Clean Charles 2005 Water Quality Report
2003 Core Monitoring Program
November 2004

Charles River near Faneuil Valley Brook , Boston

Prepared By

US EPA

Office of Environmental Measurement and Evaluation

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

TABLE

FIGURES

APPENDIX

EXECUTIVE SUMMARY

Purpose and Scope

In 1995, the U.S. 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 incorporates a comprehensive approach for improving water quality through: Combined Sewer Overflow (CSO) controls, illicit sanitary connection removals, stormwater management, public outreach, education, monitoring, enforcement, technical assistance, and the development of a Total Maximum Daily Load (TMDL) for the basin.

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 to meet the Clean Charles 2005 Initiative goals. The program is designed to sample during the summer months that coincide with peak recreational uses.

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). Five of the ten sampling stations are located in priority resource areas, which are identified as potential wading and swimming locations (see attachment). Six of the twelve stations are monitored during wet weather conditions. The Core Monitoring Program measures the following parameters: dissolved oxygen, temperature, pH, specific conductance, turbidity, clarity, transmissivity, chlorophyll a, total organic carbon, total suspended solids, apparent and true color, nutrients, bacteria, and dissolved metals.

Conclusions of the 2003 Core Monitoring Program

The conclusions below summarize the 2003 Core Monitoring Program data and the water quality conditions from 1998 to 2003. A more comprehensive statistical analysis will be conducted in future reports, as more data are available.

In addition to point source and non-point source pollutant loadings, water quality was influenced by yearly fluctuations in weather and river flows, making short-term trends difficult to determine. The weather conditions and river flow affect the transport of pollutants in the watershed.

In 2003, from June to the beginning of September flows were higher than the drier years of 1999 and 2002. In general, the flows were similar to the flow record during 1998. In 1998, the summer conditions were generally wetter with correspondingly higher flows.

One wet and three dry weather events were sampled from July through September 2003. Since weather conditions and weather forecasting allowed for only one wet weather event to be sampled in 2003, the amount of data collected was less than that of previous years. When comparing these data to the past five years' data, the following conclusions can be made. The six years of data show a pattern of the best water quality occurring near the mouth of the River (Mass Ave. Bridge to the New Charles River Dam). This part of the river met the swimming standards more often than any other part of the Basin.

The greatest clarity was recorded during the lower flow years of 1999 and 2002 at the stations near the mouth of the Basin. Past monitoring has measured elevated nutrient concentrations in the water below the pycnocline. Elevated levels of bacteria exist in the upper part of the basin. The station above the Watertown Dam has the highest dry weather geometric mean of all stations using the data from 1998-2003. Stations above the Watertown Dam and at Magazine Beach have shown a yearly increase in bacteria levels five out of the six years.

Clarity, Color and Transmissivity

Water clarity was directly measured in the field using a Secchi disk. Mean Secchi disk readings downstream of Magazine Beach were less than the means from the drier years of 1999 and 2002 and greater than the means from 1998. Generally, the greatest clarity was recorded between the Esplanade and the New Charles River Dam. Forty six percent of samples in this area met the Massachusetts Department of Environmental Protections primary contact (swimming) use support criterion of greater than or equal to 1.2 meters. The lowest clarity was measured at most of the stations during the September 9 sampling event. Based on the data collected over the last six years, the most downstream station (upstream of the New Charles River Dam) met the MA DEP swimming criterion over 80% of the time, while the station at Magazine beach met the criterion less than 15% of the time.

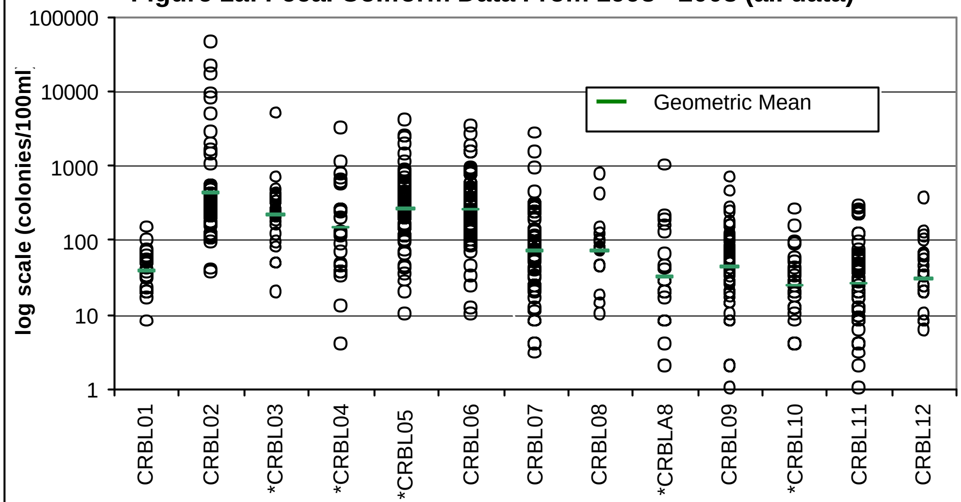
Transmissivity, a measurement of water clarity, which is independent of external light, was measured at all stations. The greatest transmissivity was recorded at stations upstream of the Watertown and South Natick Dams during September. As with Secchi disk readings, transmissivity values show increased clarity downstream from the Esplanade.

True and apparent color were additional measurements used to evaluate water clarity. The highest true and apparent color values were measured during July 8 and decreased throughout the summer. This relationship was also observed during previous years. Mean True color values were generally higher than mean values from previous years. As identified in a previous report (EPA 2003), 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 water clarity.

Bacteria

During dry weather, approximately 35% of the core monitoring fecal coliform samples exceeded the swimming criterion[1] of less than 200 colonies/100ml, (compared to 31%, 35%, 23%, 8%, and 17% in 2002, 2001, 2000, 1999 and 1998, respectively). Although the number of wet weather samples that exceeded criterion[1] of less than 200 colonies/100ml was similar to that of previous years, these data were not presented because the data set was limited to only one wet weather sampling event in 2003.

Figure 1a: Fecal Coliform Data From 1998 - 2003 (all data)



* = Priority Resource Area
Only stations 02,05,06,07,A8,09, and 11 include wet weather data

---

1 The Massachusetts fecal coliform swimming criterion of less than 200 colonies/100ml is actually based on a geometric mean of five samples or more. For this report, individual concentrations were compared to this criterion.

Fecal coliform concentrations were lower near the mouth of the Basin (Mass Ave. Bridge to the New Charles River Dam; CRBL07 - CRBL12). This is a consistent trend, which has occurred in the previous five years of data collection (Figure 1a). During 2003, the dry weather Core Monitoring samples collected at stations CRBL07 - CRBL12 exceeded the swimming criterion[1] 9% of the time. Upstream at stations CRBL02 – CRBL06 the criterion[1] was exceeded 76% of the time during dry weather. The area from station CRBL07-CRBL12 is the most heavily recreated part of the River. The area contains the MIT (Massachusetts Institute of Technology) Sailing Pavilion and Community Boating where much sailing, kayaking, windsurfing, and occasional contact with the water occurs.

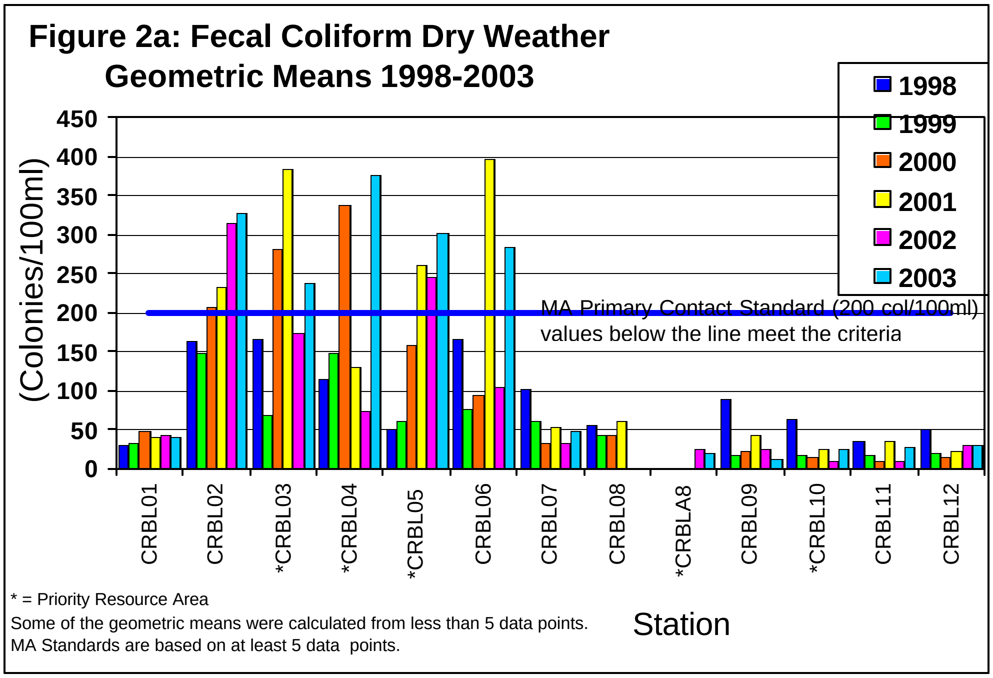


Figure 2a: Fecal Coliform Dry Weather Geometric Means 1998-2003

The 2003 dry weather fecal coliform geometric means[2] were similar to those collected during previous years. At station CRBL02, the geometric means[2] have increased over the past four years (Figure 2a). At station CRBL05, with the exception of 2002, each year the geometric mean has increased. The cause of this increase has not been identified, although a growing population of geese observed at this station, likely contributes to the bacteria contamination.

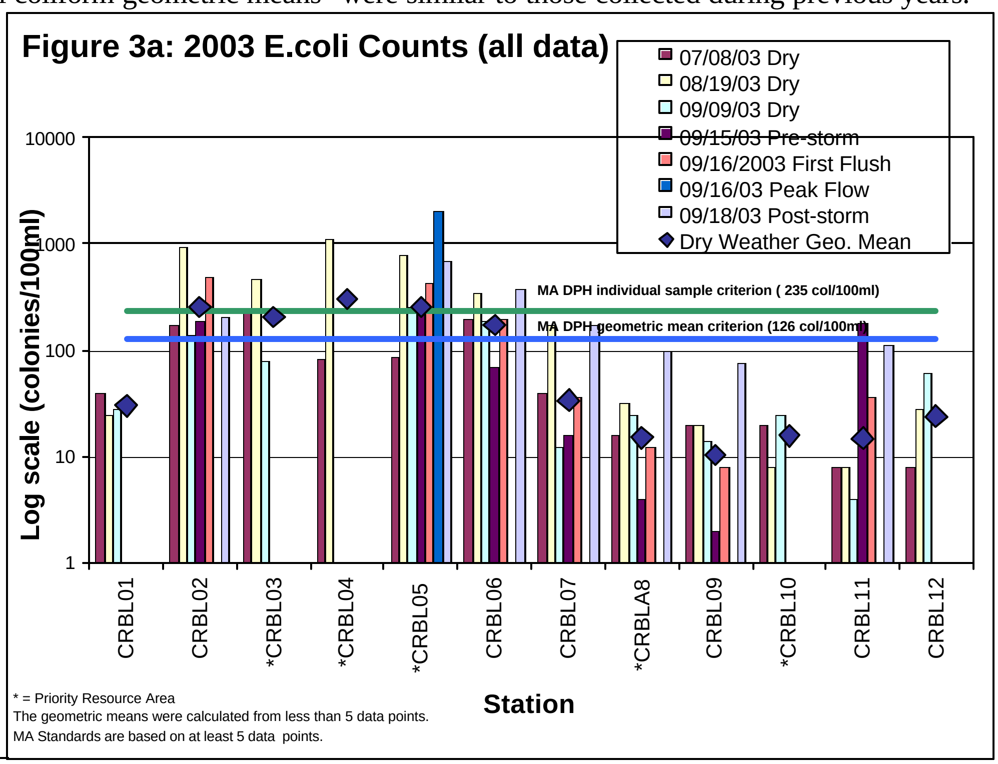


Figure 3a: 2003 E.coli Counts (all data)

E. coli bacteria was sampled during all sampling events. As

[1]The Massachusetts fecal coliform swimming criterion of less than 200 colonies/100ml is actually based on a geometric mean of five samples or more. For this report, individual concentrations were compared to this criterion.

[2]Some of the dry weather geometric means were calculated from less than five data points; the actual criterion is based on a geometric mean of five samples or more.

observed with the fecal coliform measurements, the E. coli concentrations were lower near the mouth of the Basin (Mass Ave. Bridge to the New Charles River Dam; CRBL07 - CRBL12). For these Core Monitoring stations, all calculated dry weather geometric means[1] and all individual sample results met the Department of Public Health (DPH) Bathing Beach criterion[2] (Figure 3a). During dry weather, at stations CRBL02 – CRBL06, the single sample criterion was exceeded 35% of the time and the geometric mean criterion[2] was exceeded 100% of the time at all five stations (Figure 3a). Six or approximately 14% of all dry weather core monitoring samples exceeded the E. coli bathing beach criterion for a single sample[2] (compared to 17% in 2002, 19% in 2001 and 35% in 1998).

Dissolved Oxygen (DO), pH and Temperature

Dissolved Oxygen (DO) is required for a healthy ecosystem. Fish and other aquatic organisms require DO for survival . Massachusetts has established DO criterion[3] for class B waters. No DO violations were measured during 2003 (compared to 1%, 0%, 0%, 3%, and 0% in 2002, 2001, 2000, 1999, and 1998, respectively).

The pH of an aquatic system is an important parameter in evaluating toxicity. High acidity (a low pH) can convert insoluble metal sulfides to soluble forms, which increases the bioavailability. A high pH can cause ammonia toxicity (EPA 1998). The data from all the dry and wet weather core monitoring surface measurements showed pH violated the criterion[3] eight times or approximately 14% of all field measurements (compared to 22%, 18%, 20%, 8%, and 4% in 2002, 2001, 2000, 1999, and 1998, respectively). All surface violations were greater than 8.3 and occurred during September.

Temperature is a crucial factor in maintaining a natural ecosystem. Changes in the temperature can alter the existing or natural aquatic community (EPA 1986). Temperature also governs many biochemical and physiological processes in cold-blooded aquatic organisms. Increased temperature decreases the oxygen solubility in water resulting in increased stress from oxygen-demanding waste (EPA 1998). The highest surface water temperature was recorded on July 8 at Magazine Beach (CRBL05) and downstream of the Mass Ave Bridge (CRBL07) at 29.3 ^{o}C. (84.7^{o}F). There were seven recorded temperature measurements above the state criterion[3]. All of these measurements occurred on July 8.

Nutrients

Phosphorus was the most significant nutrient in this system. Elevated phosphorus concentrations at many of the sampling stations indicated highly eutrophic conditions. All except one of the sample results exceeded the EPA recommended Ambient Water Quality Criteria for Rivers and Streams and all samples results exceeded the recommended criteria for lakes and reservoirs (EPA, 2001). Each station recorded the highest concentration during the July or August sampling events. The dry weather means were higher than last years means at eleven of the twelve stations, although, at most stations, concentrations were not elevated when compared to all previous years' means. In 2002, additional samples were collected at various depths to support the development of a water quality model for the Total Maximum Daily Load (TMDL). The results from this sampling showed elevated concentrations of total phosphorus, ortho-phosphorous, total kjeldahl nitrogen, and ammonia below the pycnocline (the interface between water of different densities).

Metals

No metals exceeded the acute Ambient Water Quality Criteria (AWQC). Lead and copper were the only metals that exceeded the chronic AWQC. Copper exceeded the criteria once and lead exceeded the criteria 24 times. One of these excedances occurred during wet weather, this exceedance occurred for lead. Approximately, 50%

---

1 Some of the dry weather geometric means were calculated from less than five data points; the actual criterion is based on a geometric mean of five samples or more.

2 The Massachusetts DPH E. coli Bathing Beach criterion for as single sample is less than or equal to 235 colonies/100ml. The geometric mean criterion is less than or equal to 126 colonies/100ml and is based on a geometric mean of the most recent five samples within the same bathing season.

3 The Massachusetts water quality criteria for Class B water for DO is $\geq$ 5 mg/l and $\geq$60% saturation, for pH is in the range of 6.5 through 8.3, and for temperature is $\leq$ 28.3^{o}C (83^{o}F).

of the dry weather lead samples exceeded the chronic criteria (compared to 21%, 33%, 27%, and 8% in 2002, 2001, 2000, and 1999, respectively). There is no explanation for this increase in 2003. The other measured priority pollutants metals (arsenic, cadmium, chromium, copper, mercury, nickel, selenium, silver, and zinc) did not exceed the AWQC.

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 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 CSO's. An EPA survey identified over 100 outfall pipes in the Basin (EPA 1996).

3.0 INTRODUCTION

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, technical assistance, and scientific studies.

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 included 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 management techniques.

EPA'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 condition, 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 core monitoring sampling stations, TMDL sampling stations, priority resource areas, CSO's, and stormwater discharge pipes. Table 1 describes the stations monitored in 2003.

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. In 2000, the analyte list was unchanged.

In 2001, transmissivity was added as an additional measurement of water clarity. In addition, E. coli bacteria was added and enterococcus bacteria was discontinued. This modification was made to reflect the changes to the Massachusetts Department of Public Health (DPH) Minimum Standards for Bathing Beaches regulations, which allowed the use of E. coli bacteria for determining compliance in freshwater.

In 2002, the Core Monitoring station inside the pond at the esplanade (CRBL08) was relocated to the main stem of the Charles and designated as CRBLA8. This station was repositioned to evaluate an alternative priority resource area. The previous station measured consistently poor water quality and did not meet the initiatives goals. In addition, modifications were made to the Program to support the development of a three-dimensional hydro-dynamic linked water quality model. The model will be used for the development of a eutrophication Total Maximum Daily Load (TMDL) to address low dissolved oxygen, numerous aesthetic impairments, algae blooms and pH violations in the Basin. Sampling stations, sampling parameters, and additional sampling dates were added to provide data for the model development. Seven additional (TMDL) stations were added between the BU Bridge and the Museum of Science.

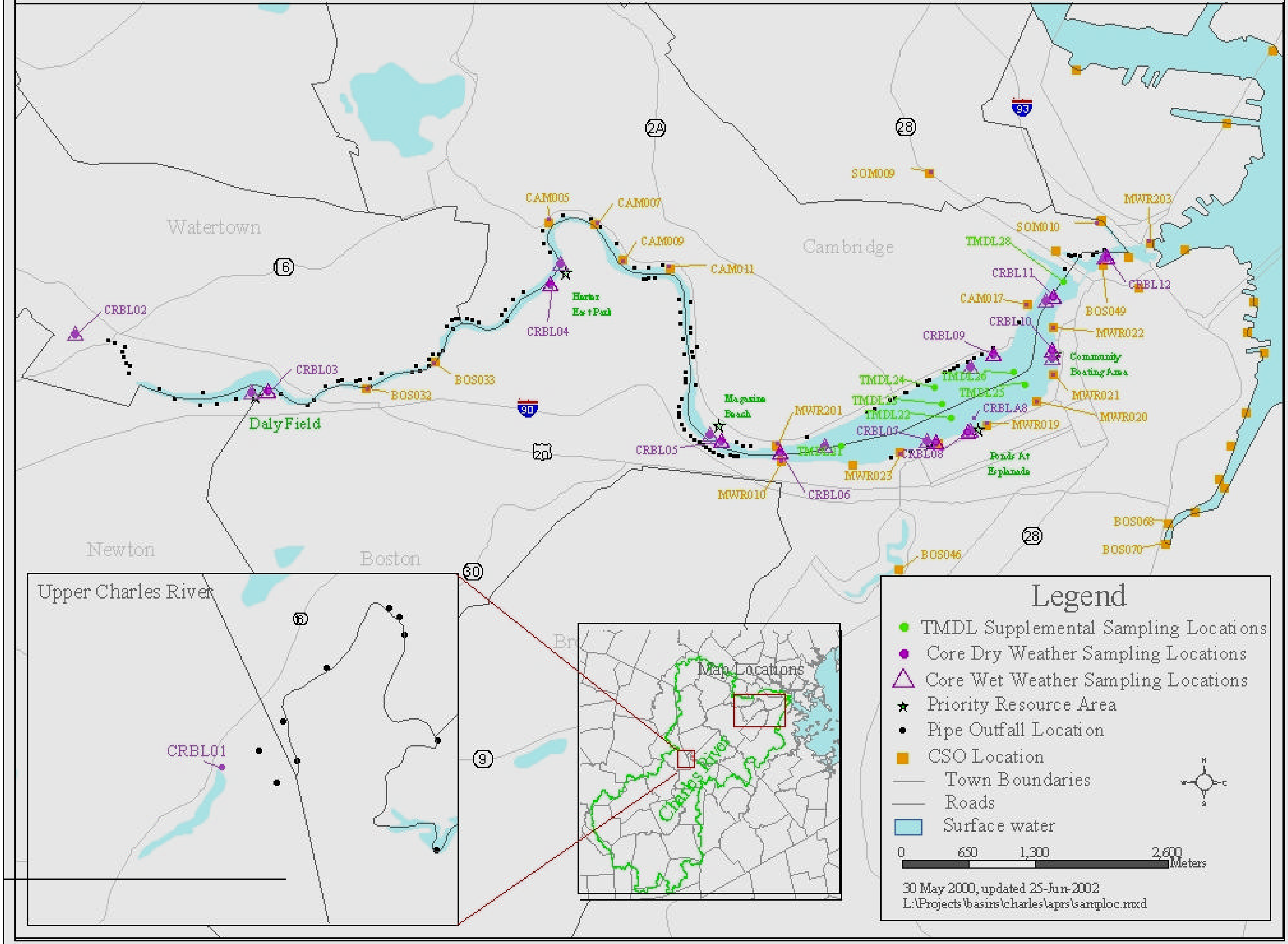
In 2003, having completed the data collection phase of the TMDL, the additional parameters and stations added to the sampling program in 2002 were discontinued. No other changes were made to the program in 2003. The description of the Core Monitoring sampling stations are presented in Table 1 and a location map is shown in Figure 1.

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 – center channel	CRBL06 WW
Downstream of Stony Brook & Mass Ave, 10 m off South shore	CRBL07 WW
~~**Pond at Esplanade**~~	~~**CRBL08**~~
Off the Esplanade (new station in 2002)	**CRBLA8**
Upstream of Longfellow Bridge, Cam. side	CRBL09 WW
Community boating area	**CRBL10**
Between Longfellow Bridge & Old Dam – center channel	CRBL11 WW
Upstream of Railroad Bridge – center channel	CRBL12

Bold = Priority resource area station
WW = Wet weather sampling station
~~CRBL08~~ = Discontinued station

Figure 1: EPA Core Monitoring Locations and Priority Resource Areas



1.0 PROJECT DESCRIPTION

The Core Monitoring Program targets one dry weather sampling event for each month of July, August, and September and three wet weather events between July and September. If no significant storms are sampled between July and September the wet weather sampling season is extended into October.

The dry weather sampling goal was to sample on days that were preceded by three days during which a total of less than 0.20 inches of rain occurs. Dry weather sampling was conducted on July 08, August 18, and September 15. In addition to these sampling days a pre-storm sampling was conducted on September 16. This pre-storm sampling event met the dry weather criterion and is included in the dry weather sample analysis.

The approach for each wet weather event was to sample six stations 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. In previous sampling years, it was identified that peak rain intensity coincides with maximum stage or peak flow in Laundry Brook (EPA 2001). Post-storm sampling occurred when the rain ceased and the flow at Laundry Brook returned to near pre-storm conditions.

The Core Monitoring Program was designed to sample three wet weather events. In 2003, only one wet weather event was sampled because predicted storms that met the criterion did not have the required three day antecedent dry period and because storms were not accurately predicted by the weather service to allow for sampling. The one wet weather sampling event began on September 15. The associated storm dropped 0.66 inches of rainfall[1] (Figure A-2 in the appendix).

The parameters analysed during 2003 Core Monitoring Program are listed in Table 2. The EPA's OEME and Office of Ecosystem Protection (OEP) field staff conducted all the sampling and field measurements. Samples were analysed by OEME and contract laboratories.

Table 2: Parameters Analyzed During the 2003 Sampling Events

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

5.0 DATA ANALYSIS

The sixth year of the Core Monitoring Program was completed in 2003. In addition to point source and non-point source pollutant loadings, water quality was influenced by yearly fluctuations in weather and river flows, making short-term trends difficult to determine. The weather conditions and river flow affect the transport of pollutants in the watershed. Rain events can cause pollutants to be transported from the landscape and can cause an increase in river flow. Increased flow can lead to greater channel loads from the erosion and resuspension of sediments and particulates.

[1] Rainfall data was collected at the USGS Waltham gaging station and are reported as preliminary data.

In 2003, from June to the beginning of September flows were higher than the drier years of 1999 and 2002. In general, the flows were similar to the flow record during 1998. In 1998, the summer conditions were generally wetter with correspondingly higher flows (Figure A-1).

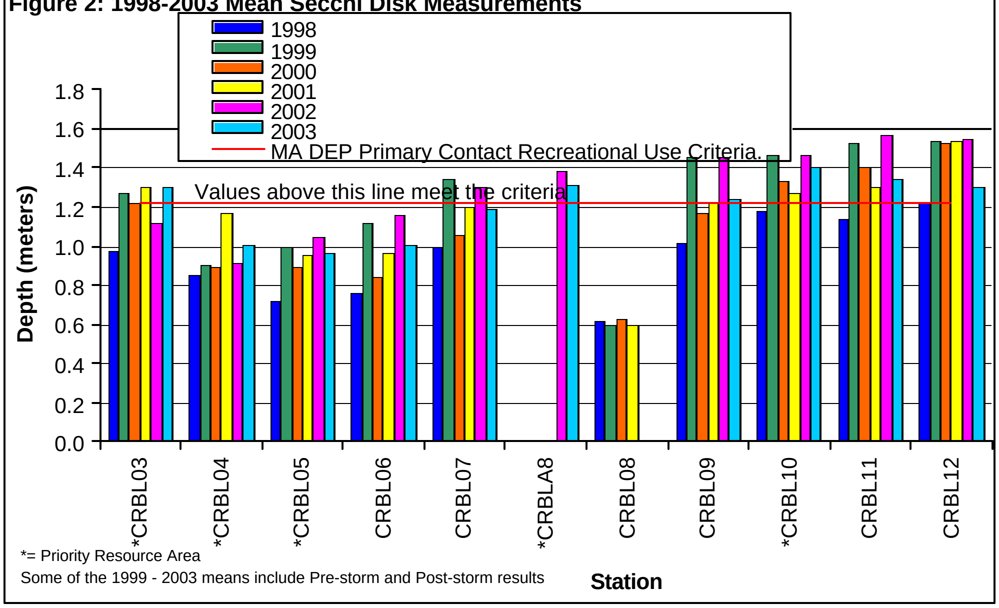
Three dry weather and one wet weather events were sampled from July – September. Since, only one wet weather event was sampled in 2003, the amount of data collected was less than that of previous years. When comparing these data to the previous five years' data, the following conclusions can be made. These data show a pattern of the best water quality occurring near the mouth of the River (Mass Ave. Bridge to the New Charles River Dam). This part of the river met the swimming standards more often than any other part of the Basin.

The greatest clarity was recorded during the lower flow years of 1999 and 2002 at the stations near the mouth of the Basin. Elevated levels of bacteria exist in the upper part of the basin. The station above the Watertown Dam has the highest dry weather geometric mean of all stations using the data from 1998-2003. Stations above the Watertown Dam and at Magazine Beach have shown a yearly increase in bacteria levels five out of the six years. Previous monitoring has measured elevated nutrient concentrations in the water below the pycnocline.

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

Secchi disk was used in the field to measure visibility/clarity. The Massachusetts DEP uses a 1.2 meter (4 foot) criterion to assess primary contact (swimming) use support. Clarity could not be measured at the South Natick Dam (CRBL01) and Watertown Dam (CRBL02) because of the shallow water at these stations.

Figure 2: 1998-2003 Mean Secchi Disk Measurements



*= Priority Resource Area
Some of the 1999 - 2003 means include Pre-storm and Post-storm results

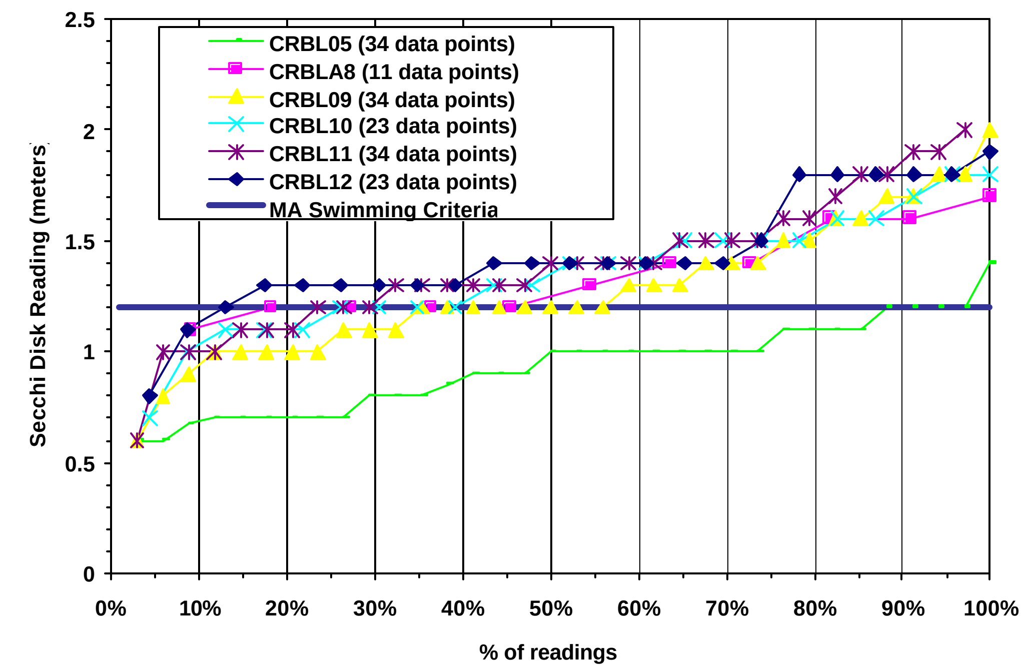
Mean Secchi disk readings downstream of Magazine Beach (CRBL05) were less than the means from the drier years of 1999 and 2002 and greater than the means of 1998 (Figure 2). Generally, the greatest clarity was recorded between the Esplanade and the New Charles River Dam (CRBLA8 - CRBL12). Forty six percent of samples in this area met the Massachusetts DEP primary contact (swimming) use support criterion of greater than or equal to 1.2 meters. The lowest clarity was measured at most of the stations during the September 9 sampling event. Based on the data collected over the last six years, the most downstream station (CRBL12) met the MA DEP swimming criterion over 80% of the time, while the station at Magazine Beach (CRBL05) met the criterion less than 15% of the time (Figure 3).

Apparent color measures the color of the water which may contain suspended matter. Apparent color values were highest during the July 8 sampling event and decreased throughout the summer. This relationship was also evident in the data collected during 2000, 2001, and 2002.

True color measures the stain in the water after the suspended particulates have been removed by centrifuging. As with apparent color, true color values were highest during the July 8 sampling event and decreased throughout the summer. The true color was on average 17% lower than the apparent color at each station.

As identified in the 1999 Core Monitoring Program Report (EPA 2000) it appears that part of the color was associated with suspended matter. This implies that reducing suspended matter and nutrients that stimulate algae growth could enhance the clarity of the water. Other sources of suspended matter include non-point, point sources (such as storm water and CSO's), resuspended bottom sediments, bank erosion, and other natural sources.

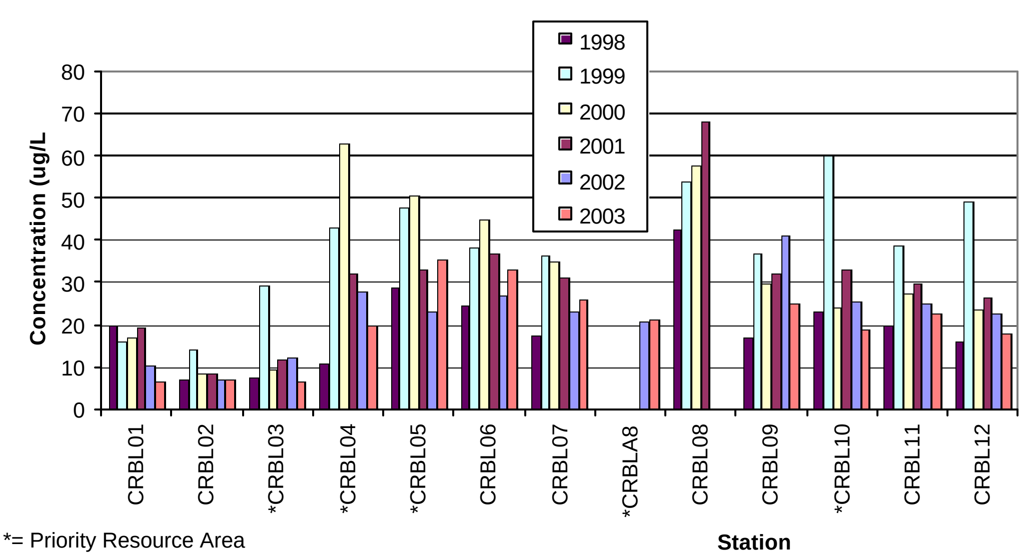
Figure 3: Secchi Disk Measurements at Stations CRBL05 - CRBL12 (1998-2003)
Cumulative Frequency Distribution



All measured TSS concentrations were less than the Massachusetts water quality standard (Table 3). Total Suspended Solids dry weather mean values were highest at the station above and below the BU Bridge; station CRBL05 and CRBL06, respectively. During previous years, the highest dry weather mean values were recorded at these locations and the stations at Herter East Park (CRBL04) and in the Lagoon (CRBL08).

Turbidity and Total Organic Carbon (TOC) were additional measurements of suspended and dissolved matter in the water. The highest measured turbidity was 28 NTU at the Mass Ave. Bridge station (CRBL07) on August 19, all other measured turbidity values were less than or equal to10 NTU. There is no explanation for this elevated value at station CRBL07. At each station, the highest TOC values were recorded during the July or August sampling event. This was consistent with the data collected in 2000, 2001 and 2002.

Figure 4: 1998-2003 Chlorophyll a Means



*= Priority Resource Area
Some of the 1998-2003 data includes pre-storm and post-storm

Transmissivity, a measurement of water clarity, which is independent of external light, was measured at all stations. Transmissivity was not measured during the wet weather sampling events. The greatest transmissivity was recorded at stations upstream of the Watertown and South Natick Dams during September. Measured values at theses two stations were similar during the three dry weather sampling events. As with Secchi disk readings, transmissivity values show increased clarity downstream from the Esplanade. Plotting the 2003 transmissivity against Secchi disk measurements shows that a Secchi disk measurement of 1.2 meters corresponds with a transmissivity of approximately 52% ($Y= 0.022x = 0.0557$, $R^2 = 0.7124$).

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 eutrophication of lakes and rivers, the total phosphorus and chlorophyll a concentrations were compared to regional criteria. Since ten of the twelve stations are located in the basin, which is a large impounded body of water with characteristics more similar to a lake than a river, criterion for lakes, ponds and reservoirs were used for accessing water quality. For lakes, ponds and reservoirs in the North Eastern Coastal Zone the recommended criterion for chlorophyll a is approximately 2.5 ug/l (NEIWPCC, 2000). All measured values were reported above this criterion. Concentrations upstream of Herter East Park (CRBL04) ranged from 5 ug/L to 10 ug/L (median value of 7 ug/L) and station downstream ranged from 9 ug/L to 66 ug/L (median value of 23 ug/L).
The mean chlorophyll a values from 1998 to 2003 are presented in Figure 4.

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% saturation
Temperature	$\leq$ 83°F (28.3°C) and ? 3°F (1.7°C) in Lakes, ?5°F (2.8°C) in Rivers
pH	Between 6.5 and 8.3
Bacteria	See Table 4
Secchi disk depth	Lakes $\geq$ 1.2 meters (for primary contact recreation use support)
Solids	Narrative and TSS $\leq$ 25.0 mg/l (for aquatic life use support)
Color and turbidity	Narrative Standard
Nutrients	Narrative “Control of Eutrophication” Site Specific

5.2 Bacteria

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.

Table 4: Massachusetts Freshwater Bacteria Criteria

Indicator Organism	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
E. coli or	≤235 colonies/100ml and a geometric mean of most recent five samples ≤126 col/100ml	NA	NA
Enterococci	≤61 colonies/100ml and a geometric mean of most recent five samples≤33 col/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

Fecal coliform and E. coli bacteria concentrations were measured during each sampling event. 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).

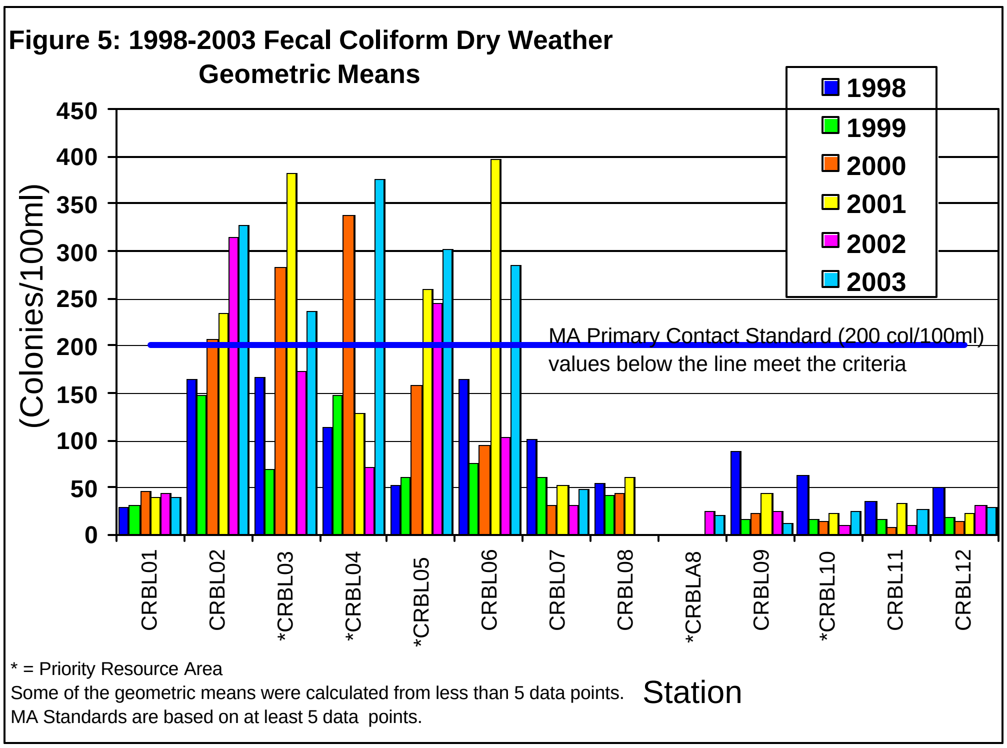


Figure 5: 1998-2003 Fecal Coliform Dry Weather Geometric Means

During dry weather, approximately 35% of the core monitoring fecal coliform samples exceeded the swimming criterion[1] of less than 200 colonies/100ml, (compared to 31%, 35%, 23%, 8%, and 17% in 2002, 2001, 2000, 1999 and 1998, respectively). Although there was less wet weather data collected during 2003 compared to

1 The Massachusetts fecal coliform swimming criterion of less than 200 colonies/100ml is actually based on a geometric mean of five samples or more. For this report, individual concentrations were compared to this criterion.

previous years, the number of wet weather samples that exceeded criterion[1] of less than 200 colonies/100ml was similar to that of previous years.

Fecal coliform concentrations were lower near the mouth of the Basin (Mass Ave. Bridge to the New Charles River Dam; CRBL07 - CRBL12). This is a consistent trend, which has occurred in the previous five years of data collection (Figure 5). During 2003, the dry weather Core Monitoring samples collected at stations CRBL07 - CRBL12 exceeded the swimming[1] criterion 9% of the time. Upstream, at stations CRBL02 – CRBL06 the criterion[1] was exceeded 76% of the time during dry weather. The area from station CRBL07- CRBL12 is the most heavily recreated part of the River. The area contains the MIT Sailing Pavilion and Community Boating where much sailing, kayaking, windsurfing, and occasional contact with the water occurs.

The 2003 dry weather fecal coliform geometric means[2] were similar to those collected during previous years. At station CRBL02, the geometric means[2] have increased over the past four years (Figure 6). At station CRBL05, with the exception of 2002, each year the geometric mean has increased. The cause of this increase has not been identified, although a growing population of geese observed at this station, likely contributes to the bacteria contamination.

E. coli bacteria was sampled during all sampling events. As observed with the fecal coliform measurements, the E. coli concentrations were lower near the mouth of the Basin (Mass Ave. Bridge to the New Charles River Dam; CRBL07 - CRBL12). For these Core Monitoring stations, all calculated dry weather geometric means[2] and all individual sample results met the Department of Public Health (DPH) Bathing Beach criterion[3]. During dry weather, at stations CRBL02 – CRBL06, the single sample criterion was exceeded 35% of the time and the geometric mean criterion was exceeded 100% of the time at all five stations.

Six or approximately 14% of all dry weather core monitoring samples exceeded the E. coli bathing beach criterion for a single sample (compared to 17% in 2002, 19% in 2001 and 35% in 1998).

5.3 Dissolved Oxygen, pH, and Temperature

Massachusetts has established criteria for class B waters for dissolved oxygen, pH, temperature, and turbidity (Table 3). One field instrument was used to measure temperature, specific conductance, DO, pH, and turbidity. Data that did not meet the quality control criteria were not reported.

Dissolved Oxygen (DO) is required for a healthy ecosystem. Fish and other aquatic organisms require DO for survival. Massachusetts has established DO criterion[4] for class B waters. No DO violations were measured during 2003 (compared to 1%, 0%, 0%, 3%, and 0% in 2002, 2001, 2000, 1999, and 1998, respectively).

The pH of an aquatic system is an important parameter in evaluating toxicity. High acidity (a low pH) can convert insoluble metal sulfides to soluble forms, which increases the bioavailability. A high pH can cause ammonia toxicity (EPA 1998). The data from all the dry and wet weather core monitoring surface measurements showed pH violated the criterion[4] eight times or approximately 14% of all field measurements (compared to 22%, 18%, 20%, 8%, and 4% in 2002, 2001, 2000, 1999, and 1998, respectively). All surface violations were greater than 8.3 and occurred during September. The cause of these elevated values was unable

---

[1] The Massachusetts fecal coliform swimming criterion of less than 200 colonies/100ml is actually based on a geometric mean of five samples or more. For this report, individual concentrations were compared to this criterion.

[2] Some of the dry weather geometric means were calculated from less than five data points; the actual criterion is based on a geometric mean of five samples or more.

[3] The Massachusetts DPH E. coli Bathing Beach criterion for as single sample is less than or equal to 235 colonies/100ml. The geometric mean criterion is less than or equal to 126 colonies/100ml and is based on a geometric mean of the most recent five samples within the same bathing season.

[4] The Massachusetts water quality criteria for Class B water for DO is $\geq$ 5 mg/l and $\geq$60% saturation, for pH is in the range of 6.5 through 8.3, and for temperature is $\leq$ 28.3^{o}C (83^{o}F) .

to be determined but may be, in part, by the photosynthesis of algae and the uptake of carbon dioxide from the water.

Temperature is a crucial factor in maintaining a natural ecosystem. Changes in the temperature can alter the existing or natural aquatic community (EPA 1986). Temperature also governs many biochemical and physiological processes in cold-blooded aquatic organisms. Increased temperature decreases the oxygen solubility in water resulting in increased stress from oxygen-demanding waste (EPA 1998). The highest surface water temperature was recorded on July 8 at Magazine Beach (CRBL05) and downstream of the Mass Ave Bridge (CRBL07) at 29.3 °C. (84.7°F). There were seven recorded temperature measurements above the state criterion[1]. All of these measurements occurred on July 8.

5.4 Nutrients

Nutrient analyses included measurements of total phosphorus, ortho-phosphorus, nitrate, nitrite, and ammonia. Phosphorus was the most significant nutrient in this system. Elevated phosphorus concentrations at many of the sampling stations indicated highly eutrophic conditions. All except one of the sample results exceeded the EPA recommended Ambient Water Quality Criteria for Rivers and Streams[2] and all samples results exceeded the recommended criteria for Lakes, Ponds, and Reservoirs in New England[3]. Each station recorded the highest concentration during the July or August sampling events. The dry weather means were higher than the 2002 means at eleven of the twelve stations, although at most stations, concentrations were not elevated when compared to all previous years' means (Figure 6). In 2002, additional samples were collected at various depths to support the development of a water quality model for the Total Maximum Daily Load (TMDL). The results from this sampling showed elevated concentrations of total phosphorus, ortho-phosphorous, total kjeldahl nitrogen, and ammonia below the pycnocline (the interface between water of different densities).

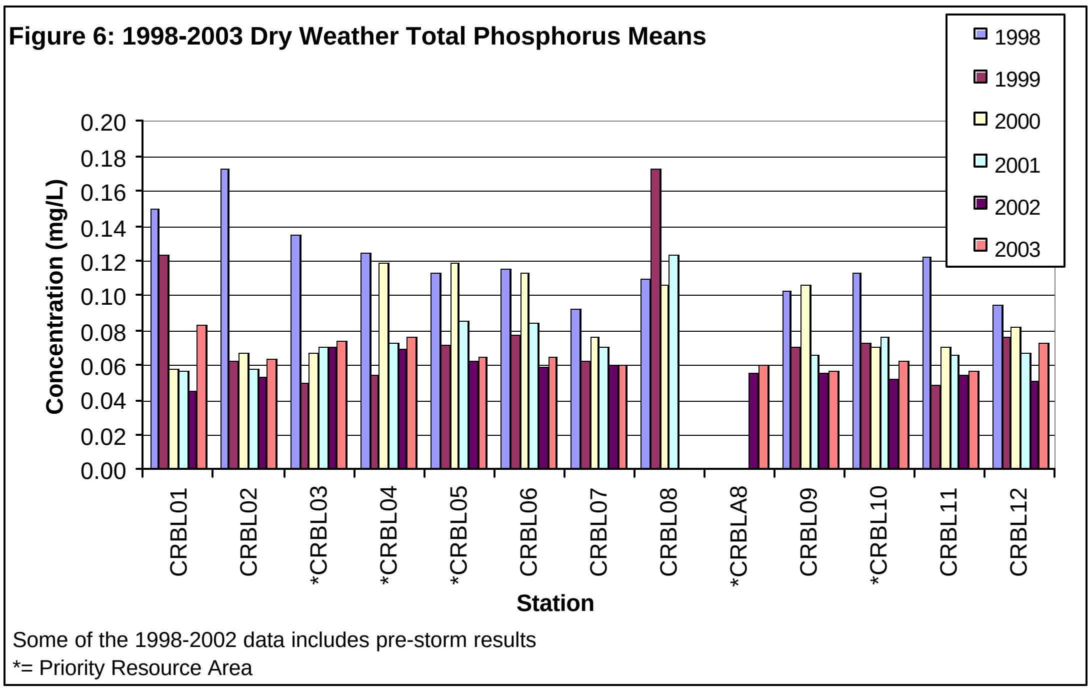


Figure 6: 1998-2003 Dry Weather Total Phosphorus Means

Some of the 1998-2002 data includes pre-storm results
*= Priority Resource Area

The highest dry weather Ortho-phosphorus concentrations were recorded during the July sampling event at each station.

---

[1] The Massachusetts water quality criteria for Class B water for DO is ≥ 5 mg/l and ≥60% saturation, for pH is in the range of 6.5 through 8.3, and for temperature is ≤ 28.3°C (83°F) .

[2] The EPA recommended Total Phosphorus criteria for Rivers and Stream in level III ecoregion 59 is 23.75 ug/L.

[3] The EPA recommended Total Phosphorus criteria for Lakes and Reservoirs in level III ecoregion 59 is 8 ug/L.

During each of the dry weather sampling events the highest concentration of nitrate was recorded at the station located at the South Natick Dam (CRBL01).

5.5 Metals

Twenty-one elements were included in the dissolved metal analyses. In addition, total recoverable mercury was analyzed. Ten of these were EPA priority metals and have associated Ambient Water Quality Criteria (AWQC)[1]. Seven of these AWQC's were dependent on the water hardness. Hardness dependent AWQC were calculated using the hardness of the water 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 presented as total recoverable. The metals concentrations and the associated criteria are presented in Tables 5. The concentrations of all the metals analyzed are presented in Appendix A.

No metals exceeded the acute Ambient Water Quality Criteria (AWQC). Lead and copper were the only metals that exceeded the chronic AWQC. Copper exceeded the criteria once and lead exceeded the criteria 24 times. Approximately, 50% of the dry weather lead samples exceeded the chronic criteria (compared to 21%, 33%, 27%, and 8% in 2002, 2001, 2000, and 1999, respectively). There is no explanation for this increase in 2003. The other measured priority pollutants metals (arsenic, cadmium, chromium, copper, mercury, nickel, selenium, silver, and zinc) did not exceed the AWQC.

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

TABLE 5: Priority Pollutant Metals 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 (III) conc. (ug/l)	Chromium (III) 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)
7/8/03 Core Dry Weather Sampling															
CRBL01	0.73	340	150	ND(0.20)	1.2	0.2	1.5	376	49	2ND	8.3	5.8	1.6	37.0	1.4
CRBL02	0.86	340	150	ND(0.20)	1.3	0.2	1.5	397	52	3.7	8.9	6.1	2.5	39.8	1.6
CRBL03	0.92	340	150	ND(0.20)	1.3	0.2	1.7	399	52	3.3	8.9	6.2	2.7	40.1	1.6
CRBL04	0.89	340	150	ND(0.20)	1.3	0.2	1.6	401	52	3.7	9.0	6.2	3.6	40.4	1.6
CRBL05	0.95	340	150	ND(0.20)	1.3	0.2	1.7	397	52	4.0	8.9	6.1	4.6	39.8	1.6
CRBL06	0.92	340	150	ND(0.20)	1.3	0.2	1.6	397	52	4.0	8.9	6.1	4.5	39.8	1.6
CRBL07	0.92	340	150	ND(0.20)	1.3	0.2	1.6	388	51	5.0	8.7	6.0	4.5	38.7	1.5
CRBLA8	0.92	340	150	ND(0.20)	1.2	0.2	1.8	376	49	5.1	8.3	5.8	4.1	37.0	1.4
CRBL09	0.88	340	150	ND(0.20)	1.3	0.2	1.6	393	51	5.0	8.8	6.1	4.9	39.2	1.5
CRBL10	0.87	340	150	ND(0.20)	1.3	0.2	1.6	399	52	5.5	8.9	6.2	4.4	40.1	1.6
CRBL11	0.92	340	150	ND(0.20)	1.3	0.2	1.6	399	52	6.1	8.9	6.2	4.5	40.1	1.6
CRBL12	0.93	340	150	ND(0.20)	1.5	0.2	1.5	448	58	5.8	10.2	7.0	4.3	46.9	1.8
8/19/03 Core Dry Weather Sampling															
CRBL01	0.62	340	150	ND(0.20)	1.2	0.2	1.4	360	47	2.5ND	7.9	5.5	1.2	34.8	1.4
CRBL02	0.92	340	150	ND(0.20)	1.3	0.2	1.4	395	51	3.0ND	8.8	6.1	2.8	39.6	1.5
CRBL03	0.87	340	150	ND(0.20)	1.3	0.2	1.1	395	51	3.0ND	8.8	6.1	3.1	39.6	1.5
CRBL04	0.88	340	150	ND(0.20)	1.3	0.2	1.3	395	51	4.0ND	8.8	6.1	3.8	39.6	1.5
CRBL05	1.0	340	150	ND(0.20)	1.3	0.2	1.2	400	52	4.0ND	9.0	6.2	5.8	40.3	1.6
CRBL06	0.99	340	150	ND(0.20)	1.3	0.2	1.2	395	51	4.0ND	8.8	6.1	5.3	39.6	1.5
CRBL07	0.93	340	150	ND(0.20)	1.3	0.2	1.3	400	52	7ND	9.0	6.2	4.5	40.3	1.6
CRBLA8	0.82	340	150	ND(0.20)	1.4	0.2	1.3	415	54	5.0ND	9.3	6.4	3.2	42.3	1.6
CRBL09	0.90	340	150	ND(0.20)	1.5	0.2	1.3	440	57	5.0ND	10.0	6.8	3.0	45.8	1.8
CRBL10	0.95	340	150	ND(0.20)	1.5	0.2	1.4	455	59	5.0ND	10.4	7.1	2.7	47.8	1.9
CRBL11	1.0	340	150	ND(0.20)	1.5	0.2	1.4	455	59	6.0ND	10.4	7.1	2.7	47.8	1.9
CRBL12	1.0	340	150	ND(0.20)	1.8	0.2	1.5	527	69	6.0ND	12.3	8.3	2.4	58.3	2.3
9/9/03 Core Dry Weather Sampling															
CRBL01	ND(0.50)	340	150	ND(0.20)	1.3	0.2	ND(0.50)	395	51	3.7	8.8	6.1	0.40	39.6	1.5
CRBL02	0.57	340	150	ND(0.20)	1.5	0.2	ND(0.50)	435	57	3.0ND	9.9	6.8	0.83	45.1	1.8
CRBL03	0.56	340	150	ND(0.20)	1.5	0.2	ND(0.50)	450	59	3.1	10.2	7.0	1.1	47.2	1.8
CRBL04	0.59	340	150	ND(0.20)	1.6	0.2	ND(0.50)	465	60	3.4	10.6	7.2	1.2	49.2	1.9
CRBL05	0.63	340	150	ND(0.20)	1.5	0.2	ND(0.50)	450	59	4.0	10.2	7.0	1.2	47.2	1.8
CRBL06	0.67	340	150	ND(0.20)	1.6	0.2	ND(0.50)	465	60	4.3	10.6	7.2	1.0	49.2	1.9
CRBL07	0.96	340	150	ND(0.20)	2.2	0.3	ND(0.50)	611	80	5.4	14.6	9.6	1.5	70.9	2.8
CRBLA8	1.0	340	150	ND(0.20)	2.3	0.3	ND(0.50)	630	82	5.5	15.1	9.9	1.4	73.8	2.9
CRBL09	1.1	340	150	ND(0.20)	2.4	0.3	ND(0.50)	652	85	6.0	15.7	10.3	1.4	77.3	3.0
CRBL10	1.2	340	150	ND(0.20)	2.5	0.3	ND(0.50)	680	88	8.0	16.5	10.8	1.6	81.6	3.2
CRBL11	1.0	340	150	ND(0.20)	2.5	0.3	ND(0.50)	680	88	6.1	16.5	10.8	1.2	81.6	3.2
CRBL12	1.3	340	150	ND(0.20)	2.8	0.3	0.51	746	97	7.4	18.3	11.9	2.5	92.3	3.6
9/15/2003 Pre-storm															
CRBL02	0.55	340	150	ND(0.20)	1.5	0.2	1.0	450	59	2ND	10.2	7.0	0.48	47.2	1.8
CRBL05	0.66	340	150	ND(0.20)	1.6	0.2	1.2	465	60	3.5	10.6	7.2	0.81	49.2	1.9
CRBL06	0.78	340	150	ND(0.20)	1.8	0.2	1.2	518	67	4.0	12.0	8.1	0.80	56.9	2.2
CRBL07	0.95	340	150	ND(0.20)	2.0	0.2	1.3	574	75	4.3	13.6	9.0	0.88	65.3	2.5
CRBL09	1.1	340	150	ND(0.20)	2.5	0.3	1.2	680	88	5.9	16.5	10.8	0.77	81.6	3.2
CRBL11	1.2	340	150	ND(0.20)	2.6	0.3	1.4	711	92	6.3	17.3	11.3	0.75	86.5	3.4
9/16/03 first flush															
CRBL02	0.51	340	150	ND(0.20)	1.5	0.2	1.2	445	58	2.8	10.1	6.9	0.53	46.5	1.8
CRBL05	0.54	340	150	ND(0.20)	1.5	0.2	1.2	455	59	3.6	10.4	7.1	0.65	47.8	1.9
CRBL06	0.59	340	150	ND(0.20)	1.5	0.2	1.2	455	59	3.3	10.4	7.1	0.85	47.8	1.9
CRBL07	0.79	340	150	ND(0.20)	2.1	0.3	1.1	593	77	4.5	14.1	9.3	0.77	68.1	2.7
CRBL09	1.0	340	150	ND(0.20)	2.4	0.3	1.1	662	86	5.5	16.0	10.5	0.80	78.7	3.1
CRBL11	1.1	340	150	ND(0.20)	2.5	0.3	1.1	680	88	5.9	16.5	10.8	0.83	81.6	3.2
9/16/03 Peak Flow															
CRBL02	0.64	340	150	ND(0.20)	1.1	0.2	1.3	344	45	4.1	7.5	5.3	1.3	32.8	1.3
9/19/03 Post-storm															
CRBL02	0.55	340	150	ND(0.20)	1.6	0.2	0.92	479	62	3ND	11.0	7.5	0.35	51.3	2.0
CRBL05	0.60	340	150	ND(0.20)	1.6	0.2	1.2	475	62	4ND	10.9	7.4	0.83	50.6	2.0
CRBL06	0.65	340	150	ND(0.20)	1.6	0.2	1.1	475	62	4ND	10.9	7.4	0.93	50.6	2.0
CRBL07	0.96	340	150		2.0	0.2	1.2	574	75	5ND	13.6	9.0	0.85	65.3	2.5
CRBL09	1.0	340	150	ND(0.20)	2.3	0.3	1.2	630	82	5ND	15.1	9.9	0.79	73.8	2.9
CRBL11	1.0	340	150	ND(0.20)	2.3	0.3	1.1	630	82	5.6	15.1	9.9	0.71	73.8	2.9

= meets or exceeds the chronic criterion
ND=not detected above the associated detection limit – the "ND" is followed by the reporting limit
A number prior to ND indicates that the value did not meet the blank criteria

TABLE 5: Priority Pollutant Metals Concentrations and the Ambient Water Quality Criteria (AWQC) - continued

STATION	Mercury Total conc. (ug/l)	Mercury Total AWQC Acute (ug/l)	Mercury Total AWQC Chronic (ug/l)	Nickel conc. (ug/l)	Nickel AWQC Acute (ug/l)	Nickel AWQC Chronic (ug/l)	Selenium conc. (ug/l)	Selenium Total 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)
7/8/03 Core Dry Weather Sampling													
CRBL01	0.0052	1.40	0.770	1.4	305	34	ND(1.0)	5.0	ND(0.20)	1.3	ND(5.0)	76	77
CRBL02	0.0049	1.40	0.770	1.4	322	36	ND(1.0)	5.0	ND(0.20)	1.5	ND(5.0)	81	81
CRBL03	0.0117	1.40	0.770	1.5	324	36	ND(1.0)	5.0	ND(0.20)	1.5	ND(5.0)	81	82
CRBL04	0.0062	1.40	0.770	1.5	326	36	ND(1.0)	5.0	ND(0.20)	1.5	ND(5.0)	82	82
CRBL05	0.0055	1.40	0.770	1.5	322	36	ND(1.0)	5.0	ND(0.20)	1.5	ND(5.0)	81	81
CRBL06	0.0055	1.40	0.770	1.5	322	36	ND(1.0)	5.0	ND(0.20)	1.5	6.2	81	81
CRBL07	0.0065	1.40	0.770	1.6	315	35	ND(1.0)	5.0	ND(0.20)	1.4	6.5	79	79
CRBLA8	0.0054	1.40	0.770	1.5	305	34	ND(1.0)	5.0	ND(0.20)	1.3	6.3	76	77
CRBL09	0.0067	1.40	0.770	1.5	319	35	ND(1.0)	5.0	ND(0.20)	1.5	6.7	80	80
CRBL10	0.0073	1.40	0.770	1.5	324	36	ND(1.0)	5.0	ND(0.20)	1.5	6.4	81	82
CRBL11	0.0068	1.40	0.770	1.5	324	36	ND(1.0)	5.0	ND(0.20)	1.5	6.8	81	82
CRBL12	0.0058	1.40	0.770	1.5	366	41	ND(1.0)	5.0	ND(0.20)	1.9	6.7	91	92
8/19/03 Core Dry Weather Sampling													
CRBL01	0.0066	1.40	0.770	1.4	291	32	ND(1.0)	5.0	ND(0.20)	1.2	ND(5.0)	73	73
CRBL02	0.0062	1.40	0.770	1.5	321	36	ND(1.0)	5.0	ND(0.20)	1.5	5.9	80	81
CRBL03	0.0057	1.40	0.770	1.4	321	36	ND(1.0)	5.0	ND(0.20)	1.5	ND(5.0)	80	81
CRBL04	0.0059	1.40	0.770	1.4	321	36	ND(1.0)	5.0	ND(0.20)	1.5	5.7	80	81
CRBL05	0.0095	1.40	0.770	1.4	325	36	ND(1.0)	5.0	ND(0.20)	1.5	ND(5.0)	81	82
CRBL06	0.0073	1.40	0.770	1.5	321	36	ND(1.0)	5.0	ND(0.20)	1.5	ND(5.0)	80	81
CRBL07	0.007	1.40	0.770	1.4	325	36	ND(1.0)	5.0	ND(0.20)	1.5	5.7	81	82
CRBLA8	0.0048	1.40	0.770	1.4	338	38	ND(1.0)	5.0	ND(0.20)	1.7	ND(5.0)	85	85
CRBL09	0.0073	1.40	0.770	1.5	359	40	ND(1.0)	5.0	ND(0.20)	1.9	ND(5.0)	90	90
CRBL10	0.0052	1.40	0.770	1.4	371	41	ND(1.0)	5.0	ND(0.20)	2.0	ND(5.0)	93	94
CRBL11	0.0046	1.40	0.770	1.5	371	41	ND(1.0)	5.0	ND(0.20)	2.0	ND(5.0)	93	94
CRBL12	0.0046	1.40	0.770	1.5	432	48	ND(1.0)	5.0	ND(0.20)	2.7	5.1	108	109
9/9/03 Core Dry Weather Sampling													
CRBL01	0.0018	1.40	0.770	1.4	321	36	ND(1.0)	5.0	ND(0.20)	1.5	ND(5.0)	80	81
CRBL02	0.0022	1.40	0.770	1.3	355	39	ND(1.0)	5.0	ND(0.20)	1.8	5.6	89	89
CRBL03	0.0036	1.40	0.770	1.4	367	41	ND(1.0)	5.0	ND(0.20)	2.0	ND(5.0)	92	93
CRBL04	0.0049	1.40	0.770	1.5	379	42	ND(1.0)	5.0	ND(0.20)	2.1	ND(5.0)	95	96
CRBL05	0.0079	1.40	0.770	1.5	367	41	ND(1.0)	5.0	ND(0.20)	2.0	ND(5.0)	92	93
CRBL06	0.0168	1.40	0.770	1.5	379	42	ND(1.0)	5.0	ND(0.20)	2.1	ND(5.0)	95	96
CRBL07	0.0054	1.40	0.770	1.6	504	56	1.3	5.0	ND(0.20)	3.7	ND(5.0)	126	127
CRBLA8	0.0045	1.40	0.770	1.9	519	58	1.3	5.0	ND(0.20)	4.0	ND(5.0)	130	131
CRBL09	0.0093	1.40	0.770	2.0	539	60	1.6	5.0	ND(0.20)	4.3	ND(5.0)	135	136
CRBL10	0.0044	1.40	0.770	1.7	562	62	2.0	5.0	ND(0.20)	4.7	ND(5.0)	141	142
CRBL11	0.0039	1.40	0.770	1.8	562	62	1.8	5.0	ND(0.20)	4.7	ND(5.0)	141	142
CRBL12	0.0031	1.40	0.770	2.0	619	69	2.2	5.0	ND(0.20)	5.7	5.4	155	156
9/15/2003 Pre-storm													
CRBL02	0.0016	1.40	0.770	1.4	367	41	ND(1.0)	5.0	ND(0.20)	2.0	ND(5.0)	92	93
CRBL05	0.0036	1.40	0.770	1.5	379	42	ND(1.0)	5.0	ND(0.20)	2.1	ND(5.0)	95	96
CRBL06	0.0019	1.40	0.770	1.6	424	47	ND(1.0)	5.0	ND(0.20)	2.6	ND(5.0)	106	107
CRBL07	0.0025	1.40	0.770	1.5	472	52	1.1	5.0	ND(0.20)	3.3	ND(5.0)	118	119
CRBL09	0.0018	1.40	0.770	1.8	562	62	1.7	5.0	ND(0.20)	4.7	ND(5.0)	141	142
CRBL11	0.002	1.40	0.770	1.8	588	65	1.7	5.0	ND(0.20)	5.1	ND(5.0)	147	149
9/16/03 first flush													
CRBL02	0.0029	1.40	0.770	1.5	363	40	ND(1.0)	5.0	ND(0.20)	1.9	ND(5.0)	91	92
CRBL05	0.0042	1.40	0.770	1.5	371	41	ND(1.0)	5.0	ND(0.20)	2.0	ND(5.0)	93	94
CRBL06	0.0033	1.40	0.770	1.5	371	41	ND(1.0)	5.0	ND(0.20)	2.0	ND(5.0)	93	94
CRBL07	0.0019	1.40	0.770	1.6	488	54	ND(1.0)	5.0	ND(0.20)	3.5	ND(5.0)	122	123
CRBL09	0.0022	1.40	0.770	1.7	546	61	1.7	5.0	ND(0.20)	4.4	ND(5.0)	137	138
CRBL11	0.0024	1.40	0.770	1.8	562	62	1.8	5.0	ND(0.20)	4.7	ND(5.0)	141	142
9/16/03 Peak Flow													
CRBL02	0.0076	1.40	0.770	1.3	278	31	ND(1.0)	5.0	ND(0.20)	1.1	7.4	70	70
9/19/03 Post-storm													
CRBL02	0.0016	1.40	0.770	1.4	392	44	ND(1.0)	5.0	ND(0.20)	2.2	ND(5.0)	98	99
CRBL05	0.0047	1.40	0.770	1.6	388	43	ND(1.0)	5.0	ND(0.20)	2.2	ND(5.0)	97	98
CRBL06	0.0083	1.40	0.770	1.6	388	43	ND(1.0)	5.0	ND(0.20)	2.2	ND(5.0)	97	98
CRBL07	0.0037	1.40	0.770	1.7	472	52	1.3	5.0	ND(0.20)	3.3	ND(5.0)	118	119
CRBL09	0.0078	1.40	0.770	1.9	519	58	1.5	5.0	ND(0.20)	4.0	ND(5.0)	130	131
CRBL11	0.0026	1.40	0.770	1.8	519	58	1.6	5.0	ND(0.20)	4.0	ND(5.0)	130	131

= meets or exceeds the chronic criterion

ND=not detected above the associated detection limit – the "ND" is followed by the reporting limit

A number prior to ND indicates that the value did not meet the blank criteria

5.7 Data Usability

Quality control criteria were established to insure data quality. The criteria specify holding times, sample preservation, and precision and accuracy limits. Holding times were met for all samples. 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 and in the addendum dated June 10, 2002.

Instruments used in the field to measure temperature, DO, pH, specific conductance, salinity, turbidity, and transmissivity were calibrated prior to sampling and checked after use. Field monitoring data that did not meet all the established quality control criteria were not presented in this report. Field data that partially met the criteria were reported as estimated data and identified with a swung dash (~) preceding the value.

Duplicate field measurements (temperature, DO, pH, specific conductance, salinity, and turbidity) were measured during all six sampling events. The Project Work/QA Plan did not specify Relative Percent Difference (RPD) goals between the regular and duplicate samples for any of these measurements. The highest RPD between the regular and duplicate field samples was calculated for turbidity at 45.9%. The use of this turbidity data was not limited for this project since the initial calibrations and post verification were well with in the quality control limits. Excluding this turbidity difference the highest RPD between the regular and duplicate samples for all field measurements was 3.8%. Therefore none of the field measurement data was qualified based on duplicate sampling results.

Chemistry data that partially met laboratory quality control criteria or concentrations that were less than the associated reporting limit were considered estimated values and identified with a swung dash (~) preceding the value. Field duplicate chemistry samples were collected during each of the six sampling events to evaluate sampling and analytical precision. Four of the 72 duplicate samples (excluding metals, field measurements, anions and cations) analyzed during the sampling events did not meet the precision quality control goal of less than 35 relative percent difference established in the Project Work/QA Plan. The data not meeting the criteria are described below. Three of the four duplicate samples were for fecal coliform and E. coli, which can have large variation in the environment. All of these samples and duplicate results were less than 50 colonies/100ml. The highest of these duplicate RPD's was 57.1%. The use of these data was not limited for this project because of the factors listed above. The other RPD that did not meet the quality control limit of 35 relative percent difference was for total phosphorus. This RPD was calculated at 40% during the September 16, first flush sampling event. The duplicate sampling result was reported by the laboratory as an estimated value because the laboratory duplicate sample did not meet laboratory duplicate RPD quality Control criteria of 20%. Therefore, all the data for this sampling event was reported as estimated data and were identified with a swung dash (~) preceding the value.

Four of 132 field duplicate samples for dissolved metals and total mercury analyzed during the six sampling events did not meet the precision quality control goal of less than 35 relative percent difference. These four duplicate samples not meeting the criteria occurred during two different sampling events for antimony, and during one sampling for cobalt and another sampling event for mercury. The project use of these metals data where the field duplicate data did not meet the RPD goal were not limited for the reasons described below. At least one of results from the samples and duplicate samples for antimony and cobalt were relatively close to the reporting limit were RPD's are often elevated. The laboratory quality control data for all of these metals (including mercury) met all quality control limits.

For the first time anions and cations have been reported in this report. These results have been presented as additional information. Although there was no duplicate relative percent difference criteria establish in the QAPP, all of the 54 calculated RPD's were less than 10%.

For the chemistry analyses, trip blanks were used to evaluate any contamination caused by: the sample container, sample preservation, sampling method, and/or transportation to the laboratory. A filter blank was used to evaluate contamination to the dissolved metal samples from the filter, sampling equipment, sample container, sample preservation, sampling method, and/or transportation to the laboratory. Sample results were evaluated using the results of the associated blank for that sampling day. If the blank result was reported as “ND” (non detect) the use of the data was not limit in any way. If a sample result was less than or equal to five times the associated positive blank value, the sample result was denoted by an “ND” following the sample result. For the purpose of this report these data were evaluated as estimated values.

The non-metals chemistry sample trip blanks, collected during all three monthly dry weather sampling days, were reported as not detected above the reporting limit. A mercury a trip blank was collected during each of the six sampling event. All of these trip blanks were reported as not detected above the reporting limit.
A dissolved metals filter blank was collected during each sampling event. Except for copper, these values were all reported as not detected above the detection limit. Copper concentrations were reported above the reporting limit for each of the six sampling events. No additional qualifications were made to the data, since the reported data were already qualified from the laboratory. An “ND” following the sample result denoted this qualified data. The laboratory qualified these data if the concentration in the sample was less than 10 times the concentration in the associated laboratory blank. The Appendix contains all the validated data for this report

In past years the metals AWQC were calculated from the total or dissolved fraction of calcium and magnesium measured by Inductively Coupled Plasma-Mass Spectrometry (ICP-MS). In 2003, the hardness was calculated from the total fraction of calcium and magnesium measured with Ion Chromatography (IC). Comparing the 2003 calcium and magnesium calculated hardness from IC and the dissolved fraction from ICP-MS revealed the IC hardness were on average 22% lower than the dissolved fraction measured with ICP/MS (the maximum difference was -34%). Using the dissolved fraction hardness from ICP-MS (which has been used in past years) to calculate the AWQC’s showed there to be no copper chronic AWQC exceedences and 21 lead exceedences. Using the IC hardness showed there to be one copper chronic AWQC exceedence and 24 lead exceedences. Since the IC hardness represents the total fraction of calcium and magnesium these were presented in this report.

6.0 2004 STUDY DESIGN

In 2004, the Core Monitoring Program parameter list will continue unchanged. At five selected stations additional samples will be collected for mercury and ortho-phosphorus to evaluate a different sampling method. Targeted pipe monitoring will continue in 2004 at identified hot spots in the Basin for fecal coliform and E. coli bacteria. Future monitoring may change as different data needs arise.

7.0 REFERENCES

Breault, R.F, United States Geological Service. 2001. Personal Communication.

Breault, R.F,,Barlow, L.K., Reisig, K.D., Parker, G.W., 2000. Spatial Distribution, Temporal Variability, and Chemistry of the Salt Wedge in the Lower Charles River, Massachusetts, June 1998 to July 1999. United States Geological Service. Water-Resources Investigation Report 00-4124

Charles River Watershed Association. 1997. Charles River Watershed Integrated Monitoring, Modeling and Management Project Phase II Interim Report.

Federal Interagency Stream Restoration Working Group. 1998. Stream Corridor Restoration Principles, Processes, and Practices. EPA841_R_98_900

Fiorentino, J.F., Kennedy, L.E., Weinstein, M.J., 2000. Charles River Watershed 1997/1998 Water Quality Assessment Report. Massachusetts Department of Environmental Protection. Report Number 72-AC-3

Massachusetts Department of Environmental Protection, Division of Watershed Management. 1998. Commonwealth of Massachusetts Summary of Water Quality Report.

Metcalf & Eddy. 1994. Baseline Water Quality Assessment. Master Planning and CSO Facility Planning. Report prepared for MWRA

New England Water Pollution Control Commission and ENSR International. 2000. Collection and Evaluation of Ambient Nutrient Data for Lakes, Ponds, and Reservoirs in New England – Data Synthesis Report. Final Report. June 2000.

United States Environmental Protection Agency. 2001. Ambient Water Quality Criteria Recommendations – Lakes and Reservoirs in Nutrient Ecoregion XIV. U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA-822-B-01-011

United States Environmental Protection Agency. 2000. Ambient Water Quality Criteria Recommendations – Rivers and Streams in Nutrient Ecoregion XIV. U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA-822-B-00-022

United States Environmental Protection Agency. 1997. Charles River Sediment/Water Quality Analysis Project Report. U. S. Environmental Protection Agency, Office of Environmental Measurement and Evaluation, Region

United States Environmental Protection Agency. 1996. Charles River Shoreline Survey. U. S. Environmental Protection Agency, Office of Environmental Measurement and Evaluation, Region I

United States Environmental Protection Agency. 2003. Clean Charles 2005 Water Quality Report, 2002 Core Monitoring Program. U. S. Environmental Protection Agency, Office of Environmental Measurement and Evaluation, Region I

United States Environmental Protection Agency. 1994. Water Quality Standards Handbook - Second Edition. U.S. Environmental Protection Agency, Water Quality Standards Branch, Washington, DC. EPA-823-B-94-005a

Charles River Data Report

In 1995, the U.S. 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 incorporates a comprehensive approach for improving water quality through: Combined Sewer Overflow (CSO) controls, illicit sanitary connection removals, stormwater management, 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 to meet the Clean Charles 2005 Initiative goals. The program is designed to sample during the summer months that coincide with peak recreational uses.

In the year 2003, the program monitored a total of twelve stations. Of the twelve "Core" stations monitored, ten were located in the Basin, one was located on the upstream side of the Watertown Dam, and another was located immediately downstream of the South Natick Dam (to establish upstream boundary conditions). Seven of the twelve stations were monitored during wet weather conditions. Five sampling stations were located in priority resource areas, which were identified as potential wading and swimming locations. In 2002, sampling at priority resource site CRBL08 was discontinued to allow resources to be shifted to a new nearby station in the main stem of the River (CRBLA8).

At each sampling stations, the following parameters were measured in the surface water: dissolved oxygen, temperature, pH, specific conductance, salinity, turbidity, transmissivity, Secchi disk transparency, chlorophyll a, total organic carbon, total suspended solids, apparent and true color, nutrients, bacteria, and dissolved metals. Below are descriptions of the sampling stations:

PRIMARY CORE MONITORING STATION DESCRIPTIONS	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 – center channel	CRBL06
Downstream of Stony Brook & Mass Ave, 10 m off South shore	CRBL07
~~**Pond at Esplanade**~~	~~**CRBL08**~~
Off the Esplanade (new station in 2002)	**CRBLA8**
Upstream of Longfellow Bridge, Cam. side	CRBL09
Community boating area	**CRBL10**
Between Longfellow Bridge & Old Dam – center channel	CRBL11
Upstream of Railroad Bridge – center channel	CRBL12

~~CRBL08~~ = Discontinued station

Bold = Priority Resource areas

List of Tables and Figures

Table A-1: Results from 7/8/03 Dry Weather Core Monitoring Sampling

Station	Time	Temp (Deg C)	DO (mg/l)	DO (%)	pH	Sp Cond. (uS/cm)	Salinity (ppth)	Turbidity (NTU)	Secchi (meters)	Transmissivity (%)	True Color (color units)	Apparent Color (color units)	TOC (mg/L)	TSS (mg/L)	Fecal coliform (cfu/100ml)	E.coli (cfu/100ml)	Chlorophyll a (ug/L)	Orthophosphate as P (ug/L)	Total Phosphorus (ug/L)	NH3 as N (mg/L)	Nitirite as N (mg/L)	Nitrate as N (mg/L)
CRBL01	910	26.9	6.6	82.7	6.9	355	0.17	NA	NA	56.2	100	120	11	2.5	48	40	10	39	118	0.24	ND(0.03)	0.93
CRBL02	1015	27.4	6.9	87.3	7.0	384	0.18	NA	NA	57.8	100	120	12	3.5	230	170	8	28	95	ND (0.075)	ND (0.03)	0.72
CRBL03	1345	28.1	6.6	84.8	7.0	421	0.2	NA	1.3	54.6	110	140	11	5	240	227	5	28	100	ND (0.075)	ND (0.03)	0.74
CRBL04	1310	29.2	7.8	101.7	7.0	420	0.2	NA	1.1	43	100	110	10	5.8	128	84	15	22	95	ND (0.075)	ND (0.03)	0.72
CRBL05	1225	29.3	7.7	101.2	7.2	409	0.19	NA	1.2	47.3	110	120	11	5.8	152	88	23	15	87	ND (0.075)	ND (0.03)	0.72
CRBL06	1130	28.4	7.0	90.2	7.0	407	0.19	NA	1.1	NA	100	120	11	6.3	300	200	17	17	90	ND (0.075)	ND (0.03)	0.54
CRBL07	1110	29.3	7.0	91.6	7.1	416	0.2	NA	1.2	52.4	100	110	9.3	3.8	52	40	9	24	89	0.157	ND (0.03)	0.41
CRBLA8	1040	28.9	6.8	88.6	7.2	420	0.2	NA	1.2	54.8	90	100	9	4.3	20	16	12	23	86	0.151	ND (0.03)	0.47
CRBL09	1015	28.3	6.5	82.9	7.1	421	0.2	NA	1.2	52.4	80	100	9	5	28	20	9	27	97	0.178	ND (0.03)	0.47
CRBL10	940	28.9	5.6	72	7.1	450	0.21	NA	1.4	55.7	90	100	8.9	3.8	20	20	7	30	92	0.21	ND (0.03)	0.52
CRBL11	915	29.1	5.5	72.3	7.2	444	0.21	NA	1.3	54.6	90	110	9.1	3.8	12	8	5	30	93	0.233	ND (0.03)	0.52
CRBL12	830	28.1	5.4	69.4	7.3	534	0.26	NA	1.3	56.5	90	110	12	3.5	8	8	6	32	90	0.222	ND (0.03)	0.52
CRBL06 (dup)	1130	28.4	7.0	90.2	7.0	407	0.19	NA	1.1	NA	100	120	9.8	5.8	320	260	16	17	91	ND (0.075)	ND (0.03)	0.5
CRBL00 (blank)	1430*	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(0.0)	ND(0.0)	ND(5.0)	ND(2.5)	ND	ND	ND (2)	ND(5.0)	ND(5.0)	ND (0.075)	ND (0.03)	ND(0.02)

Dissolved Metals																							
Station	Time	Aluminum (ug/L)	Antimony (ug/L)	Arsenic (ug/L)	Barium (ug/L)	Beryllium (ug/L)	Cadmium (ug/L)	Calcium (mg/L)	Chromium (ug/L)	Cobalt (ug/L)	Copper (ug/L)	Iron (ug/L)	Lead (ug/L)	Magnesium (mg/L)	Manganese (ug/L)	Molybdenum (ug/L)	Nickel (ug/L)	Selenium (ug/L)	Silver (ug/L)	Thallium (ug/L)	Vanadium (ug/L)	Zinc (ug/L)	Mercury (ng/l)
CRBL01	910	36	ND(0.50)	0.73	41	ND(0.20)	ND(0.20)	16	1.5	0.36	2ND	940	1.6	3.2	150	1.0	1.4	ND(1.0)	ND(0.20)	ND(0.50)	1.0	ND(5.0)	5.2
CRBL02	1015	31	ND(0.50)	0.86	45	ND(0.20)	ND(0.20)	17	1.5	0.27	3.7	900	2.5	3.5	93	0.96	1.4	ND(1.0)	ND(0.20)	ND(0.50)	1.1	ND(5.0)	4.9
CRBL03	1345	30	ND(0.50)	0.92	47	ND(0.20)	ND(0.20)	18	1.7	0.32	3.3	860	2.7	3.7	110	1.0	1.5	ND(1.0)	ND(0.20)	ND(0.50)	1.2	ND(5.0)	11.7
CRBL04	1310	33	ND(0.50)	0.89	45	ND(0.20)	ND(0.20)	18	1.6	0.33	3.7	850	3.6	3.7	130	1.0	1.5	ND(1.0)	ND(0.20)	ND(0.50)	1.3	ND(5.0)	6.2
CRBL05	1225	34	ND(0.50)	0.95	43	ND(0.20)	ND(0.20)	17	1.7	0.30	4.0	850	4.6	3.6	120	1.1	1.5	ND(1.0)	ND(0.20)	ND(0.50)	1.5	ND(5.0)	5.5
CRBL06	1130	33	0.90	0.92	42	ND(0.20)	ND(0.20)	17	1.6	0.26	4.0	800	4.5	3.5	110	1.1	1.5	ND(1.0)	ND(0.20)	ND(0.50)	1.4	6.2	5.5
CRBL07	1110	33	ND(0.50)	0.92	40	ND(0.20)	ND(0.20)	16	1.6	0.52	5.0	690	4.5	3.8	100	0.95	1.6	ND(1.0)	ND(0.20)	ND(0.50)	1.4	6.5	6.5
CRBLA8	1040	33	0.82	0.92	40	ND(0.20)	ND(0.20)	17	1.8	ND(0.20)	5.1	660	4.1	3.9	100	0.96	1.5	ND(1.0)	ND(0.20)	ND(0.50)	1.4	6.3	5.4
CRBL09	1015	34	ND(0.50)	0.88	40	ND(0.20)	ND(0.20)	17	1.6	0.32	5.0	670	4.9	3.9	110	0.96	1.5	ND(1.0)	ND(0.20)	ND(0.50)	1.4	6.7	6.7
CRBL10	940	33	ND(0.50)	0.87	40	ND(0.20)	ND(0.20)	17	1.6	0.21	5.5	680	4.4	4.4	110	0.96	1.5	ND(1.0)	ND(0.20)	ND(0.50)	1.4	6.4	7.3
CRBL11	915	33	ND(0.50)	0.92	40	ND(0.20)	ND(0.20)	17	1.6	0.22	6.1	690	4.5	4.3	110	0.97	1.5	ND(1.0)	ND(0.20)	ND(0.50)	1.4	6.8	6.8
CRBL12	830	32	ND(0.50)	0.93	40	ND(0.20)	ND(0.20)	17	1.5	0.26	5.8	660	4.3	5.7	110	0.96	1.5	ND(1.0)	ND(0.20)	ND(0.50)	1.4	6.7	5.8
CRBL06 (dup)	1130	33	1.4	0.96	43	ND(0.20)	ND(0.20)	17	1.6	0.35	3.9	820	4.5	3.6	110	0.99	1.6	ND(1.0)	ND(0.20)	ND(0.50)	1.5	7.4	6.6
CRBL00 (blank)	1315*	ND(5.0)	ND(0.50)	ND(0.50)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.10)	ND(0.50)	ND(0.20)	0.4ND	ND(50)	ND(0.20)	ND(0.10)	ND(0.20)	ND(0.50)	ND(0.20)	ND(1.0)	ND(0.20)	ND(0.50)	ND(0.20)	ND(5.0)	ND (1.0)

Additional anions and cations										
Station	Time	Bromide (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Sulfate (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Hardness mg CaCO3/L
CRBL01	910	ND(0.5)	~88	0.11	8.4	18	3.7	3.2	51	60
CRBL02	1015	ND(0.5)	~99	0.11	8.2	19	4.1	2.6	~55	64
CRBL03	1345	ND(0.5)	~103	0.11	8.8	19	4.2	2.7	~58	65
CRBL04	1310	ND(0.5)	~103	0.11	8.7	19	4.3	2.8	~59	65
CRBL05	1225	ND(0.5)	~100	0.12	8.9	19	4.1	2.7	~58	64
CRBL06	1130	ND(0.5)	~100	0.11	8.8	19	4.1	2.8	~58	64
CRBL07	1110	ND(0.5)	~102	0.1	9.4	18	4.3	2.7	~59	63
CRBLA8	1040	ND(0.5)	~99	ND(0.1)	9.8	17	4.3	2.7	~58	60
CRBL09	1015	ND(0.5)	~104	0.1	10	18	4.5	2.8	~61	63
CRBL10	940	ND(0.5)	~113	0.1	11	18	4.8	3	~66	65
CRBL11	915	ND(0.5)	~111	0.1	11	18	4.8	2.9	~65	65
CRBL12	830	ND(0.5)	~139	0.1	15	19	6.6	3.5	~81	75
CRBL06 (dup)	1130	ND(0.5)	~101	0.11	8.7	19	4.1	2.7	~59	64
CRBL00 (blank)	1315*	ND(0.5)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)

Note:
* Blank samples were collected in the laboratory at 1430 on 7/7/03, the dissolved metals filter blank was filtered in the field at 13:15 on 7/8/03
ND = not detected above the associated detection limit
A number prior to ND indicates that the value did not meet the blank criteria
NA = not available
~ = estimated data

Table A-2: Results from 8/19/03 Dry Weather Core Monitoring Sampling

Station	Time	Temp (Deg C)	DO (mg/l)	DO (%)	pH	Sp Cond. (uS/cm)	Salinity (ppth)	Turbidity (NTU)	Secchi (meters)	Transmissivity (%)	True Color (color units)	Apparent Color (color units)	TOC (mg/L)	TSS (mg/L)	Fecal coliform (cfu/100ml)	E.coli (cfu/100ml)	Chlorophyll a (ug/L)	Orthophosphate as P (ug/L)	Total Phosphorus (ug/L)	NH3 as N (mg/L)	Nitrite as N (mg/L)	Nitrate as N (mg/L)
CRBL01	910	23.5	6.7	79.1	6.7	334	0.16	5	NA	60.7	90	100	13	4	40	24	5	38	107	ND(0.075)	ND(0.03)	0.9
CRBL02	1020	24.2	7.0	84	6.9	404	0.19	5	NA	58	80	90	12	4.3	1054	955	7	26	91	ND(0.075)	ND(0.03)	0.7
CRBL03	1250	26.3	7.5	93.1	7.2	417	0.2	4	1.2	49.7	70	90	12	3.8	694	468	6	22	90	ND(0.075)	ND(0.03)	0.74
CRBL04	1215	26.6	8.0	99.5	7.1	428	0.2	10	1	42	70	80	11	5.5	1100	1100	14	18	93	ND(0.075)	ND(0.03)	0.79
CRBL05	1130	25.7	6.9	84.9	7.1	421	0.2	9	0.9	37.9	80	90	10	9.3	800	800	16	15	90	ND(0.075)	ND(0.03)	0.7
CRBL06	1110	25.9	6.8	83.3	7.0	421	0.2	6	1	42	70	80	11	6.8	460	350	18	13	84	ND(0.075)	ND(0.03)	0.7
CRBL07	1040	26.2	7.0	87.1	7.1	425	0.2	28	1.2	45.1	60	70	9.7	6.8	230	170	20	14	77	ND(0.075)	ND(0.03)	0.81
CRBLA8	1020	26.1	7.7	94.5	7.3	455	0.22	5	1.4	55.1	40	60	8.7	5.8	40	32	19	7.6	59	ND(0.075)	ND(0.03)	0.59
CRBL09	950	25.8	7.5	92	7.2	512	0.25	5	1.2	52.7	40	60	8.2	6.8	28	20	26	7.7	58	ND(0.075)	ND(0.03)	0.56
CRBL10	925	26.6	6.5	81.3	7.2	549	0.26	7	1.6	57.9	50	70	7.7	4	24	8	21	8.9	58	0.126	ND(0.03)	0.59
CRBL11	900	26.9	6.4	80.7	7.2	559	0.27	5	1.5	57.6	60	60	9.2	4.8	12	8	22	11	59	ND(0.075)	ND(0.03)	0.61
CRBL12	825	26.3	7.8	97.3	7.2	716	0.35	5	1.4	59	60	70	7.9	4.5	52	28	22	11	90	0.154	ND(0.03)	0.63
CRBL09 (dup)	950	25.9	7.5	91.9	7.2	512	0.25	5	1.2	53.1	40	60	8.1	7.5	44	36	24	5.9	56	ND(0.075)	ND(0.03)	0.56
CRBL00 (blank)	1350*	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(0)	ND(0)	ND(5.0)	ND(2.5)	NA	NA	ND(2.0)	ND(5.0)	ND(5.0)	ND(0.075)	ND(0.03)	ND(0.02)

Dissolved Metals

Station	Time	Aluminum (ug/L)	Antimony (ug/L)	Arsenic (ug/L)	Barium (ug/L)	Beryllium (ug/L)	Cadmium (ug/L)	Calcium (mg/L)	Chromium (ug/L)	Cobalt (ug/L)	Copper (ug/L)	Iron (ug/L)	Lead (ug/L)	Magnesium (mg/L)	Manganese (ug/L)	Molybdenum (ug/L)	Nickel (ug/L)	Selenium (ug/L)	Silver (ug/L)	Thallium (ug/L)	Vanadium (ug/L)	Zinc (ug/L)	Mercury (ng/L)
CRBL01	910	32	ND(0.50)	0.62	38	ND(0.20)	ND(0.20)	16	1.4	0.28	2.5ND	780	1.2	3.2	82	1.2	1.4	ND(1.0)	ND(0.20)	ND(0.50)	0.93	ND(5.0)	6.6
CRBL02	1020	25	ND(0.50)	0.92	46	ND(0.20)	ND(0.20)	19	1.4	0.92	3.0ND	730	2.8	3.6	110	0.94	1.5	ND(1.0)	ND(0.20)	ND(0.50)	1.4	5.9	6.2
CRBL03	1250	24	ND(0.50)	0.87	46	ND(0.20)	ND(0.20)	19	1.1	0.53	3.0ND	690	3.1	3.7	130	0.91	1.4	ND(1.0)	ND(0.20)	ND(0.50)	1.3	ND(5.0)	5.7
CRBL04	1215	24	ND(0.50)	0.88	46	ND(0.20)	ND(0.20)	19	1.3	0.63	4.0ND	690	3.8	3.7	130	0.94	1.4	ND(1.0)	ND(0.20)	ND(0.50)	1.4	5.7	5.9
CRBL05	1130	25	ND(0.50)	1.0	43	ND(0.20)	ND(0.20)	19	1.2	0.68	4.0ND	750	5.8	3.6	160	0.96	1.4	ND(1.0)	ND(0.20)	ND(0.50)	1.7	ND(5.0)	9.5
CRBL06	1110	25	ND(0.50)	0.99	44	ND(0.20)	ND(0.20)	19	1.2	0.29	4.0ND	720	5.3	3.7	140	0.98	1.5	ND(1.0)	ND(0.20)	ND(0.50)	1.6	ND(5.0)	7.3
CRBL07	1040	21	ND(0.50)	0.93	40	ND(0.20)	ND(0.20)	19	1.3	ND(0.20)	7ND	620	4.5	4.0	49	0.99	1.4	ND(1.0)	ND(0.20)	ND(0.50)	1.6	5.7	7
CRBLA8	1020	15	ND(0.50)	0.82	38	ND(0.20)	ND(0.20)	19	1.3	ND(0.20)	5.0ND	430	3.2	4.8	9.1	1.0	1.4	ND(1.0)	ND(0.20)	ND(0.50)	1.4	ND(5.0)	4.8
CRBL09	950	13	0.57	0.90	37	ND(0.20)	ND(0.20)	19	1.3	0.47	5.0ND	360	3.0	5.8	12	1.2	1.5	ND(1.0)	ND(0.20)	ND(0.50)	1.3	ND(5.0)	7.3
CRBL10	925	12	ND(0.50)	0.95	37	ND(0.20)	ND(0.20)	19	1.4	0.40	5.0ND	350	2.7	6.4	6.1	1.1	1.4	ND(1.0)	ND(0.20)	ND(0.50)	1.3	ND(5.0)	5.2
CRBL11	900	13	ND(0.50)	1.0	36	ND(0.20)	ND(0.20)	19	1.4	0.40	6.0ND	350	2.7	6.6	6.3	1.1	1.5	ND(1.0)	ND(0.20)	ND(0.50)	1.3	ND(5.0)	4.6
CRBL12	825	11	0.67	1.0	37	ND(0.20)	ND(0.20)	20	1.5	1.1	6.0ND	310	2.4	9.2	6.1	1.1	1.5	ND(1.0)	ND(0.20)	ND(0.50)	1.3	5.1	4.6
CRBL09 (dup)	950	12	ND(0.50)	0.91	35	ND(0.20)	ND(0.20)	19	1.1	0.53	4.0ND	350	2.9	5.5	12	1.1	1.5	ND(1.0)	ND(0.20)	ND(0.50)	1.2	ND(5.0)	7
CRBL00 (blank)	1350*	ND(5.0)	ND(0.50)	ND(0.50)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.10)	ND(0.50)	ND(0.20)	1.0ND	ND(50)	ND(0.20)	ND(0.10)	ND(0.20)	ND(0.50)	ND(0.20)	ND(1.0)	ND(0.20)	ND(0.50)	ND(0.20)	ND(5.0)	ND(1.0)

Additional anions and cations

Station	Time	Bromide (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Sulfate (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Hardness mg CaCO3/L
CRBL01	910	ND(0.50)	~80	ND(0.10)	6.2	17	3.6	3.4	42	57
CRBL02	1020	ND(0.50)	~101	ND(0.10)	11	19	3.9	3.3	53	64
CRBL03	1250	ND(0.50)	~104	ND(0.10)	10	19	4.1	3.3	~55	64
CRBL04	1215	ND(0.50)	~107	ND(0.10)	11	19	4.1	3.2	~56	64
CRBL05	1130	ND(0.50)	~107	ND(0.10)	10	19	4.2	3.2	~56	65
CRBL06	1110	ND(0.50)	~106	ND(0.10)	10	19	4.1	3.2	~56	64
CRBL07	1040	ND(0.50)	~107	ND(0.10)	10	19	4.2	3.2	~56	65
CRBLA8	1020	ND(0.50)	~117	ND(0.10)	12	19	5.0	3.4	~62	68
CRBL09	950	ND(0.50)	~137	ND(0.10)	14	19	6.2	3.8	~71	73
CRBL10	925	ND(0.50)	~150	ND(0.10)	16	19	6.9	4	~77	76
CRBL11	900	ND(0.50)	~153	ND(0.10)	16	19	7.0	4.0	~79	76
CRBL12	825	ND(0.50)	~214	ND(0.10)	22	20	10	5.1	~106	91
CRBL09 (dup)	950	ND(0.50)	137	ND(0.10)	15	19	6.1	3.5	~71	73
CRBL00 (blank)	1350*	ND(0.50)	ND(0.10)	ND(0.10)	ND(0.10)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)

Note:
* Blank samples were collected in the laboratory at 13:50 on 8/18/03, the dissolved metals filter blank was filtered in the field at 12:50 on 8/18/03
ND = not detected above the associated detection limit
A number prior to ND indicates that the value did not meet the blank criteria
NA = not availab
~ = estimated da

Table A-3: Results from 9/09/03 Dry Weather Core Monitoring Sampling

Station	Time	Temp (Deg C)	DO (mg/L)	DO (%)	pH	Sp Cond. (uS/cm)	Salinity (ppt h)	Turbidity (NTU)	Secchi (meters)	Transmissivity (%)	True Color (color units)	Apparent Color (color units)	TOC (mg/L)	TSS (mg/L)	Fecal coliform (cfu/100ml)	E.coli (cfu/100ml)	Chlorophyll a (ug/L)	Orthophosphate as P (ug/L)	Total Phosphorus (ug/L)	NH3 as N (mg/L)	Nitirite as N (mg/L)	Nitrate as N (mg/L)
CRBL01	10:30	20.4	7.7	84.4	7.1	445	NA	3	NA	78.9	35	35	5.9	ND(2.5)	32	28	5	ND(10)	25	ND(0.075)	ND(0.03)	1.2
CRBL02	11:35	20.3	7.6	82.2	7.2	480	NA	4	NA	74.1	35	40	5.6	3	211	136	8	ND(10)	40	ND(0.075)	ND(0.03)	0.43
CRBL03	13:35	20.9	8.7	97.6	7.3	491	0.24	4	1.4	64.5	35	35	5.5	5.5	80	80	9	ND(10)	33	ND(0.075)	ND(0.03)	0.38
CRBL04	12:55	21.5	9.6	108.7	7.4	520	0.25	5	1	48.4	40	45	6.2	8.5	NA	NA	31	ND(10)	41	ND(0.075)	ND(0.03)	0.47
CRBL05	12:20	21.3	11.1	125.3	7.8	513	0.25	8	0.7	33	40	45	6.2	15	270	250	66	ND(10)	50	ND(0.075)	ND(0.03)	0.16
CRBL06	11:45	21.2	9.9	111.5	7.4	556	0.27	8	0.7	33.7	45	50	6.5	15	500	190	62	ND(10)	56	ND(0.075)	ND(0.03)	0.45
CRBL07	11:05	21.4	9.2	103.7	7.6	883	0.43	8	1	54.8	40	45	6.2	8.3	20	12	35	ND(10)	39	0.087	ND(0.03)	0.47
CRBLA8	10:30	21.6	9.0	102.4	7.6	917	0.45	4	1.2	57.1	40	50	6.6	6.5	28	24	32	ND(10)	36	0.086	ND(0.03)	0.5
CRBL09	10:10	21.9	8.2	94	7.4	973	0.48	5	1.2	54.4	40	45	6.6	8.8	14	14	32	ND(10)	43	0.093	ND(0.03)	0.5
CRBL10	9:50	22.2	8.1	92.7	7.4	1048	0.52	4	1.2	54.7	45	50	6.4	5.8	32	24	28	ND(10)	39	0.118	ND(0.03)	0.52
CRBL11	9:15	22.6	8.1	94.3	7.4	1060	0.52	4	1.2	59.3	40	45	6.7	4.8	16	4	30	ND(10)	40	0.116	ND(0.03)	0.52
CRBL12	8:40	22.5	8.2	94.6	7.2	1217	0.61	3	1.2	61.5	35	40	6.9	5	64	60	25	ND(10)	37	0.105	ND(0.03)	0.54
CRBL07 (dup)	11:06	21.5	9.1	103.2	7.6	882	0.43	5	1	54.6	35	40	6.4	8.8	28	20	36	ND(10)	43	ND(0.075)	ND(0.03)	0.5
CRBL00 (blank)	15:10*	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(0)	ND(0)	ND(5.0)	ND(2.5)	NA	NA	ND(2)	ND(10)	ND(5.0)	ND(0.075)	ND(0.03)	ND(0.02)

Dissolved Metals

Station	Time	Aluminum (ug/L)	Antimony (ug/L)	Arsenic (ug/L)	Barium (ug/L)	Beryllium (ug/L)	Cadmium (ug/L)	Calcium (mg/L)	Chromium (ug/L)	Cobalt (ug/L)	Copper (ug/L)	Iron (ug/L)	Lead (ug/L)	Magnesium (mg/L)	Manganese (ug/L)	Molybdenum (ug/L)	Nickel (ug/L)	Selenium (ug/L)	Silver (ug/L)	Thallium (ug/L)	Vanadium (ug/L)	Zinc (ug/L)	Mercury (ng/L)
CRBL01	10:30	7.8	ND(0.50)	ND(0.50)	38	ND(0.20)	ND(0.20)	19	ND(0.50)	2.0	3.7	130	0.40	4.0	31	1.7	1.4	ND(1.0)	ND(0.20)	ND(0.50)	0.38	ND(5.0)	1.8
CRBL02	11:35	8.3	ND(0.50)	0.57	43	ND(0.20)	ND(0.20)	22	ND(0.50)	0.39	3.0ND	200	0.83	4.6	58	1.1	1.3	ND(1.0)	ND(0.20)	ND(0.50)	0.51	5.6	2.2
CRBL03	13:35	12	ND(0.50)	0.56	43	ND(0.20)	ND(0.20)	21	ND(0.50)	0.95	3.1	210	1.1	4.6	66	1.1	1.4	ND(1.0)	ND(0.20)	ND(0.50)	0.56	ND(5.0)	3.6
CRBL04	12:55	11	ND(0.50)	0.59	45	ND(0.20)	ND(0.20)	23	ND(0.50)	0.75	3.4	180	1.2	4.9	59	1.2	1.5	ND(1.0)	ND(0.20)	ND(0.50)	0.58	ND(5.0)	4.9
CRBL05	12:20	11	ND(0.50)	0.63	41	ND(0.20)	ND(0.20)	22	ND(0.50)	0.67	4.0	140	1.2	4.8	10	1.2	1.5	ND(1.0)	ND(0.20)	ND(0.50)	0.61	ND(5.0)	7.9
CRBL06	11:45	7.9	ND(0.50)	0.67	39	ND(0.20)	ND(0.20)	22	ND(0.50)	1.1	4.3	130	1.0	5.1	10	1.3	1.5	ND(1.0)	ND(0.20)	ND(0.50)	0.59	ND(5.0)	16.8
CRBL07	11:05	6.9	0.78	0.96	39	ND(0.20)	ND(0.20)	24	ND(0.50)	0.29	5.4	150	1.5	11	5.0	1.6	1.6	1.3	ND(0.20)	ND(0.50)	0.73	ND(5.0)	5.4
CRBLA8	10:30	6.2	0.73	1.0	38	ND(0.20)	ND(0.20)	25	ND(0.50)	3.4	5.5	150	1.4	12	8.5	1.6	1.9	1.3	ND(0.20)	ND(0.50)	0.66	ND(5.0)	4.5
CRBL09	10:10	7.3	0.80	1.1	39	ND(0.20)	ND(0.20)	25	ND(0.50)	3.5	6.0	140	1.4	13	20	4.4	2.0	1.6	ND(0.20)	ND(0.50)	0.69	ND(5.0)	9.3
CRBL10	9:50	6.0	0.56	1.2	39	ND(0.20)	ND(0.20)	25	ND(0.50)	0.89	8.0	140	1.6	15	6.7	1.6	1.7	2.0	ND(0.20)	ND(0.50)	0.67	ND(5.0)	4.4
CRBL11	9:15	5.6	0.52	1.0	38	ND(0.20)	ND(0.20)	25	ND(0.50)	0.66	6.1	130	1.2	15	7.9	1.5	1.8	1.8	ND(0.20)	ND(0.50)	0.64	ND(5.0)	3.9
CRBL12	8:40	17	0.76	1.3	39	ND(0.20)	ND(0.20)	26	0.51	4.3	7.4	190	2.5	17	35	1.6	2.0	2.2	ND(0.20)	ND(0.50)	0.84	5.4	3.1
CRBL07 (dup)	11:06	6.8	0.54	0.93	38	ND(0.20)	ND(0.20)	25	ND(0.50)	0.73	4.9	140	1.5	11	5.2	1.7	1.7	1.2	ND(0.20)	ND(0.50)	0.72	ND(5.0)	5.6
CRBL00 (blank)	15:10*	ND(5.0)	ND(0.50)	ND(0.50)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.10)	ND(0.50)	ND(0.20)	0.5ND	ND(50)	ND(0.20)	ND(0.10)	ND(0.20)	ND(0.50)	ND(0.20)	ND(1.0)	ND(0.20)	ND(0.50)	ND(0.20)	ND(5.0)	ND(1.0)

Additional anions and cations

Station	Time	Bromide (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Sulfate (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Hardness mg CaCO3/L
CRBL01	10:30	ND(0.50)	~100	ND(0.10)	13	19	4.1	5.2	~53	64
CRBL02	11:35	ND(0.50)	~112	ND(0.10)	13	21	4.7	3.5	~59	72
CRBL03	13:35	ND(0.50)	~117	ND(0.10)	14	22	4.8	3.5	~61	75
CRBL04	12:55	ND(0.50)	~125	ND(0.10)	15	23	5.0	3.5	~66	78
CRBL05	12:20	ND(0.50)	~121	ND(0.10)	16	22	4.9	3.4	~65	75
CRBL06	11:45	ND(0.50)	~133	ND(0.10)	18	22	5.6	3.6	~72	78
CRBL07	11:05	ND(0.50)	~250	ND(0.10)	28	24	12	5.6	~127	109
CRBLA8	10:30	ND(0.50)	~259	ND(0.10)	29	24	13	5.7	~132	113
CRBL09	10:10	ND(0.50)	~280	ND(0.10)	31	24	14	6.1	~140	118
CRBL10	9:50	ND(0.50)	~307	ND(0.10)	33	25	15	6.4	~152	124
CRBL11	9:15	ND(0.50)	~306	ND(0.10)	33	25	15	6.4	~152	124
CRBL12	8:40	ND(0.50)	~372	ND(0.10)	39	26	18	7.4	~181	139
CRBL07 (dup)	11:06	ND(0.50)	~249	ND(0.10)	28	24	12	5.4	~127	109
CRBL00 (blank)	15:10*	ND(0.50)	ND(0.10)	ND(0.10)	ND(0.10)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)

Note:
* Blank samples were collected in laboratory at 15:10 on 9/10/03, the dissolved metals filter blank was filtered in the field at 13:00 on 9/11/03
ND = not detected above the associated detection limit
A number prior to ND indicates that the value did not meet the blank criteria
NA = not available
~ = estimated data

Table A-4: Results from 9/15/03 Dry Weather Core Monitoring Pre-storm Sampling

Station	Time	Temp (Deg C)	DO (mg/L)	DO (%)	pH	Sp Cond. (uS/cm)	Salinity (ppt h)	Turbidity (NTU)	Secchi (meters)	Transmissivity (%)	True Color (color units)	Apparent Color (color units)	TOC (mg/L)	TSS (mg/L)	Fecal coliform (cfu/100ml)	E.coli (cfu/100ml)	Chlorophyll a (ug/L)	Orthophosphate as P (ug/L)	Total Phosphorus (ug/L)	NH3 as N (mg/L)	Nitirite as N (mg/L)	Nitrate as N (mg/L)
CRBL02	18:50	23.0	8.9	104.2	7.7	508	0.24	3	NA	83.9	20	30	5.5	ND(2.5)	226	189	7	9.8	30	ND(0.075)	ND(0.03)	0.47
CRBL05	17:10	23.3	11.6	136.1	8.6	563	0.27	5	1.2	53.79	35	40	6.3	8.5	253	234	35	5.3	30	ND(0.075)	ND(0.03)	0.34
CRBL06	16:50	23.6	11.7	138.2	8.7	666	0.32	5	1.4	56.9	35	35	6.2	8	96	68	28	~3.8	28	ND(0.075)	ND(0.03)	0.38
CRBL07	16:10	22.9	11.8	137.6	8.8	822	0.4	6	1.4	58.4	35	45	7.2	9.3	24	16	31	~4	34	ND(0.075)	ND(0.03)	0.41
CRBLA8	15:55	22.8	12.5	145.6	8.9	929	0.46	6	1.4	58.4	NA	NA	NA	NA	ND(4)	ND(4)	NA	NA	NA	NA	NA	NA
CRBL09	15:45	23.5	12.0	141.3	8.9	1067	0.53	6	1.4	58.8	35	40	6.6	7.3	8	4	23	ND(5.0)	30	ND(0.075)	ND(0.03)	0.45
CRBL11	15:10	24.1	11.5	136.9	8.7	1114	0.55	5	1.4	60.2	35	40	6.5	7	ND(4)	ND(4)	29	ND(5.0)	35	ND(0.075)	ND(0.03)	0.47
CRBL05 (dup)	17:10	23.3	11.6	135.7	8.6	566	0.27	5	1.2	54	35	45	6.4	9	230	183	34	~4.7	39	0.083	ND(0.03)	0.34
CRBL00 (blank)	11:50	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Dissolved Metals																							
Station	Time	Aluminum (ug/L)	Antimony (ug/L)	Arsenic (ug/L)	Barium (ug/L)	Beryllium (ug/L)	Cadmium (ug/L)	Calcium (mg/L)	Chromium (ug/L)	Cobalt (ug/L)	Copper (ug/L)	Iron (ug/L)	Lead (ug/L)	Magnesium (mg/L)	Manganese (ug/L)	Molybdenum (ug/L)	Nickel (ug/L)	Selenium (ug/L)	Silver (ug/L)	Thallium (ug/L)	Vanadium (ug/L)	Zinc (ug/L)	Mercury (ng/L)
CRBL02	18:50	10	ND(0.50)	0.55	42	ND(0.20)	ND(0.20)	23	1.0	0.32	2ND	110	0.48	5.0	49	1.2	1.4	ND(1.0)	ND(0.20)	ND(0.50)	0.59	ND(5.0)	1.6
CRBL05	17:10	10	ND(0.50)	0.66	41	ND(0.20)	ND(0.20)	24	1.2	0.46	3.5	91	0.81	6.3	2.0	1.3	1.5	ND(1.0)	ND(0.20)	ND(0.50)	0.76	ND(5.0)	3.6
CRBL06	16:50	8.6	ND(0.50)	0.78	40	ND(0.20)	ND(0.20)	24	1.2	0.29	4.0	78	0.80	8.1	2.5	1.5	1.6	ND(1.0)	ND(0.20)	ND(0.50)	0.81	ND(5.0)	1.9
CRBL07	16:10	9.4	ND(0.50)	0.95	40	ND(0.20)	ND(0.20)	26	1.3	0.20	4.3	77	0.88	11	4.1	1.9	1.5	1.1	ND(0.20)	ND(0.50)	0.87	ND(5.0)	2.5
CRBLA8	15:55	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CRBL09	15:45	5.4	ND(0.50)	1.1	40	ND(0.20)	ND(0.20)	27	1.2	ND(0.20)	5.9	67	0.77	16	3.5	2.4	1.8	1.7	ND(0.20)	ND(0.50)	0.86	ND(5.0)	1.8
CRBL11	15:10	ND(5.0)	0.56	1.2	39	ND(0.20)	ND(0.20)	27	1.4	0.30	6.3	72	0.75	17	5.8	2.5	1.8	1.7	ND(0.20)	ND(0.50)	0.91	ND(5.0)	2
CRBL05 (dup)	17:10	11	ND(0.50)	0.67	41	ND(0.20)	ND(0.20)	24	1.1	0.33	3.5	92	0.83	6.2	2.0	1.3	1.5	ND(1.0)	ND(0.20)	ND(0.50)	0.72	ND(5.0)	2.4
CRBL00 (blank)	11:50	ND(5.0)	ND(0.50)	ND(0.50)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.10)	ND(0.50)	ND(0.20)	0.5ND	ND(50)	ND(0.20)	ND(0.10)	ND(0.20)	ND(0.50)	ND(0.20)	ND(1.0)	ND(0.20)	ND(0.50)	ND(0.20)	ND(5.0)	ND(1.0)

Additional anions and cations										
Station	Time	Bromide (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Sulfate (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Hardness mg CaCO3/L
CRBL02	18:50	ND(0.50)	~152	ND(0.10)	15	22	4.8	4.1	~63	75.0
CRBL05	17:10	ND(0.50)	~199	ND(0.10)	16	22	5.6	3.6	~72	78.0
CRBL06	16:50	ND(0.50)	~230	ND(0.10)	21	23	7.6	4.3	~88	89.0
CRBL07	16:10	ND(0.50)	~296	ND(0.10)	26	24	10	5.1	~112	101.0
CRBLA8	15:55	NA	NA	NA	NA	NA	NA	NA	NA	NA
CRBL09	15:45	ND(0.50)	~316	ND(0.10)	36	25	15	6.5	~150	124.0
CRBL11	15:10	ND(0.50)	~323	ND(0.10)	37	26	16	6.8	~160	131.0
CRBL05 (dup)	17:10	ND(0.50)	~197	ND(0.10)	16	22	5.7	3.7	~72	78.0
CRBL00 (blank)	11:50*	NA	NA	NA	NA	NA	NA	NA	NA	NA

Note:
* Blank samples were collected in the laboratory at 11:50 on 9/15/03, the dissolved metals filter blank was filtered in the field at 16:10 on 9/15/03
ND = not detected above the associated detection limit
A number prior to ND indicates that the value did not meet the blank criteria
NA = not available

Table A-5: Results from 9/16/03 Wet Weather Core Monitoring First Flush Sampling

Station	Time	Temp (Deg C)	DO (mg/l)	DO (%)	pH	Sp Cond. (uS/cm)	Salinity (ppth)	Turbidity (NTU)	Secchi (meters)	Transmissivity (%)	True Color (color units)	Apparent Color (color units)	TOC (mg/L)	TSS (mg/L)	Fecal coliform (cfu/100ml)	E.coli (cfu/100ml)	Chlorophyll a (ug/L)	Orthophosphate as P (ug/L)	Total Phosphorus (ug/L)	NH3 as N (mg/L)	Nitirite as N (mg/L)	Nitrate as N (mg/L)
CRBL02	5:35	21.4	6.5	73.5	7.5	499	0.24	4	NA	NA	30	35	5.3	3.3	540	480	NA	11	~36	0.116	ND(0.03)	0.5
CRBL05	6:55	22.4	9.5	109.8	7.9	517	0.25	5	NA	NA	35	45	6.3	8	1099	423	NA	ND(5.0)	~25	ND(0.075)	ND(0.03)	0.34
CRBL06	7:15	22.2	9.1	104	7.7	527	0.25	5	NA	NA	35	40	6.1	6.5	1500	200	NA	~4.2	~26	0.08	ND(0.03)	0.38
CRBL07	7:30	22.4	9.7	111.7	8.0	761	0.37	6	NA	NA	35	40	6.5	6	56	36	NA	ND(5.0)	~33	0.08	ND(0.03)	0.43
CRBLA8	8:10	22.5	9.7	111.9	8.4	908	0.45	6	NA	NA	NA	NA	NA	NA	20	12	NA	NA	NA	NA	NA	NA
CRBL09	7:50	22.8	9.4	109.3	8.2	1034	0.51	6	NA	NA	35	35	8.1	5.3	8	8	NA	ND(5.0)	~17	ND(0.075)	ND(0.03)	0.45
CRBL11	8:25	22.9	9.3	108.1	8.2	1083	0.54	6	NA	NA	35	45	7.5	5.3	40	36	NA	ND(5.0)	~30	ND(0.075)	ND(0.03)	0.47
CRBL11 (dup)	8:25	22.9	9.5	110.7	8.2	1082	0.54	6	NA	NA	35	40	7.9	5	44	40	NA	ND(5.0)	~20	ND(0.075)	ND(0.03)	0.47
CRBL00 (blank)	3:50	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Dissolved Metals																							
Station	Time	Aluminum (ug/L)	Antimony (ug/L)	Arsenic (ug/L)	Barium (ug/L)	Beryllium (ug/L)	Cadmium (ug/L)	Calcium (mg/L)	Chromium (ug/L)	Cobalt (ug/L)	Copper (ug/L)	Iron (ug/L)	Lead (ug/L)	Magnesium (mg/l)	Manganese (ug/L)	Molybdenum (ug/L)	Nickel (ug/L)	Selenium (ug/L)	Silver (ug/L)	Thallium (ug/L)	Vanadium (ug/L)	Zinc (ug/L)	Mercury (ng/L)
CRBL02	5:35	6.2	ND(0.50)	0.51	48	ND(0.20)	ND(0.20)	24	1.2	0.26	2.8	130	0.53	5.0	65	1.2	1.5	ND(1.0)	ND(0.20)	ND(0.50)	0.66	ND(5.0)	2.9
CRBL05	6:55	8.4	ND(0.50)	0.54	42	ND(0.20)	ND(0.20)	24	1.2	0.29	3.6	90	0.65	5.5	4.6	1.3	1.5	ND(1.0)	ND(0.20)	ND(0.50)	0.70	ND(5.0)	4.2
CRBL06	7:15	8.2	ND(0.50)	0.59	41	ND(0.20)	ND(0.20)	24	1.2	0.61	3.3	120	0.85	5.5	20	1.4	1.5	ND(1.0)	ND(0.20)	ND(0.50)	0.70	ND(5.0)	3.3
CRBL07	7:30	6.9	ND(0.50)	0.79	40	ND(0.20)	ND(0.20)	25	1.1	0.29	4.5	69	0.77	11	2.9	1.8	1.6	ND(1.0)	ND(0.20)	ND(0.50)	0.76	ND(5.0)	1.9
CRBLA8	8:10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CRBL09	7:50	5.8	ND(0.50)	1.0	41	ND(0.20)	ND(0.20)	27	1.1	0.35	5.5	67	0.80	15	4.1	2.2	1.7	1.7	ND(0.20)	ND(0.50)	0.79	ND(5.0)	2.2
CRBL11	8:25	5.1	ND(0.50)	1.1	40	ND(0.20)	ND(0.20)	27	1.1	0.43	5.9	70	0.83	16	9.2	2.2	1.8	1.8	ND(0.20)	ND(0.50)	0.79	ND(5.0)	2.4
CRBL11 (dup)	8:25	5.2	ND(0.50)	1.1	40	ND(0.20)	ND(0.20)	28	1.1	0.34	5.8	60	0.74	16	8.6	2.2	1.7	1.6	ND(0.20)	ND(0.50)	0.84	ND(5.0)	2.3
CRBL00 (blank)	3:50	ND(5.0)	ND(0.50)	ND(0.50)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.10)	ND(0.50)	ND(0.20)	0.5ND	ND(50)	ND(0.20)	ND(0.10)	ND(0.20)	ND(0.50)	ND(0.20)	ND(1.0)	ND(0.20)	ND(0.50)	ND(0.20)	ND(5.0)	ND(1.0)

Additional anions and cations										
Station	Time	Bromide (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Sulfate (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Hardness mg CaCO3/L
CRBL02	5:35	ND(0.50)	~145	ND(0.10)	15	22	4.7	4.2	~62	74
CRBL05	6:55	ND(0.50)	~162	ND(0.10)	15	22	5.1	3.5	~65	76
CRBL06	7:15	ND(0.50)	~167	ND(0.10)	15	22	5.1	3.6	~66	76
CRBL07	7:30	ND(0.50)	~271	ND(0.10)	27	24	11	5.1	~114	105
CRBLA8	8:10	NA	NA	NA	NA	NA	NA	NA	NA	NA
CRBL09	7:50	ND(0.50)	~311	ND(0.10)	35	25	14	6.4	~147	120
CRBL11	8:25	ND(0.50)	~319	ND(0.10)	37	25	15	6.5	~153	124
CRBL11 (dup)	8:25	ND(0.50)	~318	ND(0.10)	37	25	15	6.6	~155	124
CRBL00 (blank)	3:50*	NA	NA	NA	NA	NA	NA	NA	NA	NA

Note:
* Blank samples were collected in the laboratory at 03:50 on 9/16/03, the dissolved metals filter blank was filtered in the field at 07:50 on 9/16/03
ND = not detected above the associated detection limit
A number prior to ND indicates that the value did not meet the blank criteria
NA = not available
~ = estimated data

Table A-6: Results from 9/16/03 Wet Weather Core Monitoring Peak Flow Sampling

Station	Sample Number	Time	Temp (Deg C)	DO (mg/l)	DO (%)	pH	Sp Cond. (uS/cm)	Salinity (ppth)	Turbidity (NTU)	Secchi (meters)	Transmissivit (%)	True Color (color units	Apparent Color (color units	TOC (mg/L)	TSS (mg/L)	Fecal coliform (cfu/100ml	E.coli (cfu/100ml	Chlorophyl (ug/L)	Orthophos as P (ug/L)	Total Phosphoru (ug/L)	NH3 as N (mg/L)	Nitirite as N (mg/L)	Nitrate as N (mg/L)
CRBL02	33249	10:05	21.32	7.23	81.7	7.51	371	0.18	8.9	NA	NA	20	30	5.8	11	17182	2000	NA	49	~86	0.117	ND(0.03)	0.41

Dissolved Metals

Station	Sample Number	Time	Aluminum (ug/L)	Antimony (ug/L)	Arsenic (ug/L)	Barium (ug/L)	Beryllium (ug/L)	Cadmium (ug/L)	Calcium (mg/L)	Chromium (ug/L)	Cobalt (ug/L)	Copper (ug/L)	Iron (ug/L)	Lead (ug/L)	Magnesiur (mg/l)	Manganes (ug/L)	Molybdenu (ug/L)	Nickel (ug/L)	Selenium (ug/L)	Silver (ug/L)	Thallium (ug/L)	Vanadium (ug/L)	Zinc (ug/L)	Mercury (ng/L)
CRBL02	33249	10:05	14	ND(0.50)	0.64	34	ND(0.20)	ND(0.20)	17	1.3	0.44	4.1	130	1.3	3.7	69	0.90	1.3	ND(1.0)	ND(0.20)	ND(0.50)	0.86	7.4	7.6

Additional anions and cations

Station	Sample Number	Time	Bromide (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Sulfate (mg/L)	Calcium (mg/L)	Magnesiur (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Hardness mg CaCO3/L
CRBL02	33249	10:05	ND(0.50)	~92	ND(0.10)	12	16	3.3	3.6	45	54

Note:
* Blank samples were collected in the laboratory at 03:50 on 9/16/03, the dissolved metals filter blank was filtered in the field at 07:50 on 9/16/03
ND = not detected above the associated detection limit
A number prior to ND indicates that the value did not meet the blank criteria
NA = not available
~ = estimated data

Table A-7: Results from 9/18/03 Wet Weather Core Monitoring Post-storm Sampling

Station	Time	Temp (Deg C)	DO (mg/l)	DO (%)	pH	Sp Cond. (uS/cm)	Salinity (ppth)	Turbidity (NTU)	Secchi (meters)	Transmissivity (%)	True Color (color units)	Apparent Color (color units)	TOC (mg/L)	TSS (mg/L)	Fecal coliform (cfu/100ml)	E.coli (cfu/100ml)	Chlorophyll a (ug/L)	Orthophosphate as P (ug/L)	Total Phosphorus (ug/L)	NH3 as N (mg/L)	Nitirite as N (mg/L)	Nitrate as N (mg/L)
CRBL02	11:25	20.6	8.1	89.7	7.2	570	0.28	3	NA	82.9	15	20	6.3	ND(2.5)	264	209	5	9.1	31	ND(0.075)	ND(0.03)	0.5
CRBL05	10:00	21.9	8.7	99.8	7.6	526	0.25	6	1.1	50.9	30	35	7.4	9.3	773	695	36	5.3	50	ND(0.075)	ND(0.03)	0.2
CRBL06	9:30	22.1	8.5	97.7	7.7	537	0.26	8	1	43.5	35	40	6.8	12	560	380	39	8.5	53	ND(0.075)	ND(0.03)	0.45
CRBL07	9:00	22.0	9.5	108.9	8.2	805	0.39	7	1.2	55.6	35	35	9	7.8	290	170	34	~4.6	37	ND(0.075)	ND(0.03)	0.41
CRBLA8	8:55	22.1	9.6	109.9	8.3	907	0.45	7	1.3	57.3	NA	NA	NA	NA	182	99	NA	NA	NA	NA	NA	NA
CRBL09	8:40	22.3	9.1	104.4	8.2	922	0.45	7	1.2	53.2	35	35	7.9	8.5	152	76	36	ND(5.0)	25	0.087	ND(0.03)	0.41
CRBL11	8:20	22.9	8.9	103.5	7.9	935	0.46	6	1.3	58.7	35	35	7.2	6.3	223	112	27	ND(5.0)	24	ND(0.075)	ND(0.03)	0.43
CRBL07 (dup)	9:00	22.0	9.6	109.6	8.2	805	0.39	7	1.2	55.4	30	35	7.8	8.3	221	138	32	~4.1	43	ND(0.075)	ND(0.03)	0.41
CRBL00 (blank)	16:20*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Dissolved Metals

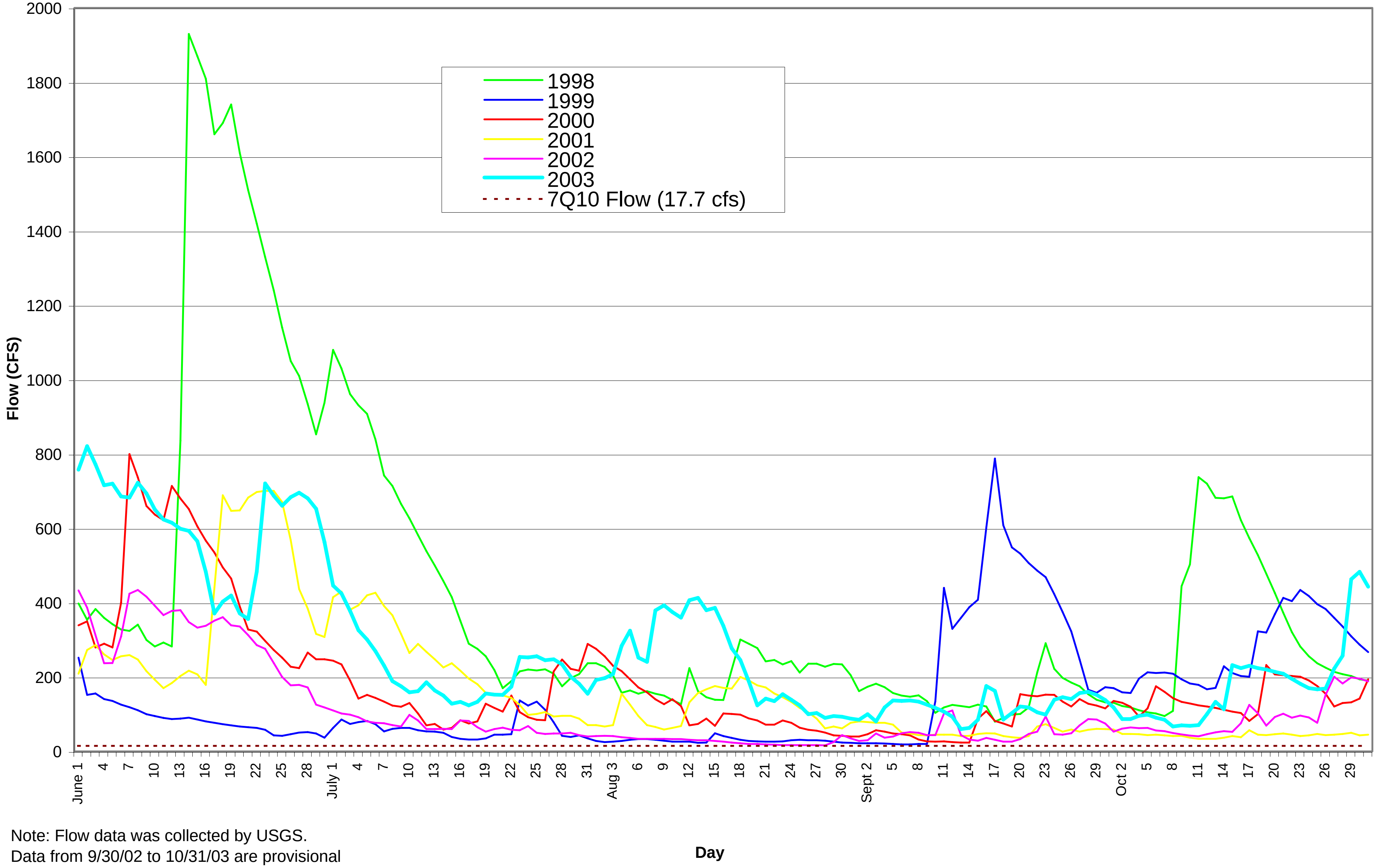
Station	Time	Aluminum (ug/L)	Antimony (ug/L)	Arsenic (ug/L)	Barium (ug/L)	Beryllium (ug/L)	Cadmium (ug/L)	Calcium (mg/L)	Chromium (ug/L)	Cobalt (ug/L)	Copper (ug/L)	Iron (ug/L)	Lead (ug/L)	Magnesium (mg/L)	Manganese (ug/L)	Molybdenum (ug/L)	Nickel (ug/L)	Selenium (ug/L)	Silver (ug/L)	Thallium (ug/L)	Vanadium (ug/L)	Zinc (ug/L)	Mercury (ng/L)
CRBL02	8:20	5.2	ND(0.50)	0.55	47	ND(0.20)	ND(0.20)	24	0.92	0.20	3ND	91	0.35	4.8	72	1.1	1.4	ND(1.0)	ND(0.20)	ND(0.50)	0.44	ND(5.0)	1.6
CRBL05	8:40	8.3	ND(0.50)	0.60	42	ND(0.20)	ND(0.20)	24	1.2	ND(0.20)	4ND	110	0.83	5.3	19	1.4	1.6	ND(1.0)	ND(0.20)	ND(0.50)	0.73	ND(5.0)	4.7
CRBL06	9:00	9.5	0.52	0.65	42	ND(0.20)	ND(0.20)	24	1.1	0.20	4ND	110	0.93	5.4	13	1.5	1.6	ND(1.0)	ND(0.20)	ND(0.50)	0.75	ND(5.0)	8.3
CRBL07	9:30	7.7	0.54	0.96	38	ND(0.20)	ND(0.20)	24	1.2	ND(0.20)	5ND	64	0.85	10	2.7	2.0	1.7	1.3	ND(0.20)	ND(0.50)	0.84	ND(5.0)	3.7
CRBLA8	10:00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CRBL09	11:25	7.0	0.56	1.0	39	ND(0.20)	ND(0.20)	26	1.2	ND(0.20)	5ND	60	0.79	13	18	2.2	1.9	1.5	ND(0.20)	ND(0.50)	0.85	ND(5.0)	7.8
CRBL11	8:55	6.8	0.64	1.0	39	ND(0.20)	ND(0.20)	25	1.1	ND(0.20)	5.6	54	0.71	13	8.3	2.1	1.8	1.6	ND(0.20)	ND(0.50)	0.78	ND(5.0)	2.6
CRBL07 (dup)	9:00	7.6	0.58	0.91	37	ND(0.20)	ND(0.20)	24	1.0	ND(0.20)	5ND	60	0.81	10	2.7	1.9	1.6	1.2	ND(0.20)	ND(0.50)	0.77	ND(5.0)	3.6
CRBL00 (blank)	16:20*	ND(5.0)	ND(0.50)	ND(0.50)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.10)	ND(0.50)	ND(0.20)	0.5ND	ND(50)	ND(0.20)	ND(0.10)	ND(0.20)	ND(0.50)	ND(0.20)	ND(1.0)	ND(0.20)	ND(0.50)	ND(0.20)	ND(5.0)	ND(1.0)

Additional anions and cations

Station	Time	Bromide (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Sulfate (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Hardness mg CaCO3/L
CRBL02	8:20	ND(0.50)	~151	ND(0.10)	15	24	5.1	4.3	~71	81
CRBL05	8:40	ND(0.50)	~132	ND(0.10)	14	23	5.4	4.0	~64	80
CRBL06	9:00	ND(0.50)	~134	ND(0.10)	15	23	5.4	3.9	~65	80
CRBL07	9:30	ND(0.50)	~247	ND(0.10)	25	24	10	5.1	~105	101
CRBLA8	10:00	NA	NA	NA	NA	NA	NA	NA	NA	NA
CRBL09	11:25	ND(0.50)	~317	ND(0.10)	29	24	13	5.8	~122	113
CRBL11	8:55	ND(0.50)	~325	ND(0.10)	30	24	13	5.8	~124	113
CRBL07 (dup)	9:00	ND(0.50)	~248	ND(0.10)	25	24	~11	5.1	~107	~105
CRBL00 (blank)	16:20	NA	NA	NA	NA	NA	NA	NA	NA	NA

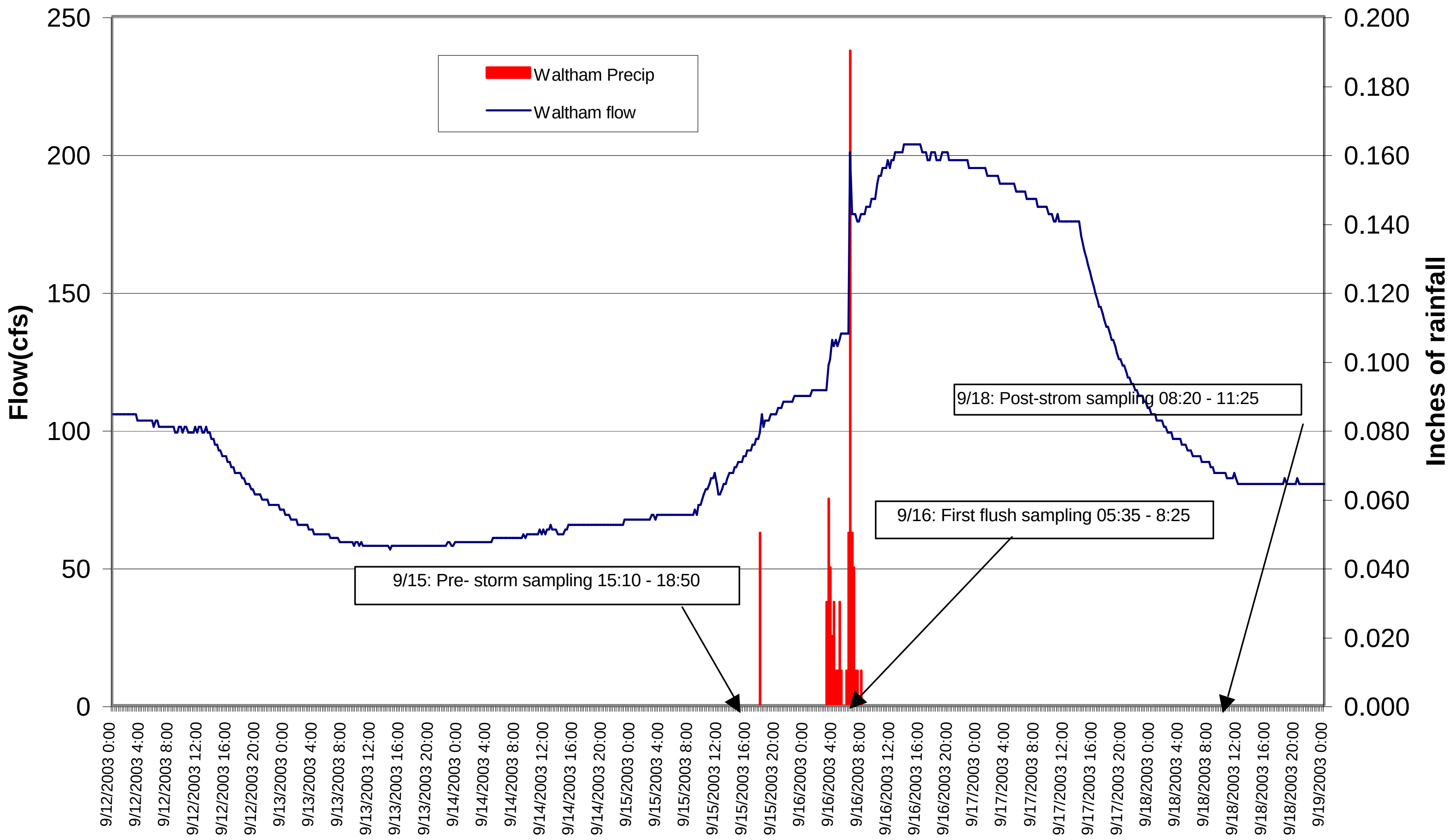
Note:
* Blank samples were collected in the laboratory at 16:20 on 9/17/03, the dissolved metals filter blank was filtered in the field at 09:30 on 9/18/03
ND = not detected above the associated detection limit
A number prior to ND indicates that the value did not meet the blank criteria
NA = not available

Figure A-1: Mean Daily Stream Flow Data at USGS Waltham Gaging Station from 1998 to 2003



Note: Flow data was collected by USGS.
Data from 9/30/02 to 10/31/03 are provisional

Figure A-2: Rainfall and Flow Data from 9/12-18/03 Wet Weather Event



Note: Data collected by USGS and is provisional
All times are in eastern daylight savings time

Previous 72 hour rainfall was 0.00 inches
Total Targeted Rainfall was 0.66 inches