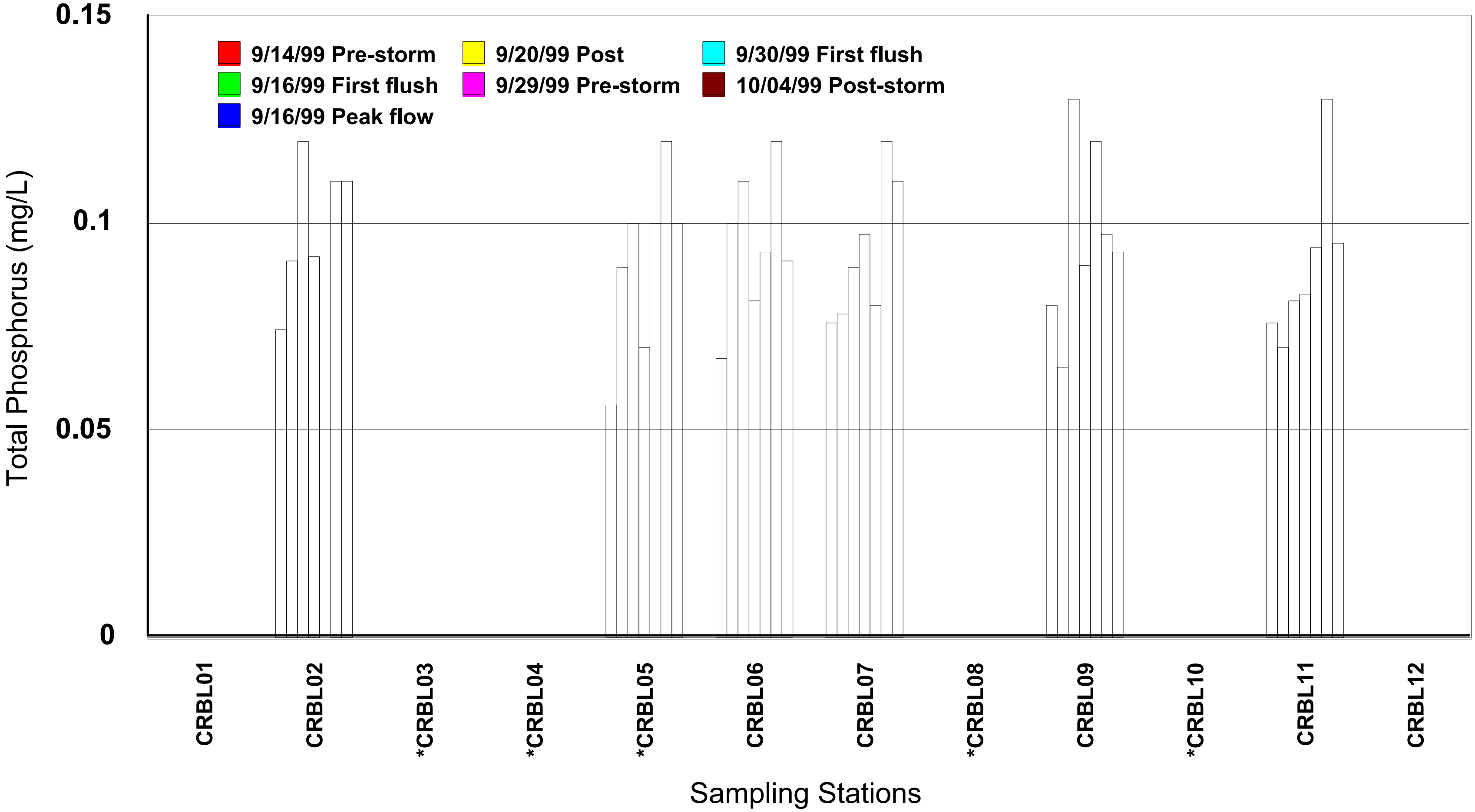
Some of the dry weather geometric means were calculated from less than 5 data points.
MA Standards are based on at least 5 data points.
* = Priority Resource Areas

Figure 6: Total Phosphorus Dry Weather Concentrations at the 12 Core Monitoring Stations



non detects are reported as half the detection limit (DL = 0.05)
*= Priority Resource Areas

Figure 7: Total Phosphorus Wet Weather Concentrations at the 12 Core Monitoring Stations



*= Priority Resource Areas

Table 5: Priority Pollutant Metals Dry Weather Concentrations and the Ambient Water Quality Criteria (AWQC)

STATION	Arsenic Conc. (ug/L)	Arsenic AWQC Acute (ug/L)	Arsenic AWQC Chronic (ug/L)	Cadmium Conc. (ug/L)	Cadmium AWQC Acute (ug/L)	Cadmium AWQC Chronic (ug/L)	Chromium Conc. (ug/L)	Chromium AWQC Acute (ug/L)	Chromium AWQC Chronic (ug/L)	Copper Conc. (ug/L)	Copper AWQC Acute (ug/L)	Copper AWQC Chronic (ug/L)	Lead Conc. (ug/L)	Lead AWQC Acute (ug/L)	Lead AWQC Chronic (ug/L)
Sampling was conducted on 7/13/99 (dry weather)															
CRBL01	0.6	340	150	ND(0.50)	2.2	1.4	ND(0.05)	342	44	1.8	7	5	0.38	32.6	1.3
CRBL02	1.1	340	150	ND(0.50)	2.6	1.6	ND(0.05)	392	51	2.1	9	6	0.78	39.1	1.5
CRBL03	1.0	340	150	ND(0.50)	2.7	1.6	0.2	406	53	2.6	9	6	1.2	41.0	1.6
CRBL04	1.0	340	150	ND(0.50)	3.0	1.8	0.1	437	57	2.6	10	7	0.9	45.3	1.8
CRBL05	1.4	340	150	ND(0.50)	3.5	2.0	0.3	493	64	3.0	11	8	**3.1**	53.2	2.1
CRBL06	1.5	340	150	ND(0.50)	4.0	2.1	0.4	545	71	3.3	13	9	**2.8**	60.8	2.4
CRBL07	1.7	340	150	ND(0.50)	6.1	2.9	0.3	748	97	4.7	18	12	1.8	92.6	3.6
CRBL08	1.6	340	150	ND(0.50)	5.5	2.7	0.4	694	90	4.4	17	11	2.50	83.9	3.3
CRBL09	1.7	340	150	ND(0.50)	6.3	2.9	0.6	767	100	4.9	19	12	1.90	95.6	3.7
CRBL10	1.7	340	150	ND(0.50)	6.6	3.0	0.3	795	103	5.3	20	13	1.6	100.2	3.9
CRBL11	1.7	340	150	ND(0.50)	6.5	3.0	0.3	779	101	5.3	19	12	1.70	97.7	3.8
CRBL12	2.0	340	150	ND(0.50)	8.0	3.4	0.3	920	120	5.9	23	15	1.2	121.3	4.7
Sampling was conducted on 8/10/99 (dry weather)															
CRBL01	0.7	340	150	ND(0.20)	2.3	1.4	ND(0.50)	352	46	1.7	8	5	0.57	33.9	1.3
CRBL02	0.5	340	150	ND(0.20)	2.9	1.7	ND(0.50)	420	55	1.9	9	7	0.25	43.0	1.7
CRBL03	1.0	340	150	ND(0.20)	2.8	1.7	ND(0.50)	418	54	3.5	9	6	0.92	42.7	1.7
CRBL04	1.2	340	150	ND(0.20)	3.1	1.8	ND(0.50)	452	59	2.6	10	7	0.29	47.4	1.8
CRBL05	1.2	340	150	ND(0.20)	3.5	1.9	ND(0.50)	489	64	3.0	11	8	0.28	52.6	2.1
CRBL06	1.3	340	150	ND(0.20)	3.9	2.1	ND(0.50)	533	69	3.5	12	8	0.26	59.1	2.3
CRBL07	1.8	340	150	ND(0.20)	5.7	2.7	ND(0.50)	713	93	4.7	17	11	1.30	86.9	3.4
CRBL08	2.0	340	150	ND(0.20)	5.3	2.6	0.5	675	88	4.3	16	11	0.84	80.8	3.1
CRBL09	1.9	340	150	ND(0.20)	6.5	3.0	ND(0.50)	780	101	5.1	19	12	0.17	97.8	3.8
CRBL10	2.1	340	150	ND(0.20)	6.8	3.1	ND(0.50)	815	106	6.0	20	13	0.15	103.6	4.0
CRBL11	1.8	340	150	ND(0.20)	6.3	2.9	ND(0.50)	769	100	6.1	19	12	0.19	96.0	3.7
CRBL12	2.0	340	150	ND(0.20)	7.2	3.2	ND(0.50)	845	110	6.8	21	14	0.15	108.6	4.2
Sampling was conducted on 8/20/99 (dry weather)															
CRBL02	0.87	340	150	ND(0.05)	2.8	1.7	ND(0.2)	410	53	1.3	9	6	0.3	41.6	1.6
CRBL05	1	340	150	ND(0.05)	4.0	2.1	ND(0.2)	539	70	2.4	13	8	0.18	60.0	2.3
CRBL06	1	340	150	ND(0.05)	5.7	2.7	0.22	712	93	3.8	17	11	0.11	86.7	3.4
CRBL07	1.6	340	150	ND(0.05)	6.0	2.8	0.22	737	96	4.3	18	12	0.09	90.7	3.5
CRBL09	1.8	340	150	ND(0.05)	6.9	3.1	0.24	821	107	5.4	20	13	0.06	104.6	4.1
CRBL11	1.7	340	150	ND(0.05)	7.3	3.2	0.24	854	111	5.2	21	14	0.06	110.2	4.3
Sampling was conducted on 9/14/99 (dry weather)															
CRBL01	ND	340	150	ND (0.20)	1.7	1.2	0.5	288	37	3.6	6	4	0.71	25.8	1.0
CRBL02	0.7	340	150	ND (0.20)	1.9	1.3	0.2	311	40	2.0	7	5	0.88	28.7	1.1
CRBL03	0.8	340	150	ND (0.20)	1.9	1.3	ND (0.20)	313	41	2.2	7	5	1.00	28.8	1.1
CRBL04	0.8	340	150	ND (0.20)	1.9	1.3	ND (0.20)	310	40	2.7	7	5	**1.1**	28.5	1.1
CRBL05	0.8	340	150	ND (0.20)	2.0	1.3	0.3	318	41	2.2	7	5	0.58	29.4	1.1
CRBL06	0.9	340	150	ND (0.20)	2.1	1.4	ND (0.20)	330	43	2.3	7	5	0.64	31.0	1.2
CRBL07	1.1	340	150	ND (0.20)	2.0	1.3	0.3	316	41	2.1	7	5	0.54	29.3	1.1
CRBL08	1.7	340	150	ND (0.20)	5.2	2.5	0.5	658	86	3.6	16	10	0.45	78.2	3.0
CRBL09	1.4	340	150	ND (0.20)	3.2	1.9	0.5	464	60	3.8	11	7	0.22	49.1	1.9
CRBL10	1.6	340	150	ND (0.20)	4.1	2.2	0.5	553	72	6.8	13	9	0.13	62.1	2.4
CRBL11	1.6	340	150	ND (0.20)	4.0	2.1	0.5	543	71	4.3	13	9	0.40	60.6	2.4
CRBL12	1.8	340	150	ND (0.20)	4.8	2.4	0.5	624	81	5.0	15	10	0.14	72.9	2.8

Note:
Accept for Mercury, which is reported as total mercury, all metals concentrations and AWQC criteria are reported as dissolved metals
ND = Not detected above the associated detection limit
(shaded) = Exceeds Chronic Criteria

Table 5: Priority Pollutant Metals Dry Weather Concentrations and the Ambient Water Quality Criteria (AWQC) Cont.

STATION	Mercury Conc. (ug/L)	Mercury AWQC Acute (ug/L)	Mercury AWQC Chronic (ug/L)	Nickel Conc. (ug/L)	Nickel AWQC Acute (ug/L)	Nickel AWQC Chronic (ug/L)	Selenium Conc. (ug/L)	Selenium AWQC Chronic (ug/L)	Silver Conc. (ug/L)	Silver AWQC Acute (ug/L)	Zinc Conc. (ug/L)	Zinc AWQC Acute (ug/L)	Zinc AWQC Chronic (ug/L)
Sampling was conducted on 7/13/99 (dry weather)													
CRBL01	ND(0.005)	1.6	0.91	1.6	276	31	ND(0.25)	5	ND(0.50)	1.2	1.9	69	70
CRBL02	ND(0.005)	1.6	0.91	1.8	318	35	ND(0.25)	5	ND(0.50)	1.6	2.4	79	80
CRBL03	ND(0.005)	1.6	0.91	1.8	330	37	ND(0.25)	5	~0.5	1.7	2.2	82	83
CRBL04	ND(0.005)	1.6	0.91	1.7	356	40	0.5	5	ND(0.50)	2.0	2.4	89	90
CRBL05	0.006	1.6	0.91	1.8	403	45	1.0	5	ND(0.50)	2.5	2.7	101	102
CRBL06	0.006	1.6	0.91	2.0	447	50	1.3	5	ND(0.50)	3.1	3.0	112	113
CRBL07	ND(0.005)	1.6	0.91	2.2	620	69	2.9	5	ND(0.50)	6.1	2.4	155	157
CRBL08	0.011	1.6	0.91	2.3	574	64	2.6	5	ND(0.50)	5.2	1.9	144	145
CRBL09	0.008	1.6	0.91	2.4	636	71	3.2	5	ND(0.50)	6.4	2.5	159	161
CRBL10	ND(0.005)	1.6	0.91	2.2	660	73	3.3	5	ND(0.50)	6.9	2.6	165	167
CRBL11	ND(0.005)	1.6	0.91	2.2	647	72	3.2	5	ND(0.50)	6.7	2.7	162	163
CRBL12	ND(0.005)	1.6	0.91	2.3	768	85	4.2	5	ND(0.50)	9.4	2.8	192	194
Sampling was conducted on 8/10/99 (dry weather)													
CRBL01	ND(0.005)	1.6	0.91	1.6	285	32	ND(2.5)	5	ND(0.20)	1.3	12.4*	71	72
CRBL02	ND(0.005)	1.6	0.91	1.6	342	38	ND(2.5)	5	ND(0.20)	1.8	3.3*	86	86
CRBL03	ND(0.005)	1.6	0.91	1.6	340	38	ND(2.5)	5	ND(0.20)	1.8	10.0*	85	86
CRBL04	ND(0.005)	1.6	0.91	1.7	369	41	ND(2.5)	5	ND(0.20)	2.1	10.5*	92	93
CRBL05	ND(0.005)	1.6	0.91	1.6	399	44	ND(2.5)	5	ND(0.20)	2.5	1.0*	100	101
CRBL06	ND(0.005)	1.6	0.91	1.6	437	49	ND(2.5)	5	ND(0.20)	3.0	1.1*	109	110
CRBL07	ND(0.005)	1.6	0.91	1.7	590	66	3.0	5	ND(0.20)	5.5	2.5*	148	149
CRBL08	ND(0.005)	1.6	0.91	1.8	558	62	2.7	5	ND(0.20)	4.9	1.0*	140	141
CRBL09	ND(0.005)	1.6	0.91	1.7	648	72	3.4	5	ND(0.20)	6.7	1.2*	162	163
CRBL10	ND(0.005)	1.6	0.91	1.7	678	75	4.0	5	ND(0.20)	7.3	1.4*	170	171
CRBL11	ND(0.005)	1.6	0.91	1.6	638	71	3.4	5	ND(0.20)	6.5	0.9*	160	161
CRBL12	ND(0.005)	1.6	0.91	1.6	704	78	4.1	5	ND(0.20)	7.9	1.2*	176	178
Sampling was conducted on 8/20/99 (dry weather)													
CRBL02	ND(0.005)	1.6	0.91	1.4	334	37	0.4	5	ND(0.20)	1.7	ND(10.0)	83	84
CRBL05	ND(0.005)	1.6	0.91	1.3	442	49	1.2	5	ND(0.20)	3.1	ND(10.0)	111	112
CRBL06	ND(0.005)	1.6	0.91	1.4	589	65	2.6	5	ND(0.20)	5.5	ND(10.0)	147	149
CRBL07	ND(0.005)	1.6	0.91	1.4	611	68	2.8	5	ND(0.20)	5.9	ND(10.0)	153	154
CRBL09	ND(0.005)	1.6	0.91	1.4	683	76	3.3	5	ND(0.20)	7.4	ND(10.0)	171	172
CRBL11	ND(0.005)	1.6	0.91	1.5	712	79	3.5	5	ND(0.20)	8.1	ND(10.0)	178	180
Sampling was conducted on 9/14/99 (dry weather)													
CRBL01	0.012	1.6	0.91	1.6	232	26	ND (1.0)	5	ND (0.20)	0.8	12.4*	58	58
CRBL02	0.01	1.6	0.91	1.4	251	28	ND (1.0)	5	ND (0.20)	1.0	2.8*	63	63
CRBL03	0.009	1.6	0.91	1.4	252	28	ND (1.0)	5	ND (0.20)	1.0	14.4*	63	64
CRBL04	0.011	1.6	0.91	1.3	250	28	ND (1.0)	5	ND (0.20)	1.0	2.9*	62	63
CRBL05	0.008	1.6	0.91	1.3	256	28	ND (1.0)	5	ND (0.20)	1.0	2.5*	64	65
CRBL06	0.011	1.6	0.91	1.3	266	30	ND (1.0)	5	ND (0.20)	1.1	2.5*	67	67
CRBL07	0.009	1.6	0.91	1.3	255	28	ND (1.0)	5	ND (0.20)	1.0	2.8*	64	64
CRBL08	0.008	1.6	0.91	1.6	543	60	3.0	5	ND (0.20)	4.7	1.4*	136	137
CRBL09	0.009	1.6	0.91	1.5	379	42	1.7	5	ND (0.20)	2.2	4.7*	95	96
CRBL10	0.007	1.6	0.91	1.5	454	50	2.3	5	ND (0.20)	3.2	6.0*	114	115
CRBL11	0.008	1.6	0.91	1.6	446	50	2.4	5	ND (0.20)	3.1	6.4*	112	112
CRBL12	0.011	1.6	0.91	1.5	515	57	3.0	5	ND (0.20)	4.2	6.1*	129	130

Note:
Accept for Mercury, which is reported as total mercury, all metals concentrations and AWQC criteria are reported as dissolved metals
ND = Not detected above the associated detection limit
= Exceeds Chronic Criteria
~ = Estimated data
* = Reported as maximum values, because of an elevated trip blank

Table 6: Priority Pollutant Metals Wet Weather Concentrations and the Ambient Water Quality Criteria (AWQC)

STATION	Arsenic Conc. (ug/L)	Arsenic AWQC Acute (ug/L)	Arsenic AWQC Chronic (ug/L)	Cadmium Conc. (ug/L)	Cadmium AWQC Acute (ug/L)	Cadmium AWQC Chronic (ug/L)	Chromium Conc. (ug/L)	Chromium AWQC Acute (ug/L)	Chromium AWQC Chronic (ug/L)	Copper Conc. (ug/L)	Copper AWQC Acute (ug/L)	Copper AWQC Chronic (ug/L)	Lead Conc. (ug/L)	Lead AWQC Acute (ug/L)	Lead AWQC Chronic (ug/L)
Sampling was conducted on 9/16/99 (wet weather-first flush)															
CRBL02	0.8	340	150	ND (0.20)	2.0	1.3	0.3	318	41	2.2	7	5	1.00	29.6	1.2
CRBL05	0.9	340	150	ND (0.20)	2.1	1.4	ND	329	43	2.1	7	5	**1.40**	30.9	1.2
CRBL06	0.9	340	150	ND (0.20)	2.1	1.4	0.2	331	43	2.0	7	5	**1.30**	31.1	1.2
CRBL07	0.9	340	150	ND (0.20)	2.0	1.3	ND	322	42	1.9	7	5	0.68	30.0	1.2
CRBL09	1.3	340	150	ND (0.20)	3.2	1.8	0.3	455	59	2.8	10	7	0.12	47.8	1.9
CRBL11	1.3	340	150	ND (0.20)	3.2	1.8	0.4	456	59	2.9	10	7	0.14	48.0	1.9
Sampling was conducted on 9/16/99 (wet weather peak flow)															
CRBL02	0.9	340	150	ND (0.20)	1.6	1.1	0.6	271	35	2.5	6	4	**1.60**	23.7	0.9
CRBL05	1.0	340	150	ND (0.20)	2.0	1.3	ND (0.5)	320	42	2.6	7	5	**2.70**	29.8	1.2
CRBL06	1.0	340	150	ND (0.20)	2.2	1.4	ND (0.5)	341	44	2.2	7	5	1.10	32.5	1.3
CRBL07	1.2	340	150	ND (0.20)	2.9	1.7	ND (0.5)	426	55	2.3	10	7	0.19	43.8	1.7
CRBL09	1.4	340	150	ND (0.20)	3.3	1.9	ND (0.5)	470	61	2.6	11	7	0.36	50.0	1.9
CRBL11	1.2	340	150	ND (0.20)	3.1	1.8	ND (0.5)	443	58	3.0	10	7	0.15	46.1	1.8
Sampling was conducted on 9/20/99 (wet weather post-storm)															
CRBL02	ND (5.0)	340	150	ND (0.20)	1.9	1.3	0.7	306	40	3.1	7	5	**2.10**	28.0	1.1
CRBL05	ND (5.0)	340	150	ND (0.20)	1.9	1.3	0.7	305	40	3.3	7	5	**2.50**	27.9	1.1
CRBL06	ND (5.0)	340	150	ND (0.20)	1.8	1.3	0.6	302	39	3.2	6	5	**2.60**	27.5	1.1
CRBL07	ND (5.0)	340	150	ND (0.20)	2.0	1.3	0.6	324	42	3.0	7	5	**1.80**	30.3	1.2
CRBL09	ND (5.0)	340	150	ND (0.20)	2.5	1.6	0.7	384	50	3.4	9	6	1.20	38.1	1.5
CRBL11	ND (5.0)	340	150	ND (0.20)	2.5	1.6	0.7	383	50	3.2	9	6	1.10	38.0	1.5
Sampling was conducted on 9/29/99 (wet weather pre-storm)															
CRBL02	0.9	340	150	ND(0.50)	1.9	1.3	0.5	313	41	2.8	7	5	**2.10**	28.8	1.1
CRBL05	0.9	340	150	ND(0.50)	1.9	1.3	0.6	308	40	3.8	7	5	**3.00**	28.2	1.1
CRBL06	1.0	340	150	ND(0.50)	1.9	1.3	0.6	307	40	3.6	7	5	**3.10**	28.2	1.1
CRBL07	1.1	340	150	ND(0.50)	2.2	1.4	ND(0.50)	347	45	3.5	8	5	**2.20**	33.3	1.3
CRBL09	1.0	340	150	ND(0.50)	2.2	1.4	ND(0.50)	351	46	3.5	8	5	**2.10**	33.7	1.3
CRBL11	1.1	340	150	ND(0.50)	2.4	1.5	ND(0.50)	365	48	3.9	8	6	**2.10**	35.6	1.4
Sampling was conducted on 9/30/99 (wet weather-first flush)															
CRBL02	0.9	340	150	ND (0.50)	2.0	1.3	0.6	321	42	2.9	7	5	**2.20**	29.9	1.2
CRBL05	0.9	340	150	ND (0.50)	1.9	1.3	0.6	310	40	3.4	7	5	**3.90**	28.5	1.1
CRBL06	0.9	340	150	ND (0.50)	1.9	1.3	0.6	313	41	3.4	7	5	**3.90**	28.8	1.1
CRBL07	0.9	340	150	ND (0.50)	2.3	1.5	ND (0.50)	362	47	3.6	8	6	**2.40**	35.2	1.4
CRBL09	1.0	340	150	ND (0.50)	2.4	1.5	ND (0.50)	363	47	4.0	8	6	**2.00**	35.3	1.4
CRBL11	1.1	340	150	ND (0.50)	2.5	1.5	0.5	378	49	3.7	8	6	**2.00**	37.3	1.5
Sampling was conducted on 10/4/99 (wet weather post-storm)															
CRBL02	ND (2.0)	340	150	ND (0.20)	2.2	1.4	ND (2.0)	343	45	2.8	8	5	**2.00**	32.7	1.3
CRBL05	ND (2.0)	340	150	ND (0.20)	2.1	1.4	ND (2.0)	335	44	4.0	7	5	**3.40**	31.7	1.2
CRBL06	ND (2.0)	340	150	ND (0.20)	2.3	1.5	ND (2.0)	354	46	3.6	8	5	**3.10**	34.1	1.3
CRBL07	ND (2.0)	340	150	ND (0.20)	2.6	1.6	ND (2.0)	391	51	3.6	9	6	**2.30**	39.0	1.5
CRBL09	ND (2.0)	340	150	ND (0.20)	3.0	1.7	ND (2.0)	434	56	4.4	10	7	**1.80**	44.9	1.7
CRBL11	ND (2.0)	340	150	ND (0.20)	3.0	1.7	ND (2.0)	433	56	4.6	10	7	**1.70**	44.7	1.7

Note:
Accept for Mercury, which is reported as total mercury, all metals concentrations and AWQC criteria are reported as dissolved metals
ND = Not detected above the associated detection limit
[shaded] = Exceeds Chronic Criteria

Table 6: Priority Pollutant Metals Wet Weather Concentrations and the Ambient Water Quality Criteria (AWQC) cont.

STATION	Mercury Conc. (ug/L)	Mercury AWQC Acute (ug/L)	Mercury AWQC Chronic (ug/L)	Nickel Conc. (ug/L)	Nickel AWQC Acute (ug/L)	Nickel AWQC Chronic (ug/L)	Selenium Conc. (ug/L)	Selenium AWQC Chronic (ug/L)	Silver Conc. (ug/L)	Silver AWQC Acute (ug/L)	Zinc Conc. (ug/L)	Zinc AWQC Acute (ug/L)	Zinc AWQC Chronic (ug/L)
Sampling was conducted on 9/16/99 (wet weather-first flush)													
CRBL02	0.01	1.6	0.91	1.6	257	29	ND (1.0)	5	ND (0.20)	1.0	5.5	64	65
CRBL05	0.011	1.6	0.91	1.4	266	30	ND (1.0)	5	ND (0.20)	1.1	10.1	66	67
CRBL06	0.026	1.6	0.91	1.4	267	30	ND (1.0)	5	ND (0.20)	1.1	3.6	67	67
CRBL07	0.008	1.6	0.91	1.2	260	29	ND (1.0)	5	ND (0.20)	1.0	2.8	65	66
CRBL09	0.007	1.6	0.91	1.3	371	41	ND (1.0)	5	ND (0.20)	2.1	13.2	93	94
CRBL11	0.006	1.6	0.91	1.4	372	41	ND (1.0)	5	ND (0.20)	2.2	11.2	93	94
Sampling was conducted on 9/16/99 (wet weather peak flow)													
CRBL02	0.023	1.6	0.91	1.4	217	24	ND (1.0)	5	ND (0.50)	0.7	10.5	54	55
CRBL05	0.016	1.6	0.91	1.7	258	29	ND (1.0)	5	ND (0.50)	1.0	7.9	65	65
CRBL06	0.017	1.6	0.91	1.4	276	31	ND (1.0)	5	ND (0.50)	1.2	3.3	69	70
CRBL07	0.012	1.6	0.91	1.3	347	39	1.0	5	ND (0.50)	1.9	2.6	87	87
CRBL09	0.01	1.6	0.91	1.4	384	43	1.5	5	ND (0.50)	2.3	4.2	96	97
CRBL11	0.009	1.6	0.91	1.4	361	40	1.2	5	ND (0.50)	2.0	3.4	90	91
Sampling was conducted on 9/20/99 (wet weather post-storm)													
CRBL02	0.013	1.6	0.91	1.6	246	27	ND (10.0)	5	ND (0.20)	0.9	16.4	62	62
CRBL05	0.012	1.6	0.91	1.6	245	27	ND (10.0)	5	ND (0.20)	0.9	6.9	61	62
CRBL06	0.012	1.6	0.91	1.5	243	27	ND (10.0)	5	ND (0.20)	0.9	6.6	61	61
CRBL07	0.01	1.6	0.91	1.4	262	29	ND (10.0)	5	ND (0.20)	1.1	12.6	65	66
CRBL09	0.008	1.6	0.91	1.6	312	35	ND (10.0)	5	ND (0.20)	1.5	6.9	78	79
CRBL11	0.022	1.6	0.91	1.4	311	35	ND (10.0)	5	ND (0.20)	1.5	6.8	78	78
Sampling was conducted on 9/29/99 (wet weather pre-storm)													
CRBL02	0.008	1.6	0.91	1.6	252	28	ND(1.0)	5	ND(0.20)	1.0	7.0	63	64
CRBL05	0.008	1.6	0.91	1.7	248	28	ND(1.0)	5	ND(0.20)	0.9	6.6	62	62
CRBL06	0.011	1.6	0.91	1.6	247	27	ND(1.0)	5	ND(0.20)	0.9	7.3	62	62
CRBL07	0.006	1.6	0.91	1.7	281	31	ND(1.0)	5	ND(0.20)	1.2	7.0	70	71
CRBL09	0.006	1.6	0.91	1.7	284	32	ND(1.0)	5	ND(0.20)	1.2	6.9	71	72
CRBL11	0.007	1.6	0.91	1.6	296	33	ND(1.0)	5	ND(0.20)	1.4	7.0	74	75
Sampling was conducted on 9/30/99 (wet weather-peak flow)													
CRBL02	0.008	1.6	0.91	1.6	259	29	ND (1.0)	5	ND (0.20)	1.0	7.5	65	65
CRBL05	0.012	1.6	0.91	1.7	250	28	ND (1.0)	5	ND (0.20)	1.0	6.4	62	63
CRBL06	0.015	1.6	0.91	1.7	252	28	ND (1.0)	5	ND (0.20)	1.0	6.1	63	64
CRBL07	0.009	1.6	0.91	1.6	293	33	ND (1.0)	5	ND (0.20)	1.3	6.5	73	74
CRBL09	0.008	1.6	0.91	1.7	294	33	ND (1.0)	5	ND (0.20)	1.3	6.9	74	74
CRBL11	0.007	1.6	0.91	1.7	307	34	ND (1.0)	5	ND (0.20)	1.5	7.0	77	77
Sampling was conducted on 10/4/99 (wet weather post-storm)													
CRBL02	0.006	1.6	0.91	ND (2.0)	277	31	ND (2.5)	5	ND (0.20)	1.2	5.6	69	70
CRBL05	0.009	1.6	0.91	ND (2.0)	271	30	ND (2.5)	5	ND (0.20)	1.1	6.5	68	68
CRBL06	0.01	1.6	0.91	ND (2.0)	286	32	ND (2.5)	5	ND (0.20)	1.3	6.6	72	72
CRBL07	0.007	1.6	0.91	ND (2.0)	317	35	ND (2.5)	5	ND (0.20)	1.6	8.2	79	80
CRBL09	0.008	1.6	0.91	ND (2.0)	353	39	ND (2.5)	5	ND (0.20)	1.9	7.0	88	89
CRBL11	0.006	1.6	0.91	ND (2.0)	352	39	ND (2.5)	5	ND (0.20)	1.9	6.8	88	**89**

Note:
Accept for Mercury, which is reported as total mercury, all metals concentrations and AWQC criteria are reported as dissolved metals
ND = Not detected above the associated detection limit
= Exceeds Chronic Criteria

7.0 REFERENCES

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APPENDIX
Charles River 1999 Core Monitoring Data Report

Charles River Data Report

In 1995, EPA established the Clean Charles 2005Initiative to restore the Charles River Basin to a swimmable and fishable condition by Earth Day in 2005. The Initiative has a developing strategy to provide a comprehensive approach for improving water quality through: Combined Sewer Overflow (CSO) controls, illicit sanitary connection removal, stormwater management planning and implementation, public outreach, education, enforcement and technical assistance.

EPA's Office of Environmental Measurement and Evaluation (OEME) has initiated a water quality study (EPA Clean 2005 Core Monitoring Program) that will continue until 2005. EPA and it's partners in the Clean 2005 Water Quality subcommittee developed the study design in order to track improvements in the Charles River Basin (defined as the section between the Watertown Dam and the New Charles River Dam) and to identify where further pollution reductions or remediation actions are necessary in order to meet the swimmable and fishable goals. In order to further identify impairment areas, and to evaluate storm water management techniques, EPA is supporting several other water quality studies in the Charles River.

In 1999, OEME conducted the second year of the EPA Clean 2005 Core Monitoring Program. Twelve stations were monitored during dry weather conditions. The South Natick Dam was the most upstream station and was the only site located outside of the Basin. Six of the twelve stations were monitored during wet weather conditions. The study included measurements of dissolved oxygen, temperature, pH, specific conductance, apparent & true color, clarity, turbidity, nutrients, metals and bacteria. In addition acute toxicity was also tested during a wet weather event.

Station Descriptions

Primary Stations	Station #
Downstream of S. Natick Dam	CRBL01
Upstream of Watertown Dam	CRBL02
Daly Field, 10 m off south bank	**CRBL03**
Herter East Park, 10 m off south bank	**CRBL04**
Magazine Beach, 10 m off north bank	**CRBL05**
Downstream of BU Bridge, main stem	CRBL06
Downstream of Stony Brook & Mass Ave, 10 m off S. shore	CRBL07
Pond at Esplanade	**CRBL08**
Upstream of Longfellow Bridge, Cam. side	CRBL09
Community boating Area	**CRBL10**
Between Longfellow Bridge & Old Dam	CRBL11
Upstream of railroad Bridge	CRBL12
Supplemental Sampling Stations Used	
Mouth of Laundry Brook	EPCT01
Mouth of Faneuil Brook	EPCT02
Mouth of Muddy River	MUDD01
Plume of Cottage Farm CSO - under the BU Bridge	BUDRID
200 m upstream of BU Bridge & 10 m off south bank	CRBL4S
100 m downstream of River St Bridge & 10 m off south bank	CRBL5S
Between Museum of Science and Longfellow Bridge 10m of south bank	CRBL11S

Bold = Priority Resource areas

List of Tables and Figures