Final Pathogen TMDL for the Charles River Watershed

January 2007

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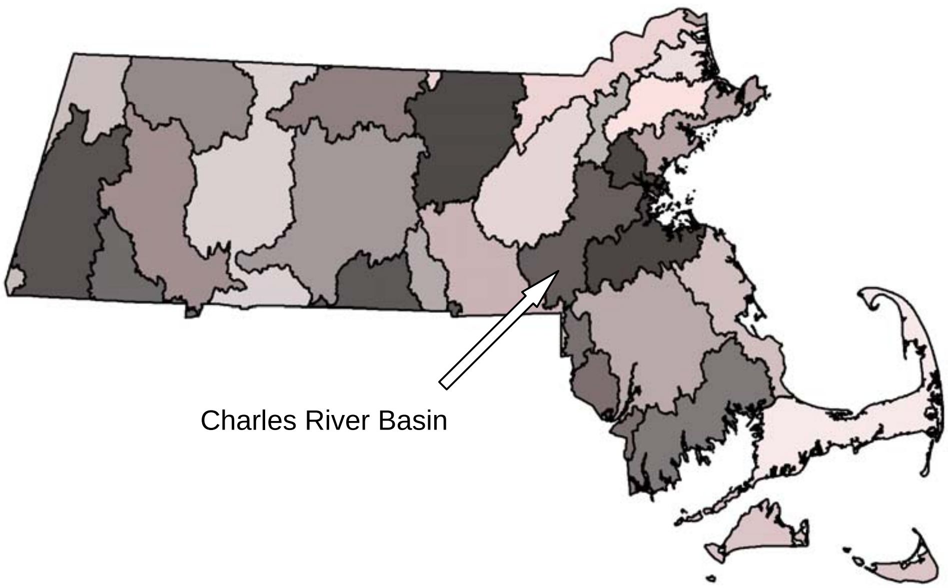

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NOTICE OF AVAILABILITY

Limited copies of this report are available at no cost by written request to:

Massachusetts Department of Environmental Protection (MASSDEP)
Division of Watershed Management
627 Main Street
Worcester, Massachusetts 01608

This report is also available from MASSDEP's home page on the World Wide Web.

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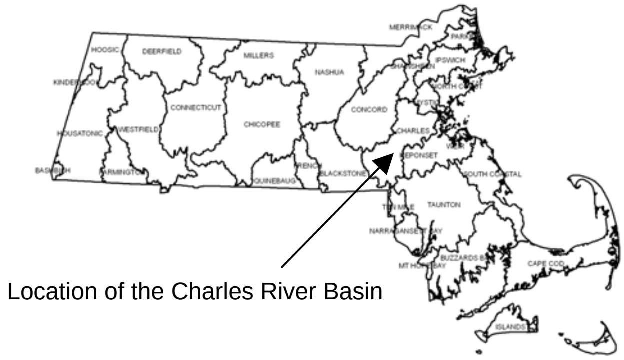
DISCLAIMER

References to trade names, commercial products, manufacturers, or distributors in this report constituted neither endorsement nor recommendations by the Division of Watershed Management for use.

Much of this document was prepared using text and general guidance from the previously approved Neponset River Basin and the Palmer River Basin Bacteria Total Maximum Daily Load documents.

Acknowledgement
This report was originally developed by ENSR through a partnership with Resource Triangle Institute (RTI) contracting with the United States Environmental Protection Agency (EPA) and the Massachusetts Department of Environmental Protection Agency under the National Watershed Protection Program.

Total Maximum Daily Loads for Pathogens within the Charles River Watershed



Key Features: Pathogen TMDL for the Charles River Watershed

Location: EPA Region 1

Land Type: New England Upland

303(d) Listings: Pathogens

Beaver Brook (MA72-28); Bogastow Brook (MA72-16); Charles River (MA72-01; MA72-02; MA72-03; MA72-04; MA72-05; MA72-06; MA72-07; MA72-08); Cheese Cake Brook (MA72-29); Fuller Brook (MA72-18); Muddy River (MA72-11); Rock Meadow Brook (MA72-21); Rosemary Brook (MA72-25); Sawmill Brook (MA72-23); South Meadow Brook (MA72-24); Stop River (MA72-10); Unnamed Tributaries (MA72-30; MA72-32)

Data Sources:

- MASSDEP “Charles River Watershed 1997/1998 Water Quality Assessment Report”
- MASSDEP “Charles River Watershed, Division of Watershed Management (DWM) Year 2002 Water Quality Monitoring Data”
- Charles River Hot Spot Monitoring Data 2002 - 2005
- EPA Office of Environmental Measurement and Evaluation “Clean Charles 2005 Water Quality Report” 2001, 2002 and 2003 Core Monitoring Programs
- MWRA “Eutrophication of the lower Charles, Mystic and Neponset rivers, and of Boston Harbor: a statistical comparison”
- MWRA “Summary of CSO Receiving Water Quality Monitoring in Boston Harbor and Tributary Rivers, 1989 – 2001” Draft Report 2003
- CRWA Water Quality Sampling Data1995-2005
- USGS “Streamflow, Water Quality, and Contaminant Loads in the Lower Charles River Watershed, Massachusetts, 1999-2000”
- Metcalf & Eddy “Evaluation of Stormwater Management Benefits to the Lower Charles River”

Data Mechanism: Massachusetts Surface Water Quality Standards for Fecal Coliform; Massachusetts Department of Public Health Bathing Beaches

Monitoring Plan: Massachusetts Watershed Five-Year Cycle

Control Measures: Watershed Management; Storm Water Management (e.g., bacterial source tracking, illicit discharge removals, public education/behavior modification); CSO & SSO Abatement; Agricultural and other BMPs; By-laws; Ordinances; Septic System Maintenance/Upgrades

Executive Summary

Purpose and Intended Audience

This document provides a framework to address bacterial and other fecal-related pollution in surface waters of Massachusetts. Fecal contamination of our surface waters is most often a direct result of the improper management of human wastes, excrement from barnyard animals, pet feces and agricultural applications of manure. It can also result from large congregations of birds such as geese and gulls. Illicit discharges of boat waste are of particular concern in coastal areas. Inappropriate disposal of human and animal wastes can degrade aquatic ecosystems and negatively affect public health. Fecal contamination can also result in closures of shellfish beds, beaches, swimming holes and drinking water supplies. The closure of such important public resources can erode quality of life and diminish property values.

Who should read this document?

The following groups and individuals can benefit from the information in this report:

a) towns and municipalities, especially Phase I and Phase II storm water communities, that are required by law to address storm water and/or combined sewage overflows (CSOs) and other sources of contamination (e.g., broken sewerage pipes and illicit connections) that contribute to a waterbody's failure to meet Massachusetts Water Quality Standards for pathogens;

b) watershed groups that wish to pursue funding to identify and/or mitigate sources of pathogens in their watersheds;

c) public health officials and/or municipalities that are responsible for monitoring, enforcing or otherwise mitigating fecal contamination that results in beach closures or results in the failure of other surface waters to meet Massachusetts standards for pathogens;

d) citizens that wish to become more aware of pollution issues and may be interested in helping build local support for funding remediation measures;

e) government agencies that provide planning, technical assistance, and funding to groups for bacterial remediation.

Major Bacteria Sources and Prioritized Areas

During the last decade, the MWRA and municipalities have made significant investments and progress in controlling and remediating Combined Sewer Overflows (CSO's), illicit connection and sewer impacts to the Charles River. These cumulative corrective actions have resulted in a cleaner Charles River – as highlighted by a "D" water quality grade issued in 1995 that rose to a "B+" in 2004. In 2004, the Lower Charles River met the state water quality standards for boating activities

96% of the time and the water quality swimming standards 54% of the time. Although surface water quality for recreational uses in the Charles is improving, episodic bacterial inputs still continue to impair 80.4% of the total river miles assessed (121.5 miles of impairment; 151.1 miles assessed) (MassGIS 2005). In total, 20 river segments, each in need of a Clean Water Act Total Maximum Daily Load (TMDL), contain indicator bacteria concentrations in excess of the Massachusetts WQS for Class A or B waterbodies (314 CMR 4.05)[1]

Illicit connection of sewage to storm drains (discharging in dry or wet weather or both), failing sewer infrastructure, Combined Sewer Overflows (CSO's) and storm water discharges (included sheet flow runoff) are the leading sources of bacterial surface water pollution in the Charles Watershed. Since CSO's are under regulatory enforcement - with specific corrective action timelines- the single biggest "dry " weather contributors of bacteria are likely to be illicit connections and leaky sewer infrastructure at low river flow. Storm water flows, sheet flow runoff and episodic sanitary sewer overflows, during rain events, continue to impair the river's water quality during wet weather.

In an effort to provide guidance for setting targeted bacterial implementation priorities within the Charles River Watershed, two summary tables are provided. Table ES-1 below provides a prioritized list of pathogen-impaired **segments** that will require additional bacterial source tracking work and implementation of structural and non-structural Best Management Practices (BMP's). Since limited source information and data are available in each impaired segment a simple scheme was used to prioritize segments based on fecal coliform concentrations. High priority was assigned to those segments where either dry or wet weather concentrations were equal to or greater than 10,000 col /100 ml since such high levels generally indicate a direct sanitary source. Medium priority was assigned to segments where concentrations ranged from 1,000 to 9,999 col/100ml since this range of concentrations generally indicates a direct sewage source that may get diluted in the conveyance system. Low priority was assigned to segments where concentrations were observed less than 1,000 col/100 ml. It should be noted that in all cases waters exceeding the water quality standards identified in Table 4-3 are considered impaired. Also prioritization can and should be adjusted based on more specific information such as proximity of each source to sensitive areas such as water supply intakes, beaches, and where applicable shellfish areas or the amount of flow from each specific source.

[1] Class A: Fecal coliform bacteria shall not exceed an arithmetic mean of 20 organisms per 100 mL in any representative set of samples, nor shall 10% of the samples exceed 100 organisms per 100 mL.
Class B: Fecal coliform bacteria shall not exceed a geometric mean of 200 organisms per 100 mL in any representative set of samples, nor shall 10% of the samples exceed 400 organisms per 100 mL. The MASSDEP may apply these standards on a seasonal basis.

Table ES-1: Charles River - Priority Segments

Segment ID	Segment Name	Length (miles)	Segment Description	Priority "Dry"	Priority "Wet"
MA72-01	Charles River	2.4	Source, outlet Echo Lake, Hopkinton to Dilla Street, Milford.	Low	Low
MA72-02	Charles River	3.1	Dilla Street, Milford-to-Milford WWTP, Hopedale.	High	High
MA72-03	Charles River	3.1	Milford WWTP, Hopedale to outlet Box Pond, Bellingham.	Medium	Medium
MA72-04	Charles River	11.4	Outlet Box Pond, Bellingham to outlet Populatic Pond, Norfolk/Medway.	Medium	Medium
MA72-05	Charles River	17.9	Outlet Populatic Pond, Norfolk/Medway to South Natick Dam, Natick.	Medium	Medium
MA72-10	Stop River	4.1	Norfolk-Walpole MCI, Norfolk to confluence with Charles River, Medfield.	Medium	Medium
MA72-16	Bogastow Brook	9.3	Outlet Factory Pond, Holliston to inlet South End Pond, Millis.	Low	Low
MA72-06	Charles River	8.0	South Natick Dam, Natick to Chestnut Street, Needham.	Medium	Medium
MA72-18	Fuller Brook	4.4	Headwaters south of Route 135, Needham to confluence with Waban Brook, Wellesley.	Medium	Medium
MA72-07	Charles River	23.2	Chestnut Street, Needham to Watertown Dam, Watertown.	Medium	Medium
MA72-21	Rock Meadow Brook	3.8	Headwaters in Fisher Meadow, Westwood through Stevens Pond and Lee Pond, Westwood to confluence Charles River, Dedham.	Low	Low
MA72-23	Sawmill Brook	2.7	Headwaters, Newton to confluence with Charles River, Boston.	Medium	Medium
MA72-24	South Meadow Brook	2.1	Isolated, interrupted, urban brook with 'headwaters' south of Route 9, Newton to confluence of Charles River, Newton.	Medium	Medium
MA72-25	Rosemary Brook	3.2	Headwaters, outlet Rosemary Lake, Needham to confluence with Charles River, Wellesley.	Low	Low
MA72-28	Beaver Brook	8.0	Headwaters, south of Route 2, Lexington through culverting to Charles River, Waltham.	High	Medium
MA72-29	Cheese Cake Brook	1.4	Headwaters, West Newton to confluence with Charles River, Newton.	High	High

Segment ID	Segment Name	Length (miles)	Segment Description	Priority "Dry"	Priority "Wet"
MA72-08	Charles River	8.6	(Charles Basin) Watertown Dam, Watertown to Science Museum, Boston.	Medium	High
MA72-30	Unnamed Tributary	0.1	Unnamed tributary locally known as Laundry Brook. Emerges north of California Street, Watertown and flows north to confluence with Charles River, Watertown.	Medium	High
MA72-32	Unnamed tributary	0.5	Locally known as Sawins Brook. Headwaters east of Elm Street to confluence with Charles River, Watertown (sections culverted).		
MA72-11	Muddy River	4.2	Outlet of unnamed pond, Olmstead Park, Boston to confluence with Charles River, Boston.	Medium	High

Table ES-2 provides a list of high priority pathogen **sources,** which have been identified within the watershed. For over a decade, a watershed advocate (Roger Frymire – Charles River Hot spot Monitoring Data 2002 – 2005) has systematically searched the shoreline of the Lower Charles River for bacterial sources of pollution. Since 2002 and continuing through 2005, several-hundred storm drain outfalls have been sampled in the Lower Charles basin for fecal coliform bacteria during both dry and wet weather events. EPA's Environmental Lab in Chelmsford performed all the fecal bacteria analysis for on-going targeted monitoring efforts. The Charles River Hot Spot Data (2002 – 2005) has become a critical source of information for finding and prioritizing episodic bacterial discharges. As a result of this investigative and targeted monitoring work, the following table provides a summary of 31 storm water outfalls that should be considered a "high" priority for additional bacterial source tracking and remediation. This prioritization table is based on level of fecal concentrations within the sample (analyzed by EPA) and observed flow observations (both dry and wet weather). Note- a link to a summary of the entire bacterial hot spot monitoring work (2002 – 2005) can be found in Appendix E.

Table ES-2: Charles River – "High" Priority Outfalls

River Segment No.	Operator	Site ID (s)	Site Description	"Dry / Wet"	Site Information / Actions
MA72-08	Watertown	D11	Watertown Square – (Galen St.)	Wet	High fecal counts ranging from 10,000 – 100,000 with grey plume; outfall is under water. Watertown has conducted preliminary testing to find source.

River Segment No.	Operator	Site ID (s)	Site Description	"Dry / Wet"	Site Information / Actions
MA72-08	Boston / MBTA		Fleet Center Drainage (~36" outfall)	Wet	High fecal counts ranging from 60,000 to 100,000; possible bacterial source from gulls and pigeons.
MA72-08	Boston	BWSC 04-2	Muddy River Conduit (~11'x14' diversion chamber)	Dry & Wet	Brown plume requires further investigation.
MA72-28	Waltham	Beaver, B001, BEB01E, BEB01W (26)	Beaver Brook: by Newton St., by Charles, east culvert, west side	Dry	Waltham is currently investigating the Beaver Brook drainage system; one illicit connection has been identified. Initial source tracking should focus on BEB01W.
MA72-08	Boston	BOS032	Fanueil Valley Brook Conduit	Dry	Boston has partially addressed this problem by finding and fixing (64) illicit connections – thus removing ~28,000 gallons per day (gpd).
MA72-08	Boston	BOS034	Downstream of River St, upstream of BU bridge (~ 30" outfall)	Dry & Wet	A potentially large bacterial source (~ 6' diameter pipe) that is submerged and negatively pitched back –causing Charles River backflow during dry weather and high bacterial outflows during wet weather events (9/05 wet sampling result 172,000 colonies). Boston has performed some initial source tracking work on this outfall, which has resulted in the illicit removal of ~ 2,000 gpd.
MA72-08	Boston / Brookline	BOS035	Salt Creek conduit (Smelt Brook-Brookline (middle boomed outfall)	Dry & Wet	Boston has performed recent investigative work to find possible sources and Brookline has prioritized this outfall in its EPA illicit action plan.
	Boston / Brookline	BOS132	Upstream of BU bridge	Wet	Boston and Brookline are investigating. September 2005 wet weather sampling events revealed bacterial pipe counts at

River Segment No.	Operator	Site ID (s)	Site Description	"Dry / Wet"	Site Information / Actions
MA72-08					85,000 and 151,000 colonies.
MA72-07	Waltham	BOSBARK	Downstream of Moody Street Dam, adjacent to Elm St.	Wet	Potential bacterial impacts from high volume non-point sources (overland runoff) directly into the Charles River.
MA72-07	Belmont	BPAIRS	Two (~42'') drainage outfalls for sections of Watertown, Belmont, MBTA.	Dry & Wet	
MA72-11	Brookline	BROD002, BROD04, BROD1A, BRODx1, BRODx2	Tannery Brook outlet (7'x121), storm drain #4 (5'x5.5'),near Netherlands Rd. @ USGS station, Village Brook outlet (9'x12') to Leverett Pond, Old Tannery Brook (ex-CSO), Pearl Street drain outlet (7'x12') – original Village Brook.	Dry & Wet	These outfalls represent a major portion of Brookline's drainage area. Brookline has initiated investigative actions to find and fix illicit connections in these outfalls. Brookline is currently following up on approximately 50 suspected illicit connections in these drainage areas.
MA72-29	Newton	CHEE16	South side of Washington St. where Cheesecake Brook exits after passing beneath Turnpike.	Dry & Wet	Newton has partially fixed dry weather flow problem (under drain #2); high counts during wet weather (120,000 colonies in 10/05). Newton has spent millions of dollars in under drain repairs for Cheesecake and Laundry Brooks.
MA72-08	Newton	HYDE01	Hyde Brook at mouth of Charles River.	Dry	Upstream of Newton Yacht Club.
MA72-30	Newton / Watertown	LAUD01	Laundry Brook near mouth of Charles	Dry	Newton has performed recent dye testing and TV inspection of area discharge drains; some offset joints were found and will be sealed and fixed. Newton has spent millions of dollars in under drain repairs for Cheesecake and Laundry Brooks.
MA72-11	Boston / Brookline	MUD253, MUD273	Downstream side of Brookline Avenue.	Wet	Centerline Muddy samples – NOT

River Segment No.	Operator	Site ID (s)	Site Description	"Dry / Wet"	Site Information / Actions
					sources
	Boston	MWR023	Stony Brook outfall	Dry	Boston's Sewer Separation project is on going; grey plume requires further investigation.
	Newton	NEW76L, NEW76R	Derby Brook- double 40" outfall pipes (L)- upstream pipe at drainage #76 California Rd., (R) – downstream pipe at drainage area #76.	Dry	Newton has conducted investigative work to locate bacterial pollution sources; source-tracking work is on going.
MA72-32	Watertown	WAT21A, WAT21B	Watertown drainage 21A and 21B to Sawins Brook.	Dry	Intermittent dry weather exceedances. April 2005 sample at drainage 21B showed fecal concentrations in excess of 200,000 colonies.
MA72-32	Watertown	SAW01	Sawins Brook near mouth of Charles River at Arsenal and Greenough.	Dry	Intermittent dry weather exceedances. April 2005 sample in Brook showed fecal counts in excess of 6,600 colonies.
MA72-28	Waltham	Drainage Area 1	Upstream of Beaver Brook.	Dry	Intermittent dry weather exceedances. August 2005 sample showed fecal concentrations at several thousand colonies.
MA72-07	Waltham	CR018 (CR10)	Upstream of Moody Street Dam – Maple/Prospect Sts. (next to Gold Star Mother Bridge) (~40")	Dry	Waltham has performed dry weather testing on this outfall pipe showing high fecal concentrations in 100,000 – 200,000 range. Sampling by Mr. Frymire on a steady dry weather pipe flow (8/17/05) showed fecal levels in excess of 12,000 colonies.

In November 2004, EPA issued administrative orders to Watertown, Waltham, Newton and Brookline based on data that those communities still had illicit discharges to the Charles or its tributaries. The orders require these communities to develop a comprehensive Illicit Discharge Detection and Elimination (IDDE) Plan. Once EPA approves the plan, the plan will be incorporated into the MS4 stormwater permit for each community, and the EPA order will be withdrawn. EPA withdrew Brookline's order as a result of amendments to its storm water management plan. Newton is close to amending its storm water management plan to address these concerns, at which point its order will be withdrawn.

The communities are being asked to address their illicit discharges in a multi-phase approach. Under initial phases, the communities must complete mapping of their systems, and address known illicit connections or known problem areas on an expedited schedule. Under subsequent phases, the communities will conduct routine monitoring of their outfalls, and will conduct a comprehensive "top-down" examination of their systems that would seek to identify any sanitary sources of pollution to their drainage systems at any point and remove all discharges by May 1, 2008. This work is high priority because there are significant bacterial loadings that the communities should be addressing in a prompt fashion.

TMDL Overview

The Massachusetts Department of Environmental Protection (MASSDEP) is responsible for monitoring the waters of the Commonwealth, identifying those waters that are impaired, and developing a plan to bring them back into compliance with the Massachusetts Water Quality Standards (WQS). The list of impaired waters, better known as the "303d list" identifies problem lakes, coastal waters and specific segments of rivers and streams and the reason for impairment.

Once a water body is identified as impaired, the MASSDEP is required by the Federal Clean Water Act (CWA) to develop a "pollutant budget" designed to restore the health of the impaired body of water. The process of developing this budget, generally referred to as a Total Maximum Daily Load (TMDL), includes identifying the source(s) of the pollutant from direct discharges (point sources) and indirect discharges (non-point sources), determining the maximum amount of the pollutant that can be discharged to a specific water body to meet water quality standards, and assigning pollutant load allocations to the sources. A plan to implement the necessary pollutant reductions is essential to the ultimate achievement of meeting the water quality standards.

Pathogen TMDL: This report represents a TMDL for pathogen indicators (e.g. fecal coliform, *E. coli*, and enterococcus bacteria) in the Charles River Watershed. Certain bacteria, such as coliform, *E. coli*, and enterococcus bacteria, are indicators of contamination from sewage and/or the feces of warm-blooded wildlife (mammals and birds). Such contamination may pose a risk to human health. Therefore, in order to prevent further degradation in water quality and to ensure that waterbodies within the watershed meet state water quality standards, the TMDL establishes indicator bacteria limits and outlines corrective actions to achieve that goal.

Sources of indicator bacteria in the Charles River Watershed were found to be many and varied. Most of the bacteria sources are believed to be storm water related. Table ES-3 provides a compilation of categories of bacteria sources in the Charles River Watershed including failing septic systems, combined sewer overflows (CSO), sanitary sewer overflows (SSO), sewer pipes connected to storm drains, certain recreational activities, wildlife including birds along with domestic pets and animals and direct overland storm water runoff. Note that bacteria from wildlife would be considered a natural condition unless some form of human inducement, such as feeding, is causing congregation of wild birds or animals. Table ES-3 also identifies the allowable TMDL waste load allocation (WLA) and load allocation (LA) by source category expressed as daily indicator bacteria concentration targets while keeping in mind that conformance with the TMDL is determined through a sufficient number of valid samples from the receiving water. A discussion of pathogen related control measures and best management practices are provided in the companion document: "*Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts*".

This TMDL applies to the 20 pathogen impaired segments of the Charles River Watershed that are currently listed on the CWA § 303(d) list of impaired waters. MASSDEP recommends however, that the information contained in this TMDL guide management activities for all other waters throughout the watershed to help maintain and protect existing water quality. For these non-impaired waters, Massachusetts is proposing "pollution prevention TMDLs" consistent with CWA § 303(d)(3).

The analyses conducted for the pathogen-impaired segments in this TMDL would apply to the non-impaired segments, since the sources and their characteristics are equivalent. The waste load and/or load allocation for each source and designated use would be the same as specified herein (e.g. Table ES-3 or Figure 7-1). Therefore, the pollution prevention TMDLs would have identical waste load and load allocations based on the sources present and the designated use of the water body segment (see Table ES-3). Any discharge would need to be consistent with the applicable waste load and load allocations, as well as with the anti-degradation provision of the Massachusetts water quality standards.

This Charles River Watershed TMDL may, in appropriate circumstances, also apply to other Charles River segments that are listed for pathogen impairment in subsequent Massachusetts CWA § 303(d) Integrated List of Waters. For such segments, this TMDL may apply if, after listing the waters for pathogen impairment and taking into account all relevant comments submitted on the CWA § 303(d) list, the Commonwealth determines with EPA approval of the CWA § 303(d) list that this TMDL should apply to future pathogen impaired segments.

Since accurate estimates of existing sources are generally unavailable, it is difficult to estimate the pollutant reductions for specific sources. For the illicit sources, the goal is complete elimination (100% reduction). However, overall wet weather indicator bacteria load reductions can be estimated using typical storm water bacteria concentrations. These data indicate that 90% or larger reductions in storm water fecal coliform loading will be necessary, especially in developed areas. This goal is expected to be accomplished through implementation of best management practices, such as those associated with the Phase II control program for storm water.

As indicated earlier, TMDLs for each type of bacteria source are provided in Table ES-3. Municipalities are the primary responsible parties for eliminating many of these sources. Some sources may not be the responsibility of the municipal government and may have to be addressed through other regulatory vehicles available to MASSDEP and EPA depending upon the severity of the source. TMDL implementation to achieve these goals should be an iterative process with selection and implementation of mitigation measures followed by monitoring to determine the extent of water quality improvement realized. Recommended TMDL implementation measures include identification and elimination of prohibited sources such as leaky or improperly connected sanitary sewer flows and best management practices to mitigate storm water runoff volume. Certain towns in the watershed are classified as Urban Areas by the United States Census Bureau and are subject to the Stormwater Phase II Final Rule that requires the development and implementation of an illicit discharge detection and elimination plan. Combined sewer overflows will be addressed through the on-going long-term control plans.

As mentioned previously, EPA and MassDEP already have taken actions to put Charles River communities on enforceable schedules for CSO abatement and illicit discharge of sanitary waste identification and elimination. The TMDL includes targets for all bacteria sources in the watershed as daily concentrations (Tables ES-3 and 7-1), percent reductions in bacteria concentrations necessary to meet water quality standards (Table 7-2) based on ambient monitoring to inform regulatory and voluntary pollution abatement efforts and allowable loading based on assimilative capacity (Figure 7-1, and Tables 7-3 and 7-4).

In most cases, authority to regulate non-point source pollution (i.e., non-NPDES sources) and thus successful implementation of this TMDL is limited to local government entities and will require cooperative support from local volunteers, watershed associations, and local officials in municipal government. Those activities can take the form of expanded education, obtaining and/or providing funding, and possibly local enforcement. In some cases, such as subsurface disposal of wastewater from homes, the Commonwealth provides the framework, but the administration occurs on the local level. Among federal and state funds to help implement this TMDL are, on a competitive basis, the Non-Point Source Control (CWA Section 319) Grants, Water Quality (CWA Section 604(b)) Grants, and the State Revolving (Loan) Fund Program (SRF). Most financial aid requires some local match as well. The programs mentioned are administered through the MASSDEP. Additional funding and resources available to assist local officials and community groups can be referenced within the Massachusetts Non-point Source Management Plan-Volume I Strategic Summary (2000) “Section VII Funding / Community Resources”. This document is available on the MAssDEP’s website at: http://mass.gov/dep/water/resources/nonpoint.htm or by contacting the MAssDEP’s Nonpoint Source Program at (508) 792-7470 to request a copy.

Table ES-3: Indicator Bacteria Waste Load Allocations (WLAs) and Load Allocations (LAs) based on a Concentration Approach. (N.B. Compliance with this TMDL is based on receiving water samples.)

Surface Water Classification	Pathogen Source	Waste Load Allocation Indicator Bacteria (CFU/100 mL)[1]	Load Allocation Indicator Bacteria (CFU/100 mL)[1]
A & B	Illicit discharges to storm drains	0	N/A
A & B	Leaking sanitary sewer lines	0	N/A
A & B	Failing septic systems	N/A	0

Surface Water Classification	Pathogen Source	Waste Load Allocation Indicator Bacteria (CFU/100 mL)[1]	Load Allocation Indicator Bacteria (CFU/100 mL)[1]
A	NPDES	Not to exceed an arithmetic mean of 20 organisms in any set of representative samples, nor shall 10% of the samples exceed 100 organisms[2,6]	N/A
A	Storm water runoff Phase I and II	Not to exceed an arithmetic mean of 20 organisms in any set of representative samples, nor shall 10% of the samples exceed 100 organisms[3]	N/A
A	Nonpoint Source Storm Water Runoff	N/A	Not to exceed an arithmetic mean of 20 organisms in any set of representative samples, nor shall 10% of the samples exceed 100 organisms[3]
B	CSOs	Shall not exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms[4]	N/A
B	NPDES – WWTP	Shall not exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms[2,6]	N/A
B	Storm water runoff Phase I and II	Not to exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms[3]	N/A
B	Nonpoint Source Storm Water Runoff	N/A	Not to exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms[3]
Fresh Water Beaches[5]	All Sources	Enterococci not to exceed a geometric mean of 33 colonies of the five most recent samples within the same bathing season, nor shall any single sample exceed 61 colonies OR *E. coli* not to exceed a geometric mean of 126 colonies of the five most recent samples within the same bathing season, nor shall any single sample exceed 235 colonies	Enterococci not to exceed a geometric mean of 33 colonies of the five most recent samples within the same bathing season, nor shall any single sample exceed 61 colonies OR *E. coli* not to exceed a geometric mean of 126 colonies of the five most recent samples within the same bathing season, nor shall any single sample exceed 235 colonies

N/A means not applicable

[1] Waste Load Allocation (WLA) and Load Allocation (LA) refer to fecal coliform densities unless specified in table.

[2] Or shall be consistent with the Waste Water Treatment Plant (WWTP) National Pollutant Discharge Elimination System (NPDES) permit.

[3]The expectation for WLAs and LAs for storm water discharges is that they will be achieved through the implementation of BMPs and other controls.

[4] Or other applicable water quality standards.

[5] Massachusetts Department of Public Health regulations (105 CMR Section 445)

[6] Seasonal disinfection may be allowed by the Department on a case-by-case basis.

Note: this table represents waste load and load reductions based on water quality standards current as of the publication date of these TMDLs. If the pathogen criteria change in the future, MassDEP intends to revise the TMDL by addendum to reflect the revised criteria.

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1.0 Introduction

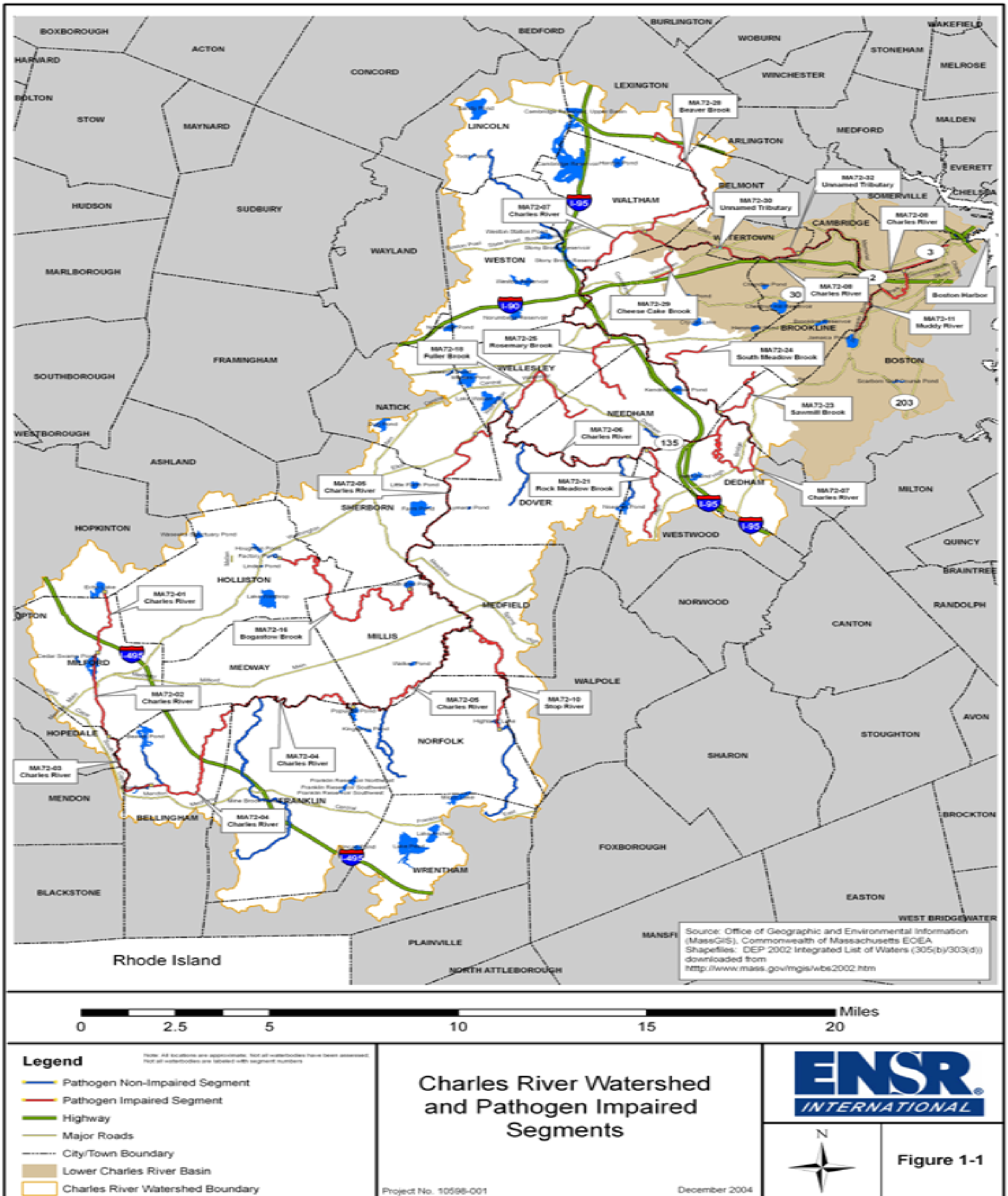
Section 303(d) of the Federal Clean Water Act (CWA) and Environmental Protection Agencies (EPA's) Water Quality Planning and Management Regulations (40 CFR Part 130) require states to place waterbodies that do not meet established water quality standards on a list of impaired waterbodies (commonly referred to as the "303d List") and to develop Total Maximum Daily Loads (TMDLs) for listed waters and the pollutant(s) contributing to the impairment. In Massachusetts, impaired waterbodies are included in Category 5 of the "*Massachusetts Year 2002 Integrated List of Water: Part 2- Final Listing of Individual Categories of Waters*" (*2002 List*; MASSDEP 2003). Figure 1-1 provides a map of the Charles River Watershed with pathogen-impaired segments indicated. Please note that not all segments have been assessed by the Massachusetts Department of Environmental Protection (MASSDEP) for pathogen impairment. As shown in Figure 1-1, much of the Charles River waterbodies are listed as a Category 5 "impaired or threatened for one or more uses and requiring a TMDL" due to excessive indicator bacteria concentrations.

TMDLs are to be developed for water bodies that are not meeting designated uses under technology-based controls only. TMDLs determine the amount of a pollutant that a waterbody can safely assimilate without violating water quality standards. The TMDL process establishes the maximum allowable loading of pollutants or other quantifiable parameters for a water body based on the relationship between pollutant sources and in stream conditions. The TMDL process is designed to assist states and watershed stakeholders in the implementation of water quality-based controls specifically targeted to identified sources of pollution in order to restore and maintain the quality of their water resources (USEPA 1999). TMDLs allow watershed stewards to establish measurable water quality goals based on the difference between site-specific in stream conditions and state water quality standards.

A major goal of this TMDL is to achieve meaningful environmental results with regard to the designated uses of the Charles River waterbodies. These include water supply, fishing, boating, and swimming. This TMDL establishes the necessary pollutant load to achieve designated uses and water quality standard and the companion document entitled; "*Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts*" provides guidance for the implementation of this TMDL.

Historically, water and sediment quality studies have focused on the control of point sources of pollutants (i.e., discharges from pipes and other structural conveyances) that discharge directly into well-defined hydrologic resources, such as lakes, ponds, or river segments. While this localized approach may be appropriate under certain situations, it typically fails to characterize the more subtle and chronic sources of pollutants that are widely scattered throughout a broad geographic region such as a watershed (e.g., roadway runoff, failing septic systems in high groundwater, areas of concentrated wildfowl use, fertilizers, pesticides, pet waste, and certain agricultural sources). These so called nonpoint sources of pollution often contribute significantly to the decline of water quality through their cumulative impacts. A watershed-level approach that uses the surface drainage area as the basic study unit enables managers to gain a more complete understanding of the potential pollutant sources impacting a waterbody and increases the precision of identifying local

Figure 1-1. Charles River Watershed and Pathogen Impaired Segments



problem areas or “hot spots” which may detrimentally affect water and sediment quality. It is within this watershed-level framework that the MASSDEP commissioned the development of watershed based TMDLs.

1.1. Pathogens and Indicator Bacteria

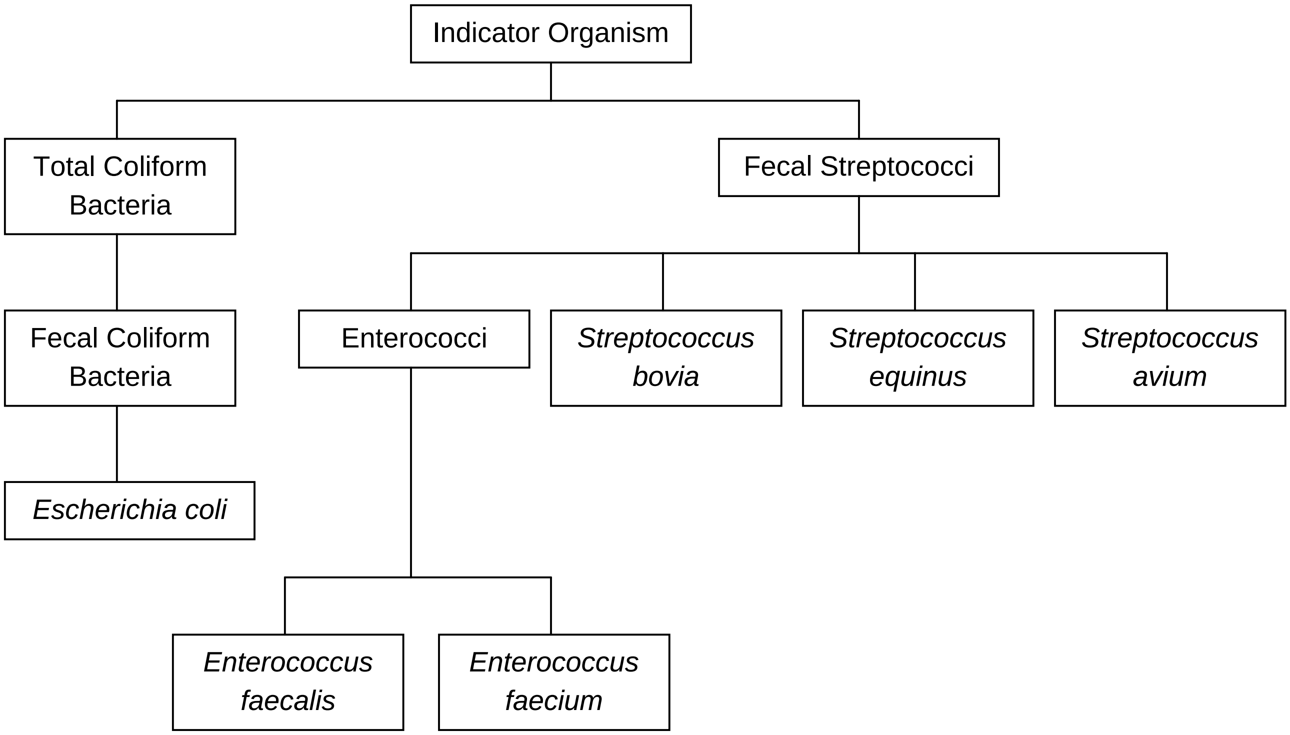
The Charles River pathogen TMDL is designed to support reduction of waterborne disease-causing organisms, known as pathogens, to reduce public health risk. Waterborne pathogens enter surface waters from a variety of sources including sewage and the feces of warm-blooded wildlife. These pathogens can pose a risk to human health due to gastrointestinal illness through exposure via ingestion and contact with recreational waters, ingestion of drinking water, and consumption of filter-feeding shellfish.

Waterborne pathogens include a broad range of bacteria and viruses that are difficult to identify and isolate. Thus, specific nonpathogenic bacteria have been identified that are typically associated with harmful pathogens in fecal contamination. These associated nonpathogenic bacteria are used as indicator bacteria as they are easier to identify and measure in the environment. High densities of indicator bacteria increase the likelihood of the presence of pathogenic organisms.

Selection of indicator bacteria is difficult as new technologies challenge current methods of detection and the strength of correlation of indicator bacteria and human illness. Currently, coliform and fecal streptococci bacteria are commonly used as indicators of potential pathogens (i.e., indicator bacteria). Coliform bacteria include total coliforms, fecal coliform and *Escherichia coli* (*E. coli*). Fecal coliform (a subset of total coliform) and *E. coli* (a subset of fecal coliform) bacteria are present in the intestinal tracts of warm-blooded animals. Presence of coliform bacteria in water indicates fecal contamination and the possible presence of pathogens. Fecal streptococci bacteria are also used as indicator bacteria, specifically enterococci a subgroup of fecal streptococci. These bacteria also live in the intestinal tract of animals, but their presence is a better predictor of human gastrointestinal illness than fecal coliform since the die-off rate of enterococci is much lower (i.e., enterococci bacteria remain in the environment longer) (USEPA 2001a). The relationship of indicator organisms is provided in Figure 1-2. The EPA, in the “*Ambient Water Quality Criteria for Bacteria – 1986*” document, recommends the use of *E. coli* or enterococci as potential pathogen indicators in fresh water and enterococci in marine waters (USEPA 1986).

Massachusetts uses fecal coliform and enterococci as indicator organisms of potential harmful pathogens. The WQS that apply to fresh water are currently based on fecal coliform concentration but will be replaced with *E. coli.* Fecal coliform are also used by the Massachusetts Division of Marine Fisheries (DMF) in their classification of shellfish growing areas. Fecal coliform as the indicator organism for shellfish growing area status is not expected to change at this time. Enterococci are used as the indicator organism for marine beaches, as required by the Beaches Environmental Assessment and Coastal Act of 2000 (BEACH Act), an amendment to the CWA.

Figure 1-2. Relationships among Indicator Organisms (USEPA 2001a).



The Charles River Watershed pathogen TMDLs have been developed using fecal coliform as an indicator bacterium for fresh waters. Any changes in the Massachusetts pathogen water quality standard will apply to this TMDL at the time of the standard change. Massachusetts believes that the magnitude of indicator bacteria loading reductions outlined in this TMDL will be both necessary and sufficient to attain present WQS and any future modifications to the WQS for pathogens.

1.2. Comprehensive Watershed-based Approach to TMDL Development

Consistent with Section 303(d) of the CWA, the MASSDEP has chosen to complete pathogen TMDLs for all waterbodies in the Charles River Watershed at this time, regardless of current impairment status (i.e., for all waterbody categories in the *2002 List*). MASSDEP believes a comprehensive management approach carried out by all watershed communities is needed to address the ubiquitous nature of pathogen sources present in the Charles River Watershed. Watershed-wide implementation is needed to meet WQS and restore designated uses in impaired segments while providing protection of desirable water quality in waters that are not currently impaired or not assessed.

As discussed below, this TMDL applies to the 20 pathogen impaired segments of the Charles River Watershed that are currently listed on the CWA § 303(d) list of impaired waters and determined to be pathogen impaired in the "*Charles River Watershed 1997/1998 Water Quality Assessment Report*" (WQA; MASSDEP 2000a) (see Figure 1-1, Table 4-3). MASSDEP recommends however, that the information contained in this TMDL guide management activities for all other waters throughout the watershed to help maintain and protect existing water quality. For these non-impaired waters, Massachusetts is proposing “pollution prevention TMDLs” consistent with CWA § 303(d)(3).

The analyses conducted for the pathogen-impaired segments in this TMDL would apply to the non-impaired segments, since the sources and their characteristics are equivalent. The waste load and/or load allocation for each source and designated use would be the same as specified herein. Therefore, the pollution prevention TMDLs would have identical waste load and load allocations based on the sources present and the designated use of the water body segment (see Table ES-3 and Table 7-1). Any discharge would need to be consistent with the applicable waste load and load allocations, as well as with the ant-degradation provision of the Massachusetts water quality standards.

This Charles River Watershed Bacteria TMDL may, in appropriate circumstances, also apply to segments that are listed for pathogen impairment in subsequent Massachusetts CWA § 303(d) Integrated List of Waters. For such segments, this TMDL may apply if, after listing the waters for pathogen impairment and taking into account all relevant comments submitted on the CWA § 303(d) list, the Commonwealth determines with EPA approval of the CWA § 303(d) list that this TMDL should apply to future pathogen impaired segments.

There are 83 waterbody segments assessed by the MASSDEP in the Charles River Watershed (MassGIS 2005). These segments consist of 31 river segments, 20 of which are pathogen impaired and appear as such on the official impaired waters list (303(d) List) (Figure 1-1). None of the 52 lake segments are pathogen impaired. Pathogen impairment has been documented by the MASSDEP in previous reports, including the MASSDEP WQAR, resulting in the impairment determination. In this TMDL document, an overview of pathogen impairment is provided to illustrate the nature and extent of the pathogen impairment problem. Additional data, not collected by the MASSDEP or used to determine impairment status, may also be provided in this TMDL to illustrate the pathogen problem. Since pathogen impairment has been previously established only a summary is provided herein.

The watershed-based approach applied to complete the Charles River Watershed pathogen TMDL is straightforward. The approach is focused on identification of sources, source reduction, and implementation of appropriate management plans. Once identified, sources are required to meet applicable WQS for indicator bacteria or be eliminated. For pathogens and indicator bacteria, water quality analyses are generally resource intensive and provide results with large degrees of uncertainty. Rather, this approach focuses on sources and required load reductions, proceeding efficiently toward water quality restoration activities.

The implementation strategy for reducing indicator bacteria is an iterative process where data are gathered on an ongoing basis, sources are identified and eliminated if possible, and control measures including Best Management Practices (BMPs) are implemented, assessed and modified as needed. Measures to abate probable sources of waterborne pathogens include everything from public education, to improved storm water management, to reducing the influence from inadequate and/or failing sanitary sewer infrastructure.

1.3. TMDL Report Format

This document contains the following sections:

- Watershed Description (Section 2) – provides watershed specific information
- Water Quality Standards (Section 3) – provides a summary of current Massachusetts WQS as they relate to indicator bacteria
- Problem Assessment (Section 4) – provides an overview of indicator bacteria measurements collected in the Charles River Watershed
- Potential Sources (Section 5) – identifies and discusses potential sources of waterborne pathogens within the Charles River Watershed.
- Prioritization and Known Sources (Section 6) – identifies known sources and prioritizes segments based on ambient data.
- Pathogen TMDL Development (Section 7) – specifies required TMDL development components including:
    - Definitions and Equation
    - Loading Capacity
    - Load and Waste Load Allocations
    - Margin of Safety
    - Seasonal Variability
- Implementation Plan (Section 8) – describes specific implementation activities designed to remove pathogen impairment. This section and the companion "*Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts*" document should be used together to support implementing management actions.
- Monitoring Plan (Section 9) – describes recommended monitoring activities
- Reasonable Assurances (Section 10) – describes reasonable assurances the TMDL will be implemented
- Public Participation (Section 11) – describes the public participation process, and
- References (Section 12)

2.0 Watershed Description

The Charles River is approximately 80 miles in length and drains 307 square miles (MASSDEP 2000a). The watershed includes 35 cities and towns within eastern Massachusetts. The Charles River begins in the Town of Hopkinton at approximately 350 feet above mean sea level and drains to the Boston Harbor. Land use within the watershed is primarily forest and residential areas (Table 2-1). Most of the forested areas lie within the upper portion of the watershed whereas dense residential areas are located in the lower portion (Figure 2-1). A discussion of land use characteristics and associated indicator bacteria levels are provided in Section 4.0 of this document.

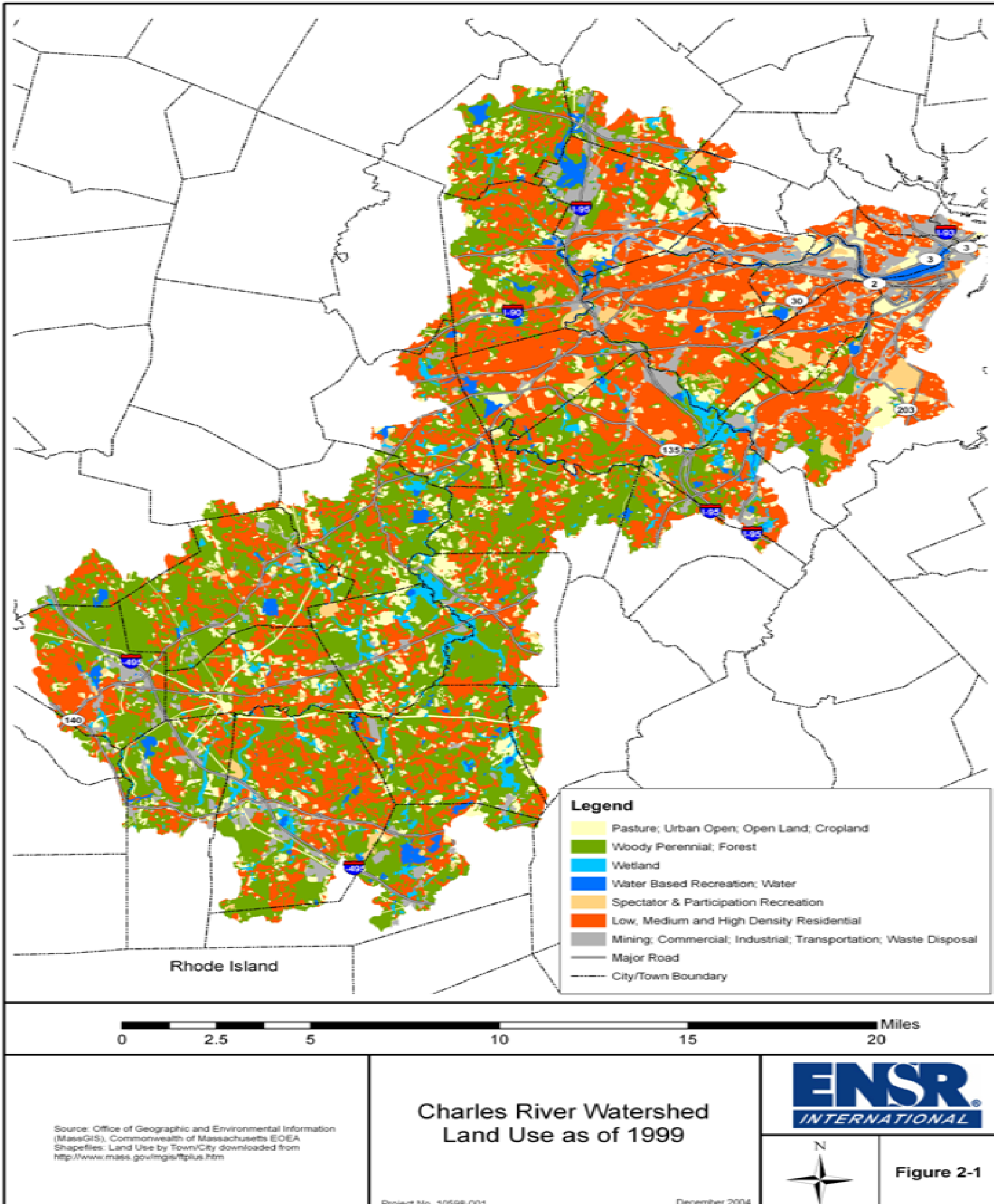
The Charles River hydrology is impacted by 20 dams along the length of the river and substantial natural storage in the upper and middle watershed. It has been estimated that it takes three to four days for peak flows in the upper portion to reach the Lower Charles (MASSDEP 2000a). These areas also allow for the release of stored water during periods of low flow.

The Charles River and tributaries are commonly used for primary and secondary contact recreation (swimming and boating), fishing, wildlife viewing, habitat for aquatic life, and drinking water supply.

Table 2-1. Charles River Watershed Land Use as of 1999.

Land Use Category	% of Total Watershed Area
Pasture	0.8
Urban Open	4.1
Open Land	2.2
Cropland	2.4
Woody Perennial	0.3
Forest	36.8
Wetland	2.9
Water Based Recreation	<0.1
Water	2.2
General Undeveloped Land	**51.8**
Spectator Recreation	0.1
Participation Recreation	2.6
> 1/2 acre lots Residential	12.9
1/4 - 1/2 acre lots Residential	11.3
< 1/4 acre lots Residential	9.7
Multi-family Residential	3.7
Mining	0.3
Commercial	2.9
Industrial	2.3
Transportation	2.2
Waste Disposal	0.2
General Developed Land	**48.2**

Figure 2-1. Charles River Watershed Land Use as of 1999.



3.0 Water Quality Standards

The Surface Water Quality Standards (WQS) for the Commonwealth of Massachusetts establish chemical, physical, and biological standards for the restoration and maintenance of the most sensitive uses (MASSDEP 2000b). The WQS limit the discharge of pollutants to surface waters for the protection of existing uses and attainment of designated uses in downstream and adjacent segments.

Fecal coliform, enterococci, and *E. coli* bacteria are found in the intestinal tract of warm-blooded animals, soil, water, and certain food and wood processing wastes. “Although they are generally not harmful themselves, they indicate the possible presence of pathogenic (disease-causing) bacteria, viruses, and protozoans that also live in human and animal digestive systems” (USEPA 2004a). These bacteria are often used as indicator bacteria since it is expensive and sometimes difficult to test for the presence of individual pathogenic organisms.

Massachusetts has recently revised and is waiting for EPA approval of its freshwater WQS by replacing fecal coliform with *E. coli* and enterococci as the regulated indicator bacteria, as recommended by the EPA in the “*Ambient Water Quality Criteria for Bacteria – 1986*” document (USEPA 1986). The state has already done so for public beaches through regulations of the Massachusetts Department of Public Health as discussed below. Until final EPA approval, Massachusetts uses fecal coliform as the indicator organism for all waters except for marine bathing beaches, where the Federal BEACH Act requires the use of enterococci. Massachusetts anticipates adopting *E. coli* and enterococci for all fresh waters and enterococci for all marine waters, including non bathing marine beaches. Fecal coliform will remain the indicator organism for shellfishing areas, however. The Charles River Watershed pathogen TMDL has been developed using fecal coliform as the pathogen indicator for fresh waters, but the goal of removing pathogen impairment of this TMDL will remain applicable when Massachusetts adopts new indicator bacteria criteria into its WQS. Massachusetts believes that the magnitude of indicator bacteria loading reductions outlined in this TMDL will be both necessary and sufficient to attain present WQS and any future modifications to the WQS for pathogens.

Pathogens can significantly impact humans through ingestion of, and contact with recreational waters, ingestion of drinking water, and consumption of filter-feeding shellfish. In addition to contact recreation, excessive pathogen numbers impact potable water supplies. The amount of treatment (i.e., disinfection) required to produce potable water increases with increased pathogen contamination. Such treatment may cause the generation of disinfection by-products that are also harmful to humans. Further detail on pathogen impacts can be accessed at the following EPA websites:

- Water Quality Criteria: Microbial (Pathogen)
  http://www.epa.gov/ost/humanhealth/microbial/microbial.html
- Human Health Advisories:
  - Fish and Wildlife Consumption Advisories
    http://www.epa.gov/ebtpages/humaadvisofishandwildlifeconsumption.html

- o Swimming Advisories
  http://www.epa.gov/ebtpages/humaadvisoswimmingadvisories.html

The Charles River Watershed contains waterbodies classified as Class A and Class B. The corresponding WQS for each class are as follows:

> Class A waterbodies - fecal coliform bacteria shall not exceed an arithmetic mean of 20 organisms per 100 mL in any representative set of samples, nor shall 10% of the samples exceed 100 organisms per 100 mL.
>
> Class B waterbodies - the geometric mean of a representative set of fecal coliform samples shall not exceed 200 organisms per 100 mL and no more than 10% of the samples shall exceed 400 organisms per 100 mL. The MASSDEP may apply these standards on a seasonal basis.

In addition to the WQS, the Commonwealth of Massachusetts Department of Public Health (MADPH) has established minimum standards for bathing beaches (105 CMR 445.000) under the State Sanitary Code, Chapter VII (www.mass.gov/dph/dcs/bb4_01.pdf). These standards will soon be adopted by the MASSDEP as state surface WQS for fresh water and these standards will subsequently apply to this TMDL. The MADPH bathing beach standards are generally the same as those which were recommended in the "*Ambient Water Quality Criteria for Bacteria – 1986"* document published by the EPA (USEPA 1986). In the above referenced document, the EPA recommended the use of enterococci as the indicator bacterium for marine recreational waters and enterococci or *E. coli* for fresh waters. As such, the following MADPH standards have been established for bathing beaches in Massachusetts:

> Marine Waters - (1) No single enterococci sample shall exceed 104 colonies per 100 mL and the geometric mean of the most recent five enterococci levels within the same bathing season shall not exceed 35 colonies per 100 mL.
>
> Freshwaters - (1) No single *E. coli* sample shall exceed 235 colonies per 100 mL and the geometric mean of the most recent five *E. coli* samples within the same bathing season shall not exceed 126 colonies per 100 mL; or (2) No single enterococci sample shall exceed 61 colonies per 100 mL and the geometric mean of the most recent five enterococci samples within the same bathing season shall not exceed 33 colonies per 100 mL.

The Federal BEACH Act of 2000 established a Federal standard for marine beaches. These standards are essentially the same as the MADPH marine beach standard (i.e., single sample not to exceed 104 cfu/100mL and geometric mean of a statistically sufficient number of samples not to exceed 35 cfu/100mL). The Federal BEACH Act and MADPH standards can be accessed on the worldwide web at http://www.epa.gov/waterscience/beaches/act.html and www.mass.gov/dph/dcs/bb4_01.pdf, respectively.

There are no marine bathing beaches in the Massachusetts portion of the Charles River Watershed. However, there are numerous freshwater beaches located within the watershed. A list of fresh (and marine) beaches by community with bacteria data can be found in the annual reports on the testing of public and semi-public beaches provided by the MADPH. These reports are available for download from the MADPH website located athttp://mass.gov/portal/site/massgovportal/menuitem.6b3609bb385731c14db4a11030468a0c/?pageID=eohhs2subtopic&L=6&L0=Home&L1=Consumer&L2=Community+Health+and+Safety&L3=Environmental+Health&L4=Environmental+Exposure+Topics&L5=Beaches+and+Water&sid=Eeohhs2.

4.0 Problem Assessment

Pathogen impairment has been documented at numerous locations throughout the Charles River Watershed, as shown in Figure 1-1. Excessive concentrations of indicator bacteria (e.g., fecal coliform, enterococci, *E. coli* etc.) can indicate the presence of sewage contamination and possible presence of pathogenic organisms. The amount of indicator bacteria and potential pathogens entering waterbodies is dependent on several factors including watershed characteristics and meteorological conditions. Indicator bacteria levels generally increase with increasing development activities, including increased impervious cover, illicit sewer connections, and failed septic systems.

Combined Sewer Overflows (CSO's), illicit sewer connections and storm water are the leading contributing sources of bacterial contamination in the Lower Charles River Basin (Watertown Dam to the Museum of Science). The MWRA has already achieved significant reduction of CSO related impacts to the Lower Charles River. The MWRA has completed most of its 1997 CSO long-term control plan, which has resulted in a 90% reduction of CSO flows into the Lower Charles River. MWRA CSO remedial work is expected to continue through 2008. Since CSO's are under regulatory enforcement - with specific corrective action timelines- the single biggest "dry " weather contributors of bacteria are likely to be illicit connections and leaky sewer infrastructure at low river flow. Storm water flows, sheet flow runoff and episodic sanitary sewer overflows, during rain events, are the major sources of bacteria at high river flow. Considerable municipal attention and progress has been made during the last decade to repair and upgrade leaky sewer infrastructure and remove illicit connections. Since 1995, well over 1 Million Gallons per Day (MGD) of illicit connections have been removed from the Lower Charles River, which has drastically improved water quality. The removal of illicit connections continues to be a high regulatory and municipal priority. Working under an EPA enforcement order issued in the fall of 2004, Waltham, Watertown, Newton and Brookline are required to develop a comprehensive action plan (with specific timelines) to "find and fix" their illicit sewer connections. Additional specific information on the known bacterial sources and corrective actions undertaken within these problem areas can be found in Section 6.0 – Prioritization and Known Sources.

Storm water discharges continue to be a major source of bacterial pollution throughout the Charles River watershed. All 35 Charles River watershed communities are regulated under EPA's Storm Water program. The development of better storm water controls through the EPA NPDES Storm Water Phase I and II programs will lessen the impact to surface waters through better controls implemented at the local level. Quantification of water quality impacts from storm water and anticipated reductions through remediation are difficult to project so implementation aimed at lessening impacts to water quality is geared towards the development and implementation of "Best Management Plans" [BMPs] which can be assessed qualitatively as to their effectiveness over time.

Indicator bacteria levels also tend to increase with wet weather conditions as storm sewer systems overflow and/or storm water runoff carries fecal matter that has accumulated to the river via overland flow and storm water conduits. In some cases, dry weather bacteria concentrations can be higher when there is a constant source that becomes diluted during periods of precipitation, such as with illicit connections. The magnitude of these relationships is variable, however, and can be substantially different temporally and spatially throughout the United States or within each watershed.

Tables 4-1 and 4-2 provide ranges of fecal coliform concentrations in storm water associated with various land use types. Pristine areas are observed to have low indicator bacteria levels and residential areas are observed to have elevated indicator bacteria levels. Development activity generally leads to decreased water quality (e.g., pathogen impairment) in a watershed. Development-related watershed modification includes increased impervious surface area which can (USEPA 1997):

- Increase flow volume,
- Increase peak flow and flow duration,
- Increase stream temperature,
- Decrease base flow, and
- Change sediment-loading rates.

Many of the impacts associated with increased impervious surface area also result in changes in pathogen loading (e.g., increased sediment loading can result in increased pathogen loading). In addition to increased impervious surface impacts, increased human and pet densities in developed areas increase potential fecal contamination. Furthermore, storm water drainage systems and associated storm water culverts and outfall pipes often result in the channelization of streams which leads to less attenuation of pathogen pollution.

Table 4-1. Wachusett Reservoir Storm Water Sampling (as reported in MASSDEP 2002) original data provided in MDC Wachusett Storm Water Study (June 1997).

Land Use Category	Fecal Coliform Bacteria[1] Organisms / 100 mL
Agriculture, Storm 1	110 – 21,200
Agriculture, Storm 2	200 – 56,400
“Pristine” (not developed, forest), Storm 1	0 – 51
“Pristine” (not developed, forest), Storm 2	8 – 766
High Density Residential (not sewered, on septic systems), Storm 1	30 – 29,600
High Density Residential (not sewered, on septic systems), Storm 2	430 – 122,000

[1] Grab samples collected for four storms between September 15, 1999 and June 7, 2000

Table 4-2. Lower Charles River Basin Storm Water Event Mean Bacteria Concentrations (data summarized from USGS 2002a)[1].

Land Use Category	Fecal Coliform (CFU/100 mL)	Enterococcus Bacteria (CFU/100 mL)	Number of Events
Single Family Residential	2,800 – 94,000	5,500 – 87,000	8
Multifamily Residential	2,200 – 31,000	3,200 – 49,000	8
Commercial	680 – 28,000	2,100 – 35,000	8

[1] An Event Mean Concentration (EMC) is the concentration of a flow-proportioned sample throughout a storm event. These samples are commonly collected using an automated sampler, which can proportion sample aliquots based on flow.

Pathogen impaired river segments represent 80.4% of the total river miles assessed (121.5 miles of impairment; 151.1 miles assessed) (MassGIS 2005). In total, 20 segments, each in need of a TMDL, contain indicator bacteria concentrations in excess of the Massachusetts WQS for Class A or B waterbodies (314 CMR 4.05)[1] and/or the MADPH standard for bathing beaches[2]. The basis for impairment listings is provided in the *2002 List* (MASSDEP 2003). Data presented in the WQA and other data collected by the MASSDEP were used to generate the *2002 List*. For more information regarding the basis for listing particular segments for pathogen impairment, please see the Assessment Methodology section of the MASSDEP WQA for this watershed.

A list of pathogen impaired segments requiring TMDLs is provided in Table 4-3. Segments are listed and discussed in hydrologic order (upstream to downstream) in the following sections. Additional details regarding each impaired segment including water withdrawals, discharges, use assessments and recommendations to meet use criteria are provided in the MASSDEP WQA.

An overview of the Charles River Watershed pathogen impairment is provided in this section to illustrate the nature and extent of the impairment. Since pathogen impairment has been previously established and documented on the *2002 List*, it is not necessary to provide detailed documentation of pathogen impairment herein.

This TMDL was based on the current WQS using fecal coliform as an indicator organism for fresh waters. The MASSDEP has developed a new WQS incorporating *E. coli* and enterococci as indicator organisms for all waters other than shellfishing and potable water intake areas and is

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[1] Class A: Fecal coliform bacteria shall not exceed an arithmetic mean of 20 organisms per 100 mL in any representative set of samples, nor shall 10% of the samples exceed 100 organisms per 100 mL.
Class B: Fecal coliform bacteria shall not exceed a geometric mean of 200 organisms per 100 mL in any representative set of samples, nor shall 10% of the samples exceed 400 organisms per 100 mL. The MASSDEP may apply these standards on a seasonal basis.

[2] Freshwater bathing beaches: No single *E. coli* sample shall exceed 235 colonies per 100 mL and the geometric mean of the most recent five *E. coli* samples within the same bathing season shall not exceed 126 colonies per 100 mL; or No single enterococci sample shall exceed 61 colonies per 100 mL and the geometric mean of the most recent five (5) enterococci samples within the same bathing season shall not exceed 33 colonies per 100 mL.

waiting final approval from EPA. Not all data presented herein were used to determine impairment listing due to a variety of reasons (including data quality assurance and quality control). The MASSDEP used only a subset of the available data to generate the *2002 List*. Data from the MASSDEP, EPA Region 1, Massachusetts Water Resources Authority (MWRA), the Charles River Watershed Association (CRWA), and United States Geological Survey (USGS) were reviewed and are summarized by segment below for illustrative purposes. All of these organizations have approved quality assurance and quality control plans (QAPP's). In some cases, where data quality may not have been well documented or questionable the data was used to indicate the potential magnitude of the problem but additional sampling would be recommended to confirm actual results.

Table 4-3. Charles River Pathogen Impaired Segments Requiring TMDLs (adapted from MASSDEP 2003 and MassGIS 2005).

Segment ID	Segment Name	Length (miles)	Segment Description
MA72-01	Charles River	2.4	Source, outlet Echo Lake, Hopkinton to Dilla Street, Milford.
MA72-02	Charles River	3.1	Dilla Street, Milford-to-Milford WWTP, Hopedale.
MA72-03	Charles River	3.1	Milford WWTP, Hopedale to outlet Box Pond, Bellingham.
MA72-04	Charles River	11.4	Outlet Box Pond, Bellingham to outlet Populatic Pond, Norfolk/Medway.
MA72-05	Charles River	17.9	Outlet Populatic Pond, Norfolk/Medway to South Natick Dam, Natick.
MA72-10	Stop River	4.1	Norfolk-Walpole MCI, Norfolk to confluence with Charles River, Medfield.
MA72-16	Bogastow Brook	9.3	Outlet Factory Pond, Holliston to inlet South End Pond, Millis.
MA72-06	Charles River	8.0	South Natick Dam, Natick to Chestnut Street, Needham.
MA72-18	Fuller Brook	4.4	Headwaters south of Route 135, Needham to confluence with Waban Brook, Wellesley.
MA72-07	Charles River	23.2	Chestnut Street, Needham to Watertown Dam, Watertown.
MA72-21	Rock Meadow Brook	3.8	Headwaters in Fisher Meadow, Westwood through Stevens Pond and Lee Pond, Westwood to confluence Charles River, Dedham.
MA72-23	Sawmill Brook	2.7	Headwaters, Newton to confluence with Charles River, Boston.
MA72-24	South Meadow Brook	2.1	Isolated, interrupted, urban brook with 'headwaters' south of Route 9, Newton to confluence of Charles River, Newton.
MA72-25	Rosemary Brook	3.2	Headwaters, outlet Rosemary Lake, Needham to confluence with Charles River, Wellesley.
MA72-28	Beaver Brook	8.0	Headwaters, south of Route 2, Lexington through culverting to Charles River, Waltham.
MA72-29	Cheese Cake Brook	1.4	Headwaters, West Newton to confluence with Charles River, Newton.
MA72-08	Charles River	8.6	(Charles Basin) Watertown Dam, Watertown to Science Museum, Boston.
MA72-30	Unnamed Tributary	0.1	Unnamed tributary locally known as Laundry Brook.

Segment ID	Segment Name	Length (miles)	Segment Description
			Emerges north of California Street, Watertown and flows north to confluence with Charles River, Watertown.
MA72-32	Unnamed tributary	0.5	Locally known as Sawins Brook. Headwaters east of Elm Street to confluence with Charles River, Watertown (sections culverted).
MA72-11	Muddy River	4.2	Outlet of unnamed pond, Olmstead Park, Boston to confluence with Charles River, Boston.

Data summarized in the following subsections may be found at:

- **CRWA** - downloaded from the CRWA website (http://www.crwa.org) under monthly water quality data or daily for the flagging program. This data was collected in accordance with an approved Quality Assurance Project Plan (QAPPP)[1].
- **MASSDEP WQA** – Charles River Watershed 1997/1998 Water Quality Assessment Report available for download at http://www.mass.gov/dep/brp/wm/wqassess.htm. This data was collected in accordance with an approved QAPP[2].
- **MASSDEP WQM-** Charles River Watershed, Division of Watershed Management (DWM) Year 2002 Water Quality Monitoring Data (WQM). Copies of this data are available by contacting MASSDEP's Division of Watershed Management in Worcester. This data was collected in accordance with an approved QAPP[3]
- **EPA Core Monitoring Program** – Clean Charles 2005 Water Quality Reports available for download at http://www.epa.gov/boston/charles/2005.html. This data was collected in accordance with a approved QAPP[4].
- **USGS** - Streamflow, Water Quality, and Contaminant Loads in the Lower Charles River Watershed, Massachusetts, 1999-2000 available for download at http://water.usgs.gov/pubs/wri/wri024137/. This data was collected in accordance with a approved QAPP[5]

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[1] Charles River Watershed Association, 2001. Quality Assurance Project Plan for the Charles River Watershed Integrated Monitoring, Modeling and Management Project. Newton, MA.

[2] Quality Assurance Project Plan (CN 30.0) For 1997 Water, Fish Tissue, Habitat and Biological Studies in the CHARLES RIVER WATERSHED, Massachusetts Department of Environmental Protection, Division of Watershed Management, Environmental Monitoring and Assessment Program, December 1998

[3] Quality Assurance Project Plan for Year 2002 Watershed Assessments of the Housatonic, Hudson, Charles, Ten Mile and North Coastal Watersheds , Division of Watershed Management, Department of Environmental Protection, 2002

[4] USEPA (United States Environmental Protection Agency). 2002(a). Addendum to the: Project Work/QA Plan, Charles River Clean 2005 Water Quality Study, June 10, 2002. Office of Environmental Measurement and Evaluation, Region 1.

[5] Breault, R.F. 2000a. U.S. Geological Survey Quality Assurance Project Plan for Stormwater and Mainstem Loads of Bacteria, Nutrients, and Selected metals, Lower Charles River Watershed, Massachusetts, Revision Date February 10, 2000.

- **MWRA** - Summary of CSO Receiving Water Quality Monitoring in Boston Harbor and Tributary Rivers, 1989 – 2001 DRAFT report. Available by contacting the MWRA (http://www.mwra.state.ma.us/). This data was collected in accordance with an approved QAPP[1]

Data are broken down into two weather conditions: wet and dry. When data were not categorized as such in individual reports, data collected on days when there was measurable precipitation were considered wet weather conditions and data collected on days when no or "trace" amounts of precipitation were reported were considered dry weather conditions. It should be noted that some reporting entities require a minimum amount of precipitation (i.e., 0.1 or 0.2 inches) before it is considered wet weather. Therefore, data between reporting entities may not be directly comparable, but overall conclusions for each segment are consistent.

The summary tables for each segment contain the data source and the calendar years data were collected (i.e., CRWA October 1995- August 2005). The "Site #" column displays the sampling location identifier issued by sampling organization. The "Description" column provides a short narrative description of the sampling location. The "Town" column provides the town name in which samples were collected. The next three columns provide statistics relating to sampling conducted during dry weather. These columns include "Min" where the minimum value reported is displayed, "Max" where the maximum value reported is displayed and "n" where the number of samples analyzed at that site over the time frame indicated. The same statistics are provided for data collected under wet weather conditions in the next three columns. It should be noted that many of these data sources also provide sampling results for other pathogen indicators (e.g., *E. coli* and enterococci), but are not summarized within the tables in the following subsection. However, figures illustrating *E. coli* and enterococci sampling results for the Lower Charles River, provided by the EPA and MWRA, are included as Figures 4-3 and 4-6 presented in the Charles River segment MA72-08 discussion in this report.

The MADPH publishes annual reports on the testing of public and semi-public beaches for both marine and fresh waters. These documents provide water quality data for each bathing beach by community and note if there were exceedances of water quality criteria. There is also a list of communities that did not report testing results. These reports can be downloaded from http://mass.gov/portal/site/massgovportal/menuitem.6b3609bb385731c14db4a11030468a0c/?pageID=eohhs2subtopic&L=6&L0=Home&L1=Consumer&L2=Community+Health+and+Safety&L3=Environmental+Health&L4=Environmental+Exposure+Topics&L5=Beaches+and+Water&sid=Eeohhs2..
Marine and freshwater beach status is highly variable and is therefore not provided in each segment description. Please see the MADPH annual beach report for specific details regarding swimming beaches.
The purpose of this section of the report is to briefly describe the impaired waterbody segments in the Charles River Watershed. For more information on any of these segments, see the "*Charles*

[1] Rex, A.C. and Taylor, D.I. 2000. Combined Work/Quality Assurance Project Plan for Water Quality Monitoring and Combined Sewer Overflow Receiving Water Monitoring in Boston Harbor and its Tributary Rivers 2000. Boston: Massachusetts Water Resources Authority. Technical Report MS-067.

River Watershed 1997/1998 Water Quality Assessment Report" on the MASSDEP website: http://mass.gov/dep/water/resources/wqassess.htm .

Charles River Segment MA72-01

This segment is a 2.4-mile long Class A warm water fishery extending from Hopkinton to Milford. Portions of this segment and its drainage area serve as a public surface water supply in Hopkinton and public surface and groundwater water supply in Milford. See MASSDEP WQA for more information regarding this segment, available for download at http://mass.gov/dep/water/resources/wqassess.htm.

MASSDEP 2002 WQM fecal coliform data for this segment are summarized in Table 4-4.

Table 4-4. MA72-01 Charles River Fecal Coliform Data Summary.

			Dry Weather (CFU/100 mL)			Wet Weather (CFU/100 mL)		
Site #	**Description**	**Town**	**Min**	**Max**	**n**	**Min**	**Max**	**n**
MASSDEP WQM 2002								
CR72.1	W. of Rte 85, Downstream of Wildcat Pond	Milford	<10	71	4	<20	20	2

Charles River Segment MA72-02

This segment is a 3.1-mile long Class B warm water fishery extending from Milford to Hopedale. A public surface water supply, Lousia Lake, discharges to this segment. There are three groundwater withdrawals in this area for the Town of Milford. Two National Pollutant Discharge Elimination System (NPDES) permits were listed in the MASSDEP WQA: a Mobile station discharging from a groundwater remediation system to a storm sewer and a storm water runoff discharge from a parking area by A.J. Knott Tool & Mfg. See MASSDEP WQA for more information regarding this segment, available for download at http://mass.gov/dep/water/resources/wqassess.htm.

CRWA October 1995 – August 2005 fecal coliform data for this segment are summarized in Table 4-5.

Table 4-5. MA72-02 Charles River Fecal Coliform Data Summary.

			Dry Weather (CFU/100 mL)			Wet Weather (CFU/100 mL)		
Site #	**Description**	**Town**	**Min**	**Max**	**n**	**Min**	**Max**	**n**
CRWA 1995-2005								
35CS	Central Street Bridge	Milford	<10	8,700	31	120	12,300	24
35CD	Discharge Pipe @ Central St.	Milford	290	49,000	29	490	37,000	23
35C2	2nd Discharge Pipe @ Central St.	Milford	<10	82,000	16	10	53,000	19

Milford

The Charles River Watershed Association (CRWA) Integrated Monitoring, Modeling and Management project (IM3), (1999) documented sewage discharges into the Charles River at Central Street in Milford and in Godfrey Brook. In 1996, the U.S. Environmental Protection Agency (EPA) issued and Administrative Order that required Milford to remove its illicit connections to three identified stormwater pipes and to develop a corrective action plan and schedule for eliminating its "dry-weather" discharges. Milford did not fully comply with the order, and subsequent sampling by CRWA confirms the fecal coliform problem still exists. In addition, elevated fecal coliform bacteria (233 – 42,000 cfu/100ml) were also documented in the 1997 annual report by ENSR at the end of this segment (ENSR Reach 1 data).

Charles River Segment MA72-03

This segment is a 3.1-mile long Class B warm water fishery that extends from Hopedale to Bellingham. The Milford Waste Water Treatment Plant (WWTP) discharges to this segment. Water from the treatment plant is also utilized by Milford Power Limited Partnership (MPLP) for cooling during electricity generation. See MASSDEP WQA for more information regarding this segment, available for download at http://mass.gov/dep/water/resources/wqassess.htm

CRWA October 1995 – August 2005 fecal coliform data for this segment are summarized in Table 4-6.

Table 4-6. MA72-03 Charles River Fecal Coliform Data Summary.

			Dry Weather (CFU/100 mL)			Wet Weather (CFU/100 mL)		
Site #	**Description**	**Town**	**Min**	**Max**	**N**	**Min**	**Max**	**N**
CRWA 1995-2005								
59CS	Mellen St. Bridge	Bellingham	<10	3,200	30	40	2,400	22

Charles River Segment MA72-04

This segment is an 11.4-mile long Class B warm water fishery extending from Bellingham to Norfolk/Medway. There are four public groundwater withdrawals in this area; three are located in Medway and one in Franklin. At the time of the MASSDEP WQA there were two additional groundwater withdrawals proposed. See MASSDEP WQA for more information regarding this segment, available for download at http://mass.gov/dep/water/resources/wqassess.htm.

CRWA (October 1995 – August 2005), MASSDEP WQA (July 1997 – April 1998) and MASSDEP WQM (2002) fecal coliform data for this segment are summarized in Table 4-7.

Table 4-7. MA72-04 Charles River Fecal Coliform Data Summary.

Site #	Description	Town	Dry Weather (CFU/100 mL) Min	Max	n	Wet Weather (CFU/100 mL) Min	Max	N
CRWA 1995-2005								
90CS	Rt. 126, N. Main St.	Bellingham	<10	3,400	34	8	1,090	21
130S	Maple St. Bridge	Bellingham	<10	1,100	32	10	1,200	25
165S	Shaw St. Bridge	Franklin	10	2,400	18	20	3,500	19
199S	Populatic Pond Boat Launch	Norfolk	<10	5,600	21	<10	500	18
MASSDEP WQA 1997-1998								
CR03	Walker Street	Medway	<20	500	6	80	120	2
MASSDEP WQM 2002								
CR03	Walker Street	Medway	52	120	4	59	59	1

Charles River Segment MA72-05

This segment is a 17.9-mile long Class B warm water fishery extending from Norfolk/Medway to Natick. There are three public groundwater withdrawals in this area, all located in the Town of Millis. There are two NPDES wastewater dischargers in this segment: the Charles River Water Pollution Control District (CRWPCD) discharges treated wastewater from the towns of Medway, Franklin, Bellingham and Millis to the Charles River in Medway and the Medfield WWTP, discharging to the Charles River in Medfield. See MASSDEP WQA for more information regarding this segment, available for download at http://mass.gov/dep/water/resources/wqassess.htm.

CRWA (October 1995 – August 2005) and MASSDEP WQM (2002) fecal coliform data for this segment are summarized in Table 4-8.

Table 4.8. MA72-05 Charles River Fecal Coliform Data Summary.

Site #	Description	Town	Dry Weather (CFU/100 mL) Min	Max	n	Wet Weather (CFU/100 mL) Min	Max	n
CRWA 1995-2005								
229S	Rt. 115, Baltimore St.	Norfolk/Millis	<10	2,800	31	10	2,000	25
267S	Dwight St. Bridge	Millis	<10	4,900	15	10	2,700	17
290S	Old Bridge St.	Medfield	<10	3,200	33	10	2,850	25
318S	Rt. 27 Bridge	Medfield	<10	2,100	33	10	1,600	22
343S	Farm Rd./Bridge St.	Sherborn/Dover	<10	3,000	18	10	720	22
MASSDEP WQM 2002								
CR36.3	Rte 16-upstream Davis Brook	Natick	20	100	**3**	**39**	59	2

Stop River Segment MA72-10

This segment is a 4.1-mile long Class B warm water fishery. This impaired segment is a tributary to the Charles River extending from Norfolk/Walpole to Medfield. There is one NPDES wastewater discharge, Norfolk MCI, in this segment. Although the upstream portion of the Stop River (segment

MA72-09) is not a 2002 pathogen listed segment, there is one additional NPDES wastewater discharger (Wrentham State School's WWTP located in Wrentham) that could potentially impact the MA72-10 segment of the Stop River. There are also seven groundwater withdrawals in this upstream segment. See MASSDEP WQA for more information regarding this segment, available for download at http://mass.gov/dep/water/resources/wqassess.htm.

CRWA (October 1995 – August 2005) and MASSDEP WQM (2002) fecal coliform data for this segment are summarized in Table 4-9.

Table 4-9. MA72-10 Stop River Fecal Coliform Data Summary.

			Dry Weather (CFU/100 mL)			**Wet Weather (CFU/100 mL)**		
Site #	**Description**	**Town**	**Min**	**Max**	**N**	**Min**	**Max**	**n**
CRWA 1995-2005								
269T	Causeway St.	Medfield	<10	2,800	19	10	4,700	21
	MASSDEP WQM 2002							
SR03	Noon Hill Rd.	Medfield	97	130	4			

<u>**Bogastow Brook Segment MA72-16**</u>

This segment is a 9.3-mile long Class B high water quality waterbody. This impaired segment is the main tributary to South End Pond, which discharges to the Charles River. This segment extends from Holliston to Millis. There are no NPDES wastewater discharges in this segment. However, there are suspected private septic system failures in the area (MASSDEP WQA). There are two public groundwater withdrawals located in Holliston and Millis and a community public water supply along the stream. See MASSDEP WQA for more information regarding this segment, available for download at http://mass.gov/dep/water/resources/wqassess.htm.

MASSDEP WQA (July/August 1997) fecal coliform data for this segment are summarized in Table 4-10.

Table 4-10. MA72-16 Bogastow Brook Fecal Coliform Data Summary.

			Dry Weather (CFU/100 mL)			**Wet Weather (CFU/100 mL)**		
Site #	**Description**	**Town**	**Min**	**Max**	**n**	**Min**	**Max**	**n**
MASSDEP WQA 1997								
BB03	Lowland St.	Holliston	140	140	1	160	160	1
BB04	Fiske St.	Holliston				600	600	1
BB04A	Central St.	Holliston	180	180	1	300	300	1
BB05	Orchard St.	Holliston	160	160	1	460	460	1
BB06	Middlesex St.	Holliston	120	120	1	220	220	1
BB08	Bogastow Pond outlet	Millis	100	100	1	80	80	1

Charles River Segment MA72-06

This segment is an 8.0-mile long Class B warm water fishery extending from Natick to Needham. There are seven public groundwater withdrawals in this area. Two of these wells are located in Wellesley, three in Needham, and two in Dover. See MASSDEP WQA for more information regarding this segment, available for download at http://mass.gov/dep/water/resources/wqassess.htm.

CRWA (October 1995 – August 2005), EPA Core Monitoring Program (June 2002 - September 2003), and MASSDEP WQA (July 1997 – April 1998) fecal coliform data for this segment are summarized in Table 4-11.

Table 4-11. MA72-06 Charles River Fecal Coliform Data Summary.

			Dry Weather (CFU/100 mL)			Wet Weather (CFU/100 mL)		
Site #	**Description**	**Town**	**Min**	**Max**	**n**	**Min**	**Max**	**N**
CRWA 1995-2005								
387S	Cheney Bridge	Wellesley	<10	2,100	29	10	500	23
400S	Charles River Road Bridge	Dover	<10	2,800	15	30	1,500	19
447S	Dover Gage	Dover	<10	3,100	22	10	310	18
EPA 2002-2003								
CRBL01	Downstream S. Natick Dam	Natick	20	60	5			
MASSDEP WQA 1997-1998								
CR02	Unnamed St northeast of Schaller St	Dover/Wellesley	20	200	5	60	160	2

Figures 4-1 and 4-2 provide a graphical representation of EPA fecal coliform data collected from 1998-2003, including station CRBL01 summarized in Table 4-11, as part of the Clean Charles 2005 Initiative. Figure 4-3 presents *E. coli* data collected in 2003 by the EPA. Figures 4-1 through 4-3 are presented within the Charles River Segment MA72-08 subsection of this report. A map showing sample locations for the EPA Clean Charles 2005 Water Quality Report is provided in Figure 4-4, also located in the Charles River Segment MA72-08 subsection of this report. Descriptions of sampling stations can be found in the Clean Charles 2005 Water Quality Report available for download at http://www.epa.gov/boston/charles/2005.html.

Fuller Brook Segment MA72-18

This segment is a 4.4-mile long Class B high water quality. This impaired segment is a tributary to Waban Brook (non-pathogen impaired segment MA72-17), which discharges to the Charles River. This impaired segment extends from Needham to Wellesley. There is one NPDES discharger along this segment, F. Diehl and Sons located in Wellesley. See MASSDEP WQA for more information regarding this segment, available for download at http://mass.gov/dep/water/resources/wqassess.htm.

MASSDEP WQA (July 1997 – April 1998) and MASSDEP WQM (2002) fecal coliform data for this segment are summarized in Table 4-12.

Table 4-12. MA72-18 Fuller Brook Fecal Coliform Data Summary.

			Dry Weather (CFU/100 mL)			Wet Weather (CFU/100 mL)		
Site #	**Description**	**Town**	**Min**	**Max**	**n**	**Min**	**Max**	**n**
MASSDEP WQA 1997-1998								
FB01	Dover St.	Wellesley	40	4,000	6	300	1,500	3
FB02	Cameron St. (100 m upstream)	Wellesley				200	200	1
FB03	Cameron St. (102 m upstream)	Wellesley				1,600	1,600	1
MASSDEP WQM 2002								
FB01	Dover St.	Wellesley	700	4,400	3	370	370	1

Charles River Segment MA72-07

This segment is a 23.2-mile long Class B warm water fishery extending from Needham to Watertown. There are seven public groundwater withdrawals in this area. Five of these wells are located in Dedham and two are located in Weston. There are eight NPDES dischargers along this segment. See MASSDEP WQA for more information regarding this segment, available for download at http://mass.gov/dep/water/resources/wqassess.htm.

CRWA (October 1995 – August 2005), EPA Core Monitoring Program (June 2002 - September 2003), USGS (June 1999 – September 2000) and MASSDEP WQA (July – November 1997) fecal coliform data for this segment are summarized in Table 4-13.

Table 4-13. MA72-07 Charles River Fecal Coliform Data Summary.

			Dry Weather (CFU/100 mL)			Wet Weather (CFU/100 mL)		
Site #	**Description**	**Town**	**Min**	**Max**	**n**	**Min**	**Max**	**n**
CRWA 1995-2005								
484S	Dedham Medical Center	Dedham	<10	1,690	34	20	2,500	22
521S	Ames St. Bridge	Dedham	<10	3,100	20	10	1,600	22
534S	Rt. 109 Bridge	Dedham	<10	3,600	32	20	1,600	25
567S	Nahanton Park	Newton	<10	2,200	21	10	900	24
591S	Rt. 9 Gaging Station	Newton	<10	2200	15	10	1,800	17
609S	Washington St. Hunnewell Bridge	Wellesley	<10	1,800	30	10	1,600	25
621S	Leo J. Martin Golf Course/Park Rd.	Weston	<10	1,700	18	10	1,100	22
635S	2391 Commonwealth Ave.	Newton	<10	750	28	20	2,700	23
648S	Lakes Region	Waltham	<10	1,400	13	10	1,800	15
662S	Moody St. Bridge	Waltham	<10	1,200	33	20	580	24
675S	North St.	Waltham	20	2,200	18	70	1,100	21
012S	Watertown Dam Footbridge	Watertown	10	3,500	35	20	4,600	24
EPA 2002-2003								
CRBL02	Upstream Watertown Dam	Watertown	68	1,396	12	92	540	4
USGS 1999-2000 (mean, min & max reported for wet weather)								
01104615	Upstream Watertown Dam	Watertown	30	5,000	13	220	17,000	9
MASSDEP WQA 1997-1998								
CR01	Watertown Dam	Watertown	100	360	4			

Figures 4-1 and 4-2 provide a graphical representation of EPA fecal coliform data collected from 1998-2003, including station CRBL02 summarized in Table 4-13, as part of the Clean Charles 2005 Initiative. Figure 4-3 presents *E. coli* data collected in 2003. Figures 4-1 through 4-3 are presented within the Charles River Segment MA72-08 subsection of this report. A map showing sample locations for the EPA Clean Charles 2005 Water Quality Report is provided in Figure 4-4, also located in the Charles River Segment MA72-08 subsection of this report. Descriptions of sampling stations can be found in the Clean Charles 2005 Water Quality Report available for download at http://www.epa.gov/boston/charles/2005.html.

Graphical representation (box and whiskers plot) of one station (012) from the MWRA Draft CSO Report (Coughlin 2003) is provided in Figure 4-5 (fecal coliform data) and 4-6 (enterococci data), following the discussion relating to pathogen impaired Charles River Segment MA72-08. A sample location map for the MWRA Draft CSO Report can be found in Figure 4-7 in the Charles River Segment MA72-08 subsection of this report.

<u>Rock Meadow Brook Segment MA72-21</u>

This segment is a 3.8-mile long Class B waterbody. This impaired segment is a tributary to the Charles River extending from Westwood to Dedham. There are two inactive public groundwater withdrawals in this area. See MASSDEP WQA for more information regarding this segment, available for download at http://mass.gov/dep/water/resources/wqassess.htm.

MASSDEP WQA (July 1997 – April 1998) and MASSDEP WQM (2002) fecal coliform data for this segment are summarized in Table 4-14.

Table 4-14. MA72-21 Rock Meadow Brook Fecal Coliform Data Summary.

			Dry Weather (CFU/100 mL)			Wet Weather (CFU/100 mL)		
Site #	**Description**	**Town**	**Min**	**Max**	**n**	**Min**	**Max**	**n**
MASSDEP WQA 1997-1998								
RM01	Summer St.	Westwood	<20	600	4	<20	60	2
MASSDEP WQM 2002								
RM01A	750m downstream Westfield St.	Dedham	<20	310	4	98	98	1

<u>Sawmill Brook Segment MA72-23</u>

This segment is a 2.7-mile long Class B waterbody. This impaired segment is a tributary to the Charles River extending from Newton to Boston. There are no permitted withdrawals or NPDES discharges in this segment. See MASSDEP WQA for more information regarding this segment, available for download at http://mass.gov/dep/water/resources/wqassess.htm.

MASSDEP WQA (July 1997 – April 1998) and MASSDEP WQM (2002) fecal coliform data for this segment are summarized in Table 4-15.

Table 4-15. MA72-23 Sawmill Brook Fecal Coliform Data Summary.

			Dry Weather (CFU/100 mL)			Wet Weather (CFU/100 mL)		
Site #	Description	Town	Min	Max	n	Min	Max	n
MASSDEP WQA 1997-1998								
SB01	Baker St.(10 m upstream)	Boston	520	7,000	4	780	3,000	2
SB02	Baker St.(100-200 m upstream)	Boston				200	200	1
SBE1	Baker St. storm pipe (100-200 m upstream)	Boston				4,000	4,000	1
MASSDEP WQM 2002								
SB02	Baker St.(100-200 m upstream)-St. Joseph's Cemetery	Boston	320	960	3	480	480	1
SB01	Baker St.(10 m upstream) – St. Joseph's Cemetery	Boston	1,400	4,000	4	760	780	2

South Meadow Brook Segment MA72-24

This segment is a 2.1-mile long Class B waterbody. This impaired segment is a tributary to the Charles River in Newton. There is one permitted NPDES discharger in this segment: The Atrium at Chestnut Hill. See MASSDEP WQA for more information regarding this segment, available for download at http://mass.gov/dep/water/resources/wqassess.htm.

MASSDEP WQA (July 1997 – April 1998) fecal coliform data for this segment are summarized in Table 4-16.

Table 4-16. MA72-24 South Meadow Brook Fecal Coliform Data Summary.

			Dry Weather (CFU/100 mL)			Wet Weather (CFU/100 mL)		
Site #	Description	Town	Min	Max	n	Min	Max	n
MASSDEP WQA 1997-1998								
SM01	Neeham St.	Newton	200	3,600	6	1,800	2,000	2
SM02	Winchester St.	Newton				320	320	1
SME1	Winchester St. Storm pipe (3 m upstream)	Newton	200	200	1			
MASSDEP WQM 2002								
SM01B	150 m downstream Needham St (upstream of storm pipe)	Newton				680	680	1
SM01	190 m downstream Needham St (downstream of storm pipe)	Newton	1,700	4,200	5			

Rosemary Brook Segment MA72-25

This segment is a 3.2-mile long Class B waterbody. This impaired segment is a tributary to the Charles River extending from Needham to Wellesley. There are four groundwater wells in Wellesley proximal to this segment; however two of these wells are inactive. See MASSDEP WQA for more information regarding this segment, available for download at http://mass.gov/dep/water/resources/wqassess.htm.

MASSDEP WQA (July 1997 – April 1998) and MASSDEP WQM (2002) fecal coliform data for this segment are summarized in Table 4-17.

Table 4-17. MA72-25 Rosemary Brook Fecal Coliform Data Summary.

			Dry Weather (CFU/100 mL)			Wet Weather (CFU/100 mL)		
Site #	**Description**	**Town**	**Min**	**Max**	**n**	**Min**	**Max**	**n**
MASSDEP WQA 1997-1998								
RB01	Barton Rd.	Wellesley	<20	200	6	40	180	2
MASSDEP WQM 2002								
RB02	Barton Rd.	Wellesley	20	450	5	59	59	1

<u>Beaver Brook Segment MA72-28</u>

This segment is a 3.2-mile long Class B waterbody. This impaired segment is a tributary to the Charles River extending from Lexington to Waltham. There are three NPDES discharges in this segment, W.R. Grace & Company and two discharges from Waverly Oaks Park Shell Oil Company. See MASSDEP WQA for more information regarding this segment, available for download at http://mass.gov/dep/water/resources/wqassess.htm.

MASSDEP WQA (July 1997 – April 1998) and MASSDEP WQM (2002) fecal coliform data for this segment are summarized in Table 4-18.

Table 4-18. MA72-28 Beaver Brook Fecal Coliform Data Summary.

			Dry Weather (CFU/100 mL)			Wet Weather (CFU/100 mL)		
Site #	**Description**	**Town**	**Min**	**Max**	**n**	**Min**	**Max**	**n**
MASSDEP WQA 1997-1998								
BE00	River St.	Waltham	480	4,400	4	2,000	2,000	1
BE01	Route 60 (upstream)	Waltham	2,000	2,000	2	1,400	1,400	1
BEE1	Route 60 Storm pipe (downstream)	Waltham				480	480	1
BEE2	Route 60 Storm pipe (upstream)	Waltham				240	240	1
MASSDEP WQM 2002								
BE03	Inlet to Mill Pond	Waltham/Belmont	310	1,100	4	260	260	1
BE02	Beaver St., Clematis Brook (downstream)	Waltham	290	12,000	5	250	250	1

<u>Cheese Cake Brook Segment MA72-29</u>

This segment is a 1.4-mile long Class B waterbody. This impaired segment is a tributary to the Charles River extending from West Newton to Newton. There are two NPDES discharges in this segment, Radiant Fuels and Mobil Oil Corporation, both in Newton. See MASSDEP WQA for more information regarding this segment, available for download at http://mass.gov/dep/water/resources/wqassess.htm.

MASSDEP WQA (July 1997 – April 1998) and MASSDEP WQM (2002) fecal coliform data for this segment are summarized in Table 4-19.

Table 4-19. MA72-29 Cheese Cake Brook Fecal Coliform Data Summary.

			Dry Weather (CFU/100 mL)			Wet Weather (CFU/100 mL)		
Site #	**Description**	**Town**	**Min**	**Max**	**n**	**Min**	**Max**	**n**
MASSDEP WQA 1997-1998								
CB01	10 m upstream of confluence	Newton	360	4,000	6	340	1,800	2
CB02	Crafts St.	Newton				1,200	1,200	1
CB05	Eddy St. (upstream)	Newton				1,200	1,200	1
CBE0	Crafts St. Storm pipe	Newton				<20	<20	1
CBE1	Watertown St. Storm pipe	Newton	50,000	50,000	1			
CBE2	Eddy St. Storm pipe (downstream)	Newton				260	260	1
MASSDEP WQM 2002								
CB03	50 m upstream of confluence	Newton	400	1,600	4			
CB03A	Rte. 16 downstream of storm pipe	Newton				350	350	
CB01	10 m upstream of confluence	Newton	190	890	4	520	520	1

Charles River Segment MA72-08

This segment is an 8.6-mile long Class B warm water fishery extending from the Watertown Dam in Watertown to Boston. According the MWRA "*Summary of CSO Receiving Water Quality Monitoring in Boston Harbor and Tributary Rivers, 1989 - 2001*" Draft Report, there are seven CSO outfalls that have been closed since March 2002, one CSO to be closed, one CSO with treatment (Cottage Farm Upgrade) and twelve untreated remaining (Coughlin 2003). There are three former or existing CSOs located along tributaries within this segment. Two of these CSO outfalls, located in an unnamed tributary (Segment MA72-32), are closed. The remaining tributary CSO is located in Muddy River (Segment MA72-11). A map showing the location and status of CSOs outfalls is provided in Appendix A from the MWRA (2004). There are also numerous NPDES dischargers in this area. See MASSDEP WQA for more information regarding this segment, available for download at http://mass.gov/dep/water/resources/wqassess.htm.

CRWA (June – August 2004 and October 1995 – August 2005), EPA Core Monitoring Program (June 2002 - September 2003), USGS (June 1999 – September 2000) and MASSDEP WQA (December 1997 – April 1998) fecal coliform data for this segment are summarized in Table 4-20.

Table 4-20. MA72-08 Charles River Fecal Coliform Data Summary.

			Dry Weather (CFU/100 mL)			Wet Weather (CFU/100 mL)		
Site #	**Description**	**Town**	**Min**	**Max**	**n**	**Min**	**Max**	**n**
CRWA Lower Charles 2004 Flagging								
NBS	N. Beacon St	Newton	140	660	9	250	3,300	4
LARZ	Larz Anderson Bridge	Boston	10	170	9	50	450	4
BU	Boston University Bridge	Boston	290	1,600	9	190	1,100	4
LONG	Longfellow Bridge	Boston	<10	310	9	45	150	4
CRWA 1995-2005								
700S	N. Beacon St.	Newton	40	4,700	22	90	6,000	21
715S	Arsenal St.	Brighton	60	7,800	34	100	24,000	23
729S	Eliot Bridge	Cambridge	<10	3,500	20	10	20,000	20
743S	Western Ave.	Cambridge	30	5,500	35	30	2,200	23
763S	Mass. Ave. at Harvard Bridge	Boston	10	3,800	32	10	30,000	24
773S	Longfellow Bridge	Boston	<10	4,600	21	10	11,000	22
784S	New Charles River Dam	Boston	10	8,150	35	10	1,700	25
EPA 2002-2003								
CRBL03	Daly Park	Boston	48	694	9			
CRBL04	Herter East Park	Boston	4	1,100	8			
CRBL05	Magazine Beach	Boston	44	2,400	12	330	1,099	4
CRBL06	Downstream Boston University Bridge	Boston	12	874	12	128	1,500	4
CRBL07	Downstream Stony Bk & Mass. Ave	Boston	4	315	12	8	56	4
CRBLA8	Off the Esplanade	Boston	<4	208	12	4	28	4
CRBL09	Upstream Longfellow Bridge	Boston	<4	76	12	8	100	4
CRBL10	Community Boating Area	Boston	4	50	9			
CRBL11	Between Longfellow Bridge & Old Dam	Boston	<4	52	12	12	44	4
CRBL12	Upstream of Railroad Bridge	Boston	8	360	9			
USGS 1999-2000 (mean min & max reported for wet weather)								
01104710	Charles River at Science Museum	Boston	<10	100	13	<10	200	6
MASSDEP WQA 1997-1998								
CR00	100 ft. Downstream of Watertown Dam	Watertown	200	500	2	920	1,800	2

Figures 4-1 and 4-2 provide a graphical representation of EPA fecal coliform data collected from 1998-2003, including stations CRBL03 through CRBL12 summarized in the Table 4-20, as part of the Clean Charles 2005 Initiative. Figure 4-3 provides a summary of the *E. coli* data collected in 2003 by the EPA for the Lower Charles River. A map showing sample locations for the EPA Clean Charles 2005 Water Quality Report is provided in Figure 4-4. Descriptions of sampling stations can be found in the Clean Charles 2005 Water Quality Report available for download at http://www.epa.gov/boston/charles/2005.html.

Thirty five percent of the fecal coliform samples collected as part of the EPA Core Monitoring Program exceeded the Class B WQS of 200 colonies/100 mL in 2003, compared to 31%, 35%, 23%, 8% and 17% in 2002, 2001, 2000, 1999 and 1998, respectively. Indicator bacteria levels are generally lower at downstream sample sites (Figure 4-2), where flow and water volume are also greater. The EPA Core Monitoring 2003 downstream dry weather fecal coliform samples exceeded the Class B WQS 9% of the time (stations CRBL01 – CRBL12), whereas upstream numbers exceeded the Class B WQS 76% of the time. *E. coli* numbers in 2003 (Figure 4-3) displayed the same pattern as fecal coliform (lower numbers near the mouth of the Charles River).

Box plots of the MWRA 1998-2001 data are provided in Figures 4-5 (fecal coliform data) and 4-6 (enterococci data). A sample location map is provided in Figure 4-7. Sample location descriptions for the MWRA data can be found in Appendix A of this report.

A similar trend with lower bacteria numbers further downstream was observed in data collected by the MWRA (Figure 4-5). Median fecal coliform values for upstream stations exceeded the Class B WQS under all weather conditions, but median values for downstream stations (008, 009, 010, 166, and 011), although elevated, generally meet this standard. Upstream enterococci median values failed to meet the MADPH bathing beach standard during all weather conditions. Median values for the downstream stations were able to meet the MADPH standard during dry weather, but most of these stations exceeded the standard under wet weather conditions.

Figure 4-1. Fecal Coliform Data from 1998-2003 (modified Figure 1 from USEPA 2004b).

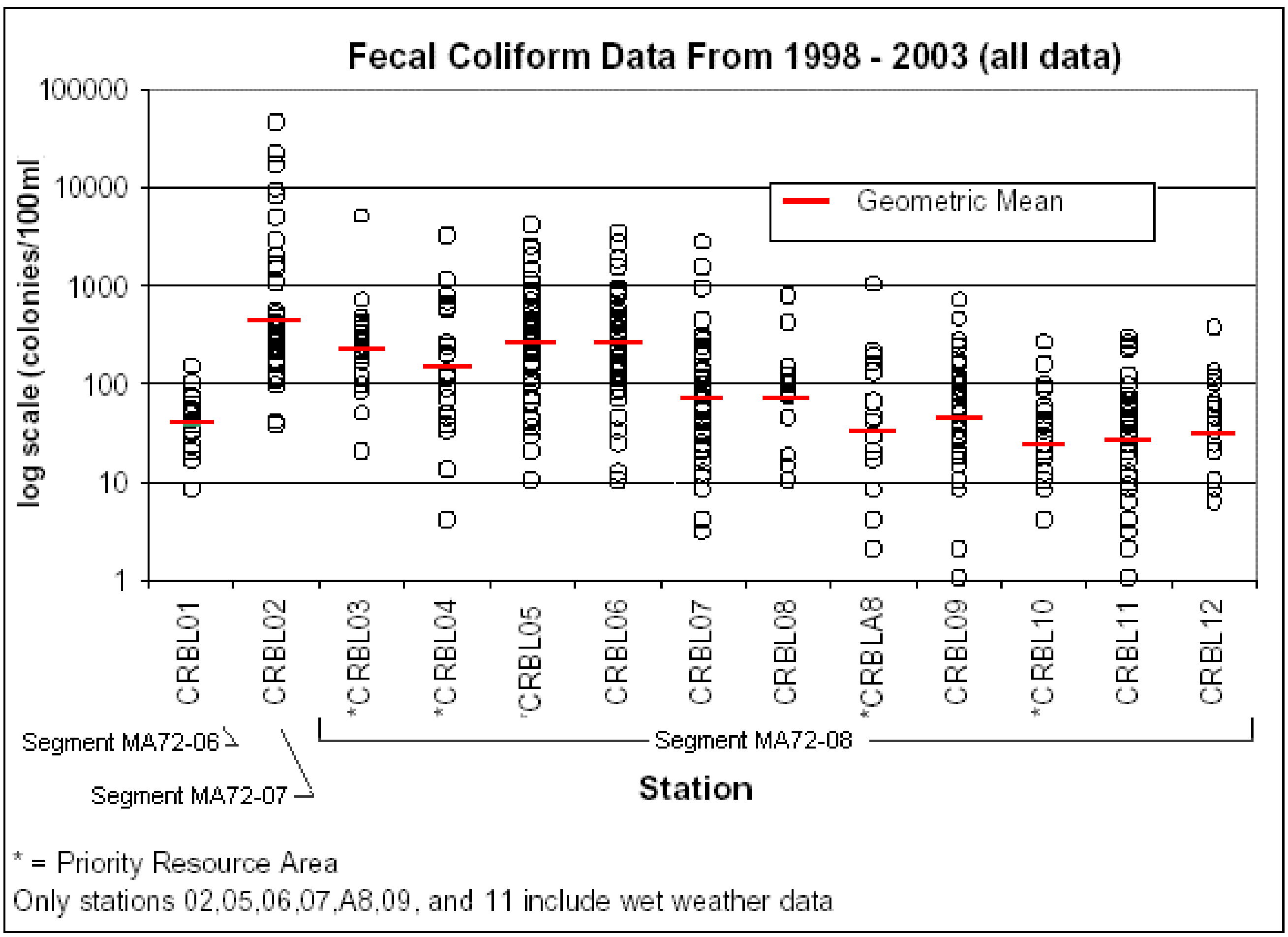


Figure 4-2. Fecal Coliform Dry Weather Geometric Means (modified Figure 2a from USEPA 2004b).

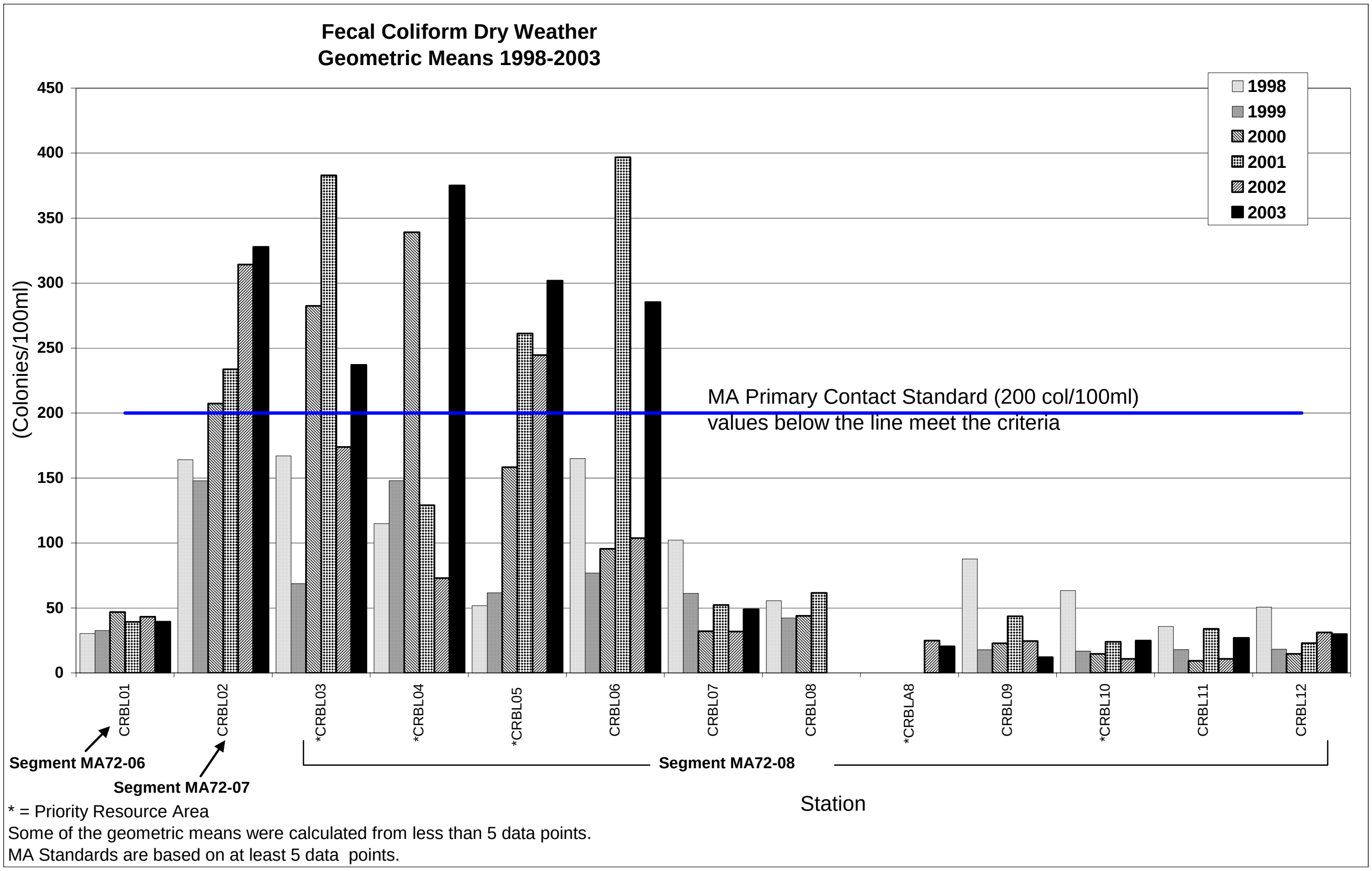


Figure 4-3. 2003 *E. coli* Counts in the Lower Charles River (modified Figure 3a from USEPA 2004b).

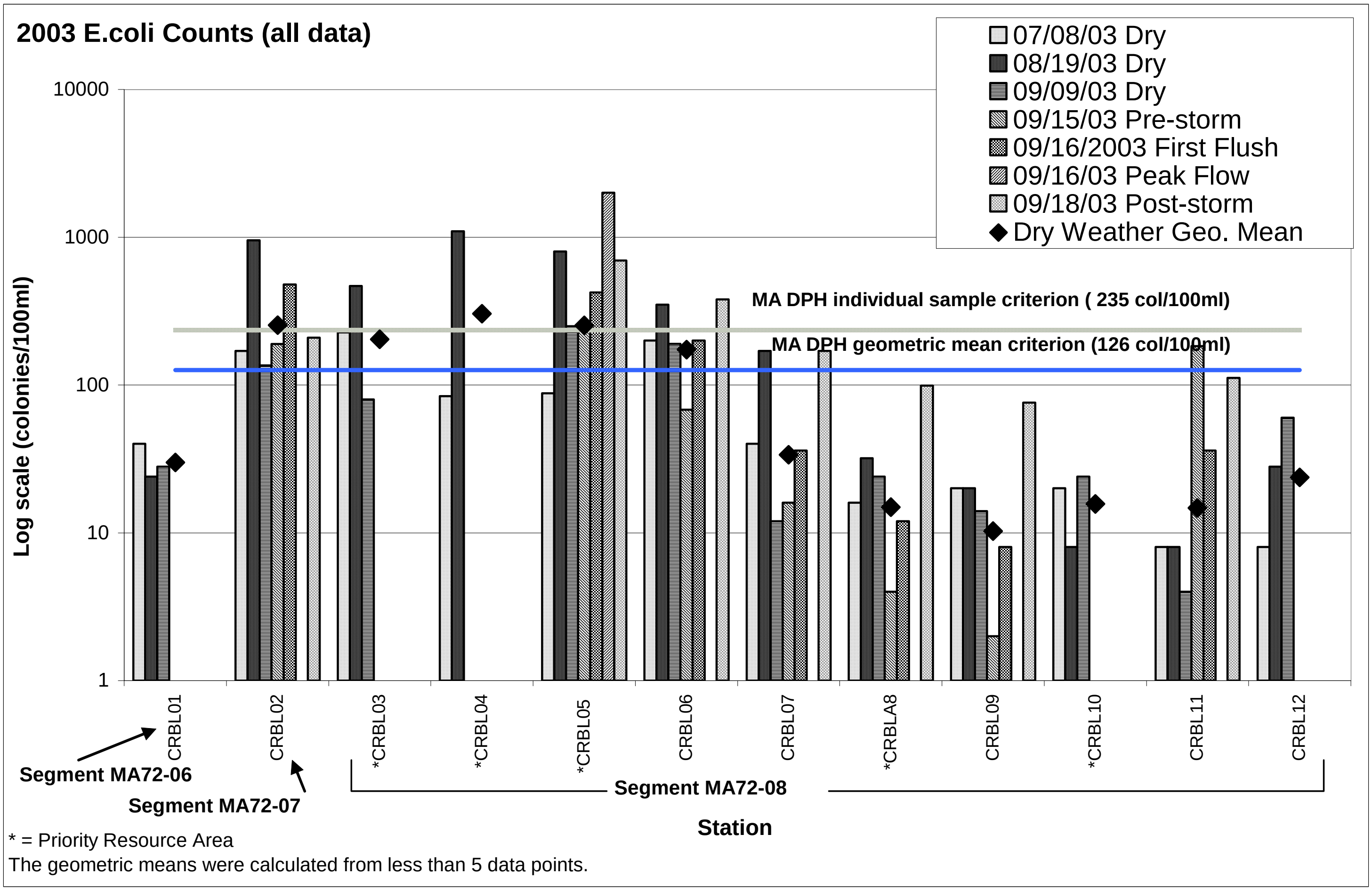


Figure 4-4. USEPA Core Monitoring Locations and Priority Resource Areas.

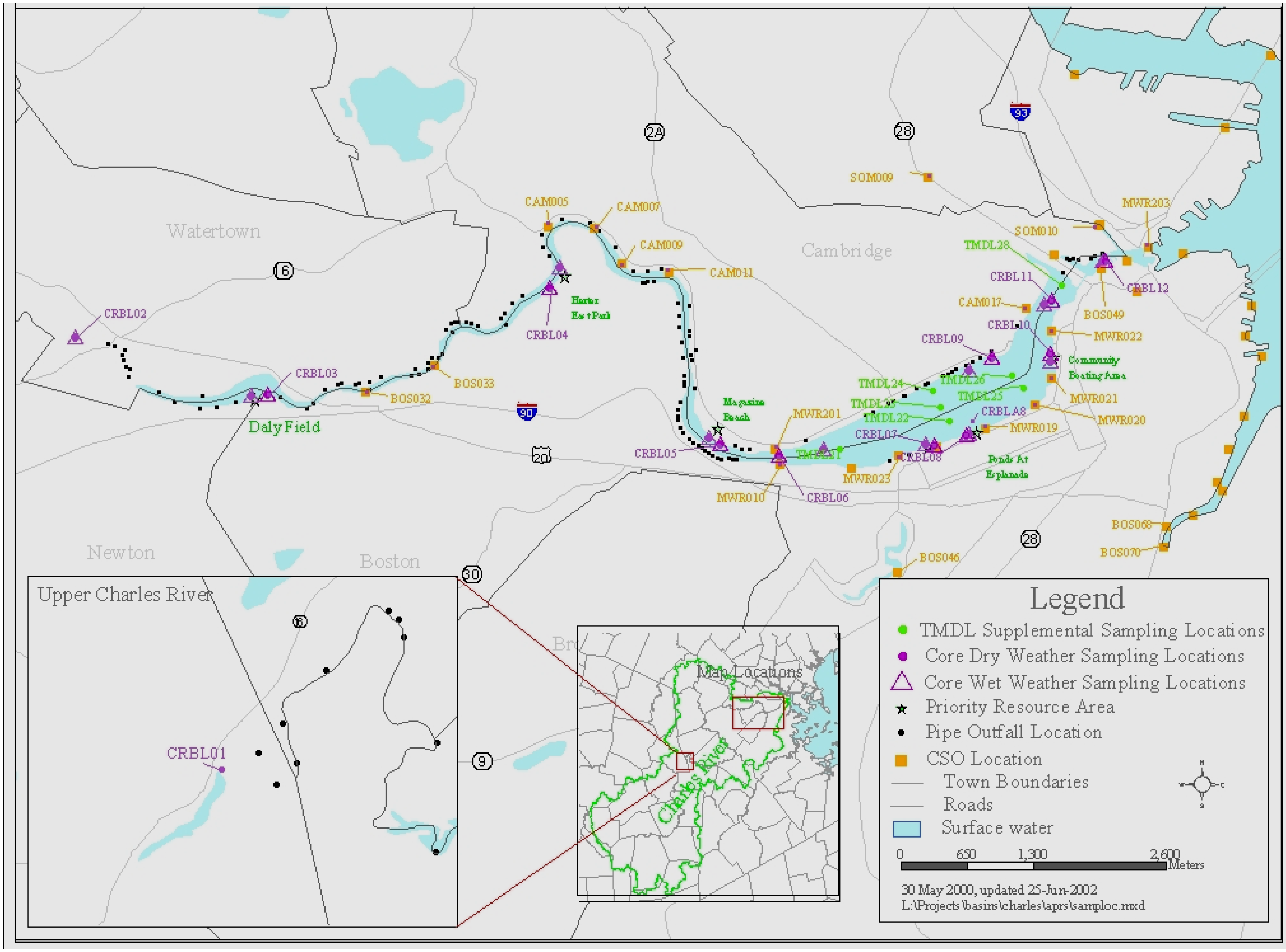


Figure 4-5. Lower Charles River Fecal Coliform Results 1998-2001 (modified from Coughlin 2003).

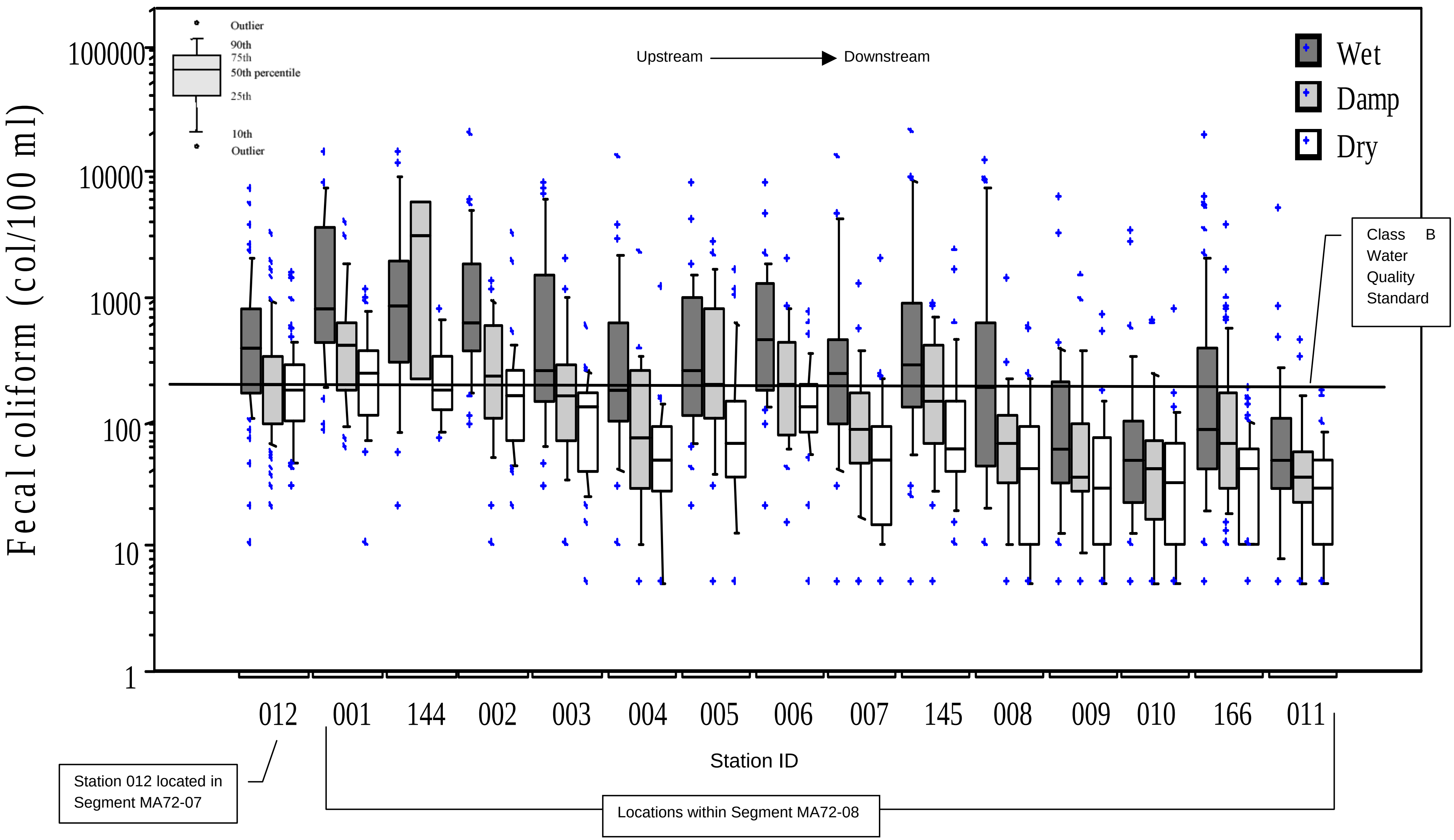


Figure 4-6. Lower Charles River Enterococci Results 1998-2001 (modified from Coughlin 2003).

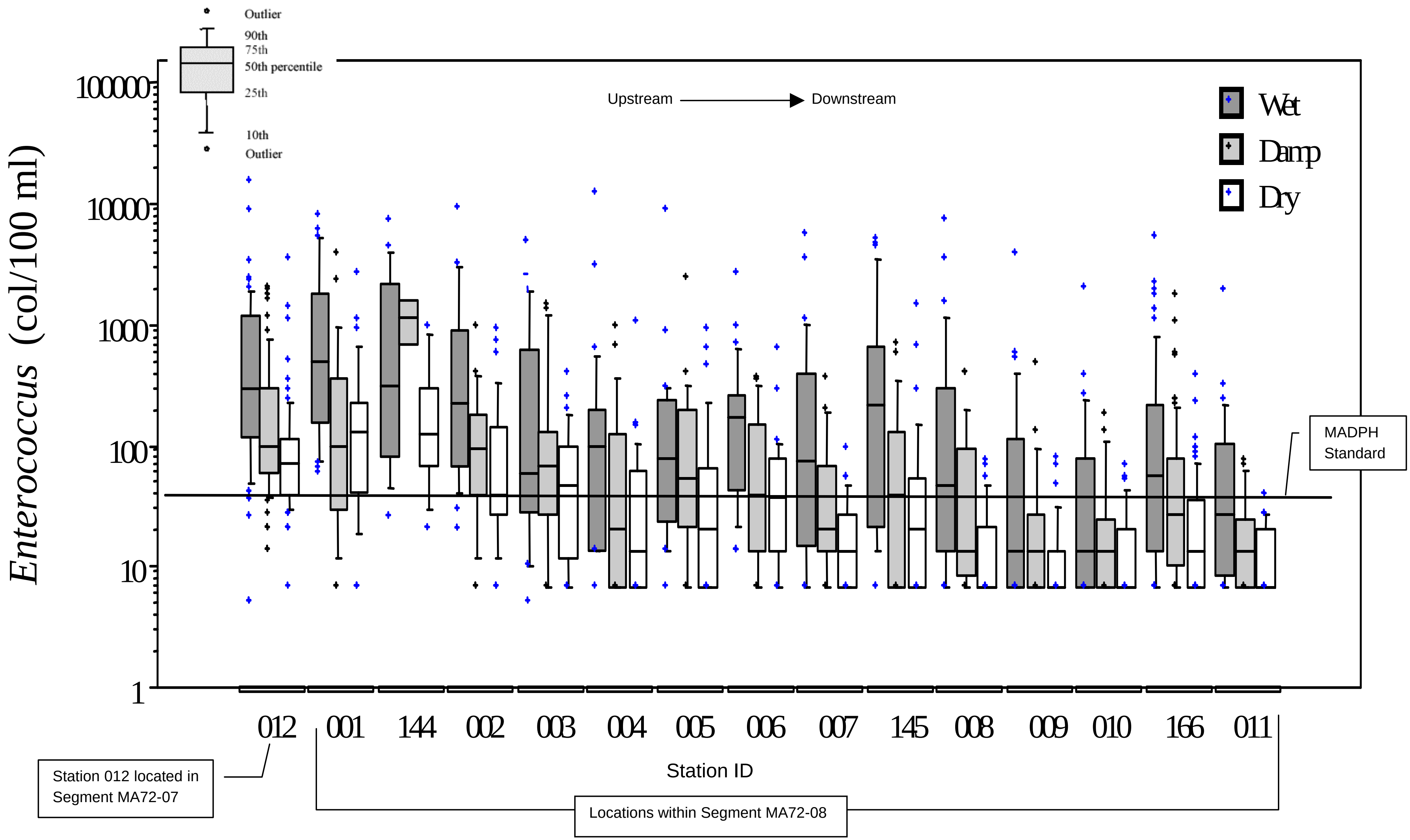
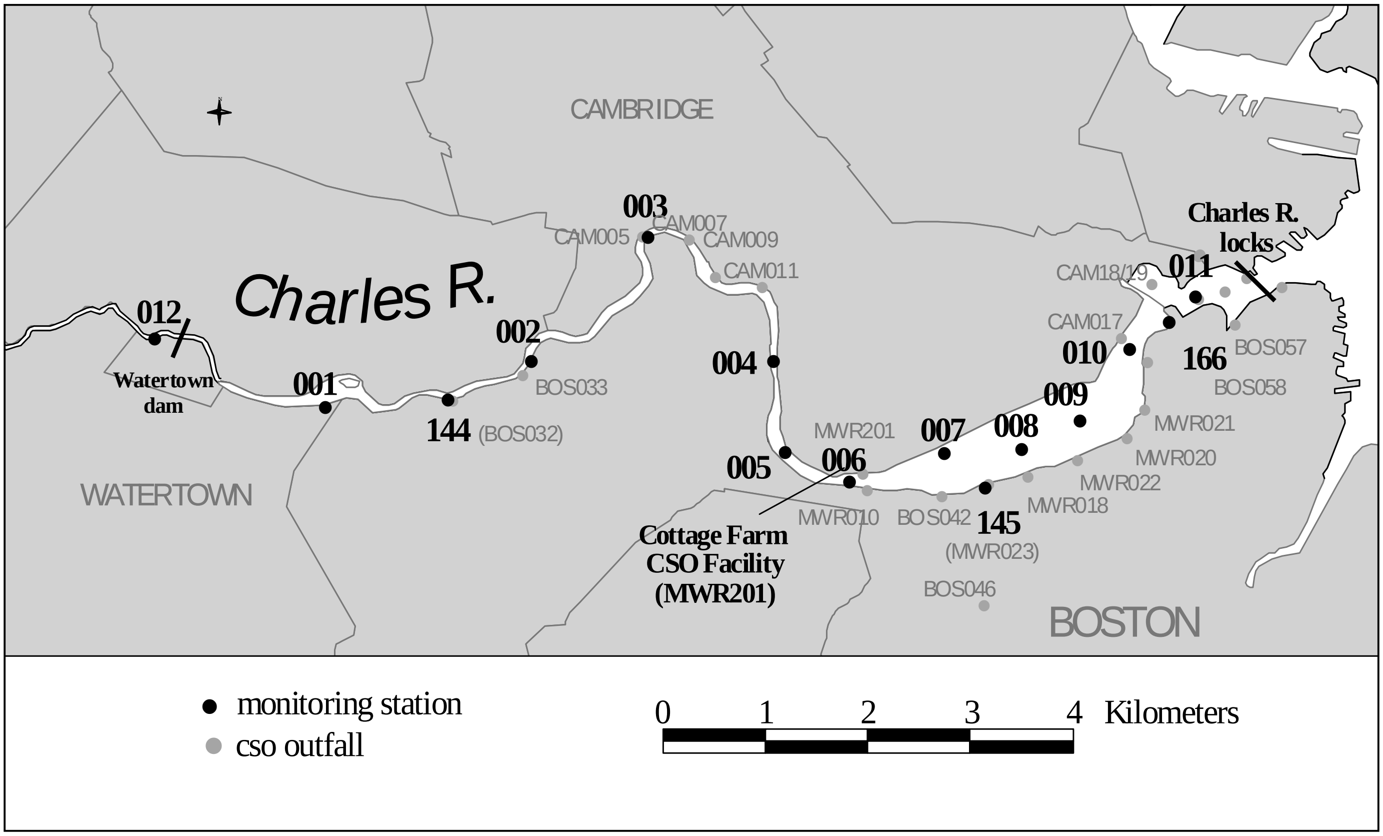


Figure 4-7. MWRA Sample Location Map (Coughlin 2003).



Unnamed Tributary Segment MA72-30

This segment is a 0.1-mile long Class B waterbody. This unnamed tributary, locally known as Laundry Brook, is located in Watertown and extends from California Street and flows north to the Charles River. There are no known NPDES discharges or water withdrawals in this segment. See MASSDEP WQA for more information regarding this segment, available for download at http://mass.gov/dep/water/resources/wqassess.htm.

USGS (June 1999 – September 2000) and MASSDEP WQA (July 1997 – April 1998) fecal coliform data for this segment are summarized in Table 4-21.

Table 4-21. MA72-30 Unnamed Tributary Fecal Coliform Data Summary

			Dry Weather (CFU/100 mL)			Wet Weather (CFU/100 mL)		
Site #	**Description**	**Town**	**Min**	**Max**	**n**	**Min**	**Max**	**n**
USGS 1999-2000 (mean, min & max reported for wet weather)								
01104640	Mouth of Laundry Brook	Watertown	50	5,500	13	1,200	44,000	9
MASSDEP WQA 1997-1998								
LB01	California St. (Laundry Bk)	Watertown	20	2,600	6	270	5,500	2

Unnamed Tributary Segment MA72-32

This segment is 0.5 miles and is not listed in the MASSDEP WQA. It is assumed Class B waterbody. This unnamed tributary, locally known as Sawins Brook, is located in Watertown and flows southeast from Elm Street to the Charles River. There are two former CSO outfalls along this tributary (MWRA 2003-02). Status of NPDES discharges, water withdrawals or water quality sampling data in this segment are unknown. There were no known fecal coliform data available for this segment at the time of this report.

Muddy River Segment MA72-11

This segment is a 4.2-mile long Class B warm water fishery. This impaired segment is a tributary to the Charles River beginning from Olmstead Park in Boston. There are four NPDES discharges in this drainage area and one CSO. The location of the CSO is provided on the MWRA map in Appendix A. See MASSDEP WQA for more information regarding this segment, available for download at http://mass.gov/dep/water/resources/wqassess.htm.

USGS (June 1999 – September 2000) fecal coliform data for this segment are summarized in Table 4-22.

Table 4-22. MA72-11 Muddy River Fecal Coliform Data Summary.

			Dry Weather (CFU/100 mL)			Wet Weather (CFU/100 mL)		
Site #	**Description**	**Town**	**Min**	**Max**	**n**	**Min**	**Max**	**N**
USGS 1999-2000 (mean, min & max reported for wet weather)								
01104683	Mouth of Muddy River	Boston	<10	4,200	12	3,100	38,000	9

In addition to the data for pathogen-impaired segments listed above, there are several recent sources of bacterial data and published reports that would be useful in determining the extent and potential sources of bacterial pollution in the Charles watershed. A brief description of these data sources is provided below.

- Upper Charles River Nutrient TMDL Project. With funding assistance from the MassDEP, the Charles River Watershed Association (CRWA) is currently developing TMDLs for total phosphorus and dissolved oxygen in the upper Charles River watershed. As part of this multi-year study, CRWA is collecting water chemistry samples (including fecal coliform and *E. coli)* in three mainstem sites on the Charles and several tributaries, including; Bogastow Brook, Chicken Brook, Fuller Brook, Hopping Brook, Mill River, Mine Brook, Stop River, Trout Brook, and Waban Brook. One dry weather-sampling round was conducted in August 2002, which revealed several sites with fecal coliform and *E. coli* values as high as 3,000 colonies/100ml (Hopping, Fuller and Waban Brooks). In addition, two wet weather sampling events were conducted in October 2002 and 2004 revealed maximum values for fecal coliform of 6,000 colonies/100ml (Fuller and Waban Brooks) and *E. coli* of 3,600 colonies/100ml (North Howard Street location in Milford). A monitoring station site map for this project has been included in Appendix D for reference.

- Clean Charles 2005 Water Quality Reports. In 1998, EPA's Office of Environmental Measurement and Evaluation (OEME) initiated the Clean Charles 2005 Core Monitoring Program that sampled 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. These reports (1998-2003) can be accessed at: http://www.epa.gov/NE/charles/2005.html

5.0 Potential Sources

The Charles River Watershed has 20 segments, located throughout the watershed, that are listed as pathogen impaired requiring a TMDL. These segments represent 80.4% of the river miles assessed. Sources of indicator bacteria in the Charles River Watershed are many and varied. A significant amount of work has been done in the last decade to improve the water quality in the Charles River Watershed.

Largely through the efforts of the CRWA, the Boston Water and Sewer Commission (BWSC), MWRA, EPA and MASSDEP field staff, numerous point and non-point sources of fecal contamination have been identified. Table 5-1 summarizes the river segments impaired due to measured indicator bacteria densities and identifies some of the suspected and known sources described in past literature.

Potential dry weather sources include:

- agriculture,
- leaking sewer pipes,
- storm water drainage systems (illicit connections of sanitary sewers to storm drains),
- failing septic systems,
- recreational activities, and
- wildlife, including birds.

Potential wet weather sources include:

- wildlife and domesticated animals (including pets),
- storm water runoff including municipal separate storm sewer systems (MS4),
- combined sewer overflows (CSOs), and
- sanitary sewer overflows (SSOs).

It is difficult to provide accurate quantitative estimates of indicator bacteria contributions from the various sources in the Charles River Watershed because many of the sources are diffuse and intermittent, and extremely difficult to monitor or accurately model. Therefore, a general level of quantification according to source category is provided (e.g., see Tables 5-2 and 5-3). This approach is suitable for the TMDL analysis because it indicates the magnitude of the sources and illustrates the need for controlling them. Additionally, many of the sources (failing septic systems, leaking sewer pipes, sanitary sewer overflows, and illicit sanitary sewer connections) are prohibited, because they indicate a potential health risk and, therefore, must be eliminated. However, estimating the magnitude of overall indicator bacteria loading (the sum of all contributing sources) is achieved for wet and dry conditions using the extensive ambient data available that define baseline conditions (see segment summary tables and WQA).

Table 5-1. Potential Sources of Bacteria in Pathogen Impaired Segments in the Charles River Basin.

Segment	Potential Sources
MA72-01 Charles River	Unknown
MA72-02 Charles River	Illicit sewer discharge to the storm drain at Central St and Godfrey Brk
MA72-03 Charles River	Unknown
MA72-04 Charles River	Unknown
MA72-05 Charles River	Unknown
MA72-10 Stop River	Unknown
MA72-16 Bogastow River	Tributary (Dopping Brook)
MA72-06 Charles River	Storm water; agricultural inputs; Waban and Fuller Brks
MA72-18 Fuller Brook	Waterfowl in pond discharging to unnamed tributary; storm water
MA72-07 Charles River	Storm water; illicit sewer discharge; tributaries; waterfowl
MA72-21 Rock Meadow Brook	Unknown
MA72-23 Sawmill Brook	Illicit sewer discharge to the storm drain located in St. Joseph's Cemetery
MA72-24 South Meadow Brook	Illicit sewer discharge to the storm drain and/or failing infrastructure
MA72-25 Rosemary Brook	Waterfowl; other unknown sources
MA72-28 Beaver Brook	Storm water; illicit sewer discharge
MA72-29 Cheese Cake Brook	Illicit sewer discharge to storm drain located upstream from Watertown St.; Additional illicit sewer discharges
MA72-08 Charles River	CSOs; urban runoff; storm drains; illicit sewer connections
MA72-30 Unnamed Tributary	Illicit sewer discharges
MA72-32 Unnamed Tributary	Unknown
MA72-11 Muddy River	Sewer cross connections (Daisy Field, Tannery Brk, Village Brk and Longwood Ave); Storm water; illicit sewer connections

MS4 = Municipal Separate Storm Water Sewer System – community storm water drainage system
Most sources were identified in the MASSDEP WQA, although some sources have been identified by other organizations such as USGS, MWRA and CRWA.

Agriculture

Land used primarily for agriculture is likely to be impacted by a number of activities that can contribute to indicator bacteria impairments of surface waters. Activities with the potential to contribute to high indicator bacteria concentrations include:

- Field application of manure,
- Runoff from grazing areas,
- Direct deposition from livestock in streams,
- Animal feeding operations,
- Leaking manure storage facilities, and
- Runoff from barnyards.

Indicator bacteria numbers are generally associated with sediment loading. Reducing sediment loading often results in a reduction of indicator bacteria loading as well. Brief summaries of some of these techniques are provided in the "*Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts*".

Sanitary Waste

Leaking sewer pipes, illicit sewer connections, sanitary sewer overflows (SSOs), combined sewer overflows (CSOs) and failing septic systems represent a direct threat to public health since they result in discharge of partially treated or untreated human wastes to the surrounding environment. Quantifying these sources is extremely speculative without direct monitoring of the source because the magnitude is directly proportional to the volume of the source and its proximity to the surface water. Typical values of fecal coliform in untreated domestic wastewater range from 10^4 to 10^6 MPN/100mL (Metcalf and Eddy 1991).

Illicit sewer connections into storm drains result in direct discharges of sewage via the storm drainage system outfalls. The existence of illicit sewer connections to storm drains is well documented in many urban drainage systems, particularly older systems that may have once been combined. The CRWA, USGS, EPA, MWRA and the Boston Water and Sewer Commission (BWSC) and many towns in the Charles River Watershed have been active in the identification and mitigation of these sources. It is estimated by EPA New England that over one million gallons per day (gpd) of illicit discharges were removed in the last decade in the greater Boston area. Additionally, CSO discharges have decreased due to the MWRA CSO Control Plan (MWRA 2004) and capacity has increased at the Deer Island Treatment Plant. It is probable that numerous other illicit sewer connections exist in storm drainage systems serving the older developed portions of the basin.

Monitoring of storm drain outfalls during dry weather is needed to document the presence or absence of sewage in the drainage systems. The majority of the Charles River Watershed (75.6%) is classified as Urban Areas by the United States Census Bureau and is therefore subject to the Stormwater Phase II Final Rule that requires the development and implementation of an illicit discharge detection and elimination plan. See Section 8.0 of this TMDL for information regarding illicit discharge detection guidance.

Septic systems designed, installed, operated and maintained in accordance with 310 CMR 15.000: Title 5, are not significant sources of fecal coliform bacteria. Studies demonstrate that wastewater located four feet below properly functioning septic systems contain on average less than one fecal coliform bacteria organism per 100 mL (Ayres Associates 1993). Failed or non-conforming septic systems, however, can be a major contributor of fecal coliform to the Charles River and tributaries. Wastes from failing septic systems enter surface waters either as direct overland flow or via groundwater. Wet weather events typically increase the rate of transport of pollutant loadings from failing septic systems to surface waters because of the wash-off effect from runoff and the increased rate of groundwater recharge.

Recreational use of waterbodies is a source of pathogen contamination. Swimmers themselves may contribute to pathogen impairment at swimming areas. When swimmers enter the water, residual fecal matter may be washed from the body and contaminate the water with pathogens. In addition, small children in diapers may contribute to contamination of the recreational waters. These sources are likely to be particularly important when the number of swimmers is high and the flushing action of waves is low.

Wildlife and Pet Waste

Animals that are not pets can be a potential source of pathogens. Geese, gulls, and ducks are speculated to be a major pathogen source, particularly at lakes and storm water ponds where large resident populations have become established (Center for Watershed Protection 1999).

Household pets such as cats and dogs can be a substantial source of bacteria – as much as 23,000,000 colonies/gram, according to the Center for Watershed Protection (1999). A rule of thumb estimate for the number of dogs is ~1 dog per 10 people producing an estimated 0.5 pound of feces per dog per day. This translates to an estimated 90,000 dogs in the watershed producing 45,000 pounds of feces per day. Uncollected pet waste is then flushed from the parks, beaches and yards where pets are walked and transported into nearby waterways during wet-weather.

Storm Water

Storm water runoff is another significant contributor of pathogen pollution. As discussed above, during rain events fecal matter from domestic animals and wildlife are readily transported to surface waters via the storm water drainage systems and/or overland flow. The natural filtering capacity provided by vegetative cover and soils is dramatically reduced as urbanization occurs because of the increase in impervious areas (i.e., streets, parking lots, etc.) and stream channelization in the watershed.

Extensive storm water data have been collected and compiled both locally and nationally (e.g., Tables 4-1, 4-2, 5-2 and 5-3) in an attempt to characterize the quality of storm water. Bacteria are easily the most variable of storm water pollutants, with concentrations often varying by factors of 10 to 100 during a single storm. Considering this variability, storm water bacteria concentrations are difficult to accurately predict. Caution must be exercised when using values from single wet weather grab samples to estimate the magnitude of bacteria loading because it is often unknown whether the sample is representative of the "true" mean. To gain an understanding of the magnitude of bacterial loading from storm water and avoid overestimating or underestimating bacteria loading, event mean concentrations (EMC) are often used. An EMC is the concentration of a flow-proportioned sample throughout a storm event. These samples are commonly collected using an automated sampler, which can proportion sample aliquots based on flow. Typical storm water event mean densities for various indicator bacteria in the Lower Charles River and nationwide are provided in Tables 5-2 and 5-3. These EMCs illustrate that storm water indicator bacteria concentrations from certain land uses (i.e., residential) are typically at levels sufficient to cause water quality problems.

The USGS water quality assessment stated "The failure of samples from most of the water-quality stations in this study to meet the minimum water-quality standards necessary to support swimming and boating after rainstorms strongly indicate sources such as urban runoff, illicit sewage discharges, and CSOs" (USGS 2002b). Figure 6 from "*Measured and Simulated Runoff to the Lower Charles River, Massachusetts, October 1999–September 2000*" (USGS 2002b) illustrates the numerous storm water discharge outfalls located within the Lower Charles River. A link to this document is provided in Appendix A of this report.

Table 5-2. Lower Charles River Basin Storm Water Event Mean Bacteria Concentrations (data summarized from USGS 2002a) and Necessary Reductions to Meet Class B WQS.

Land Use Category	Fecal Coliform EMC (CFU/100 mL)	Number of Events	Class B WQS[1]	Reduction to Meet WQS (%)
Single Family Residential	2,800 – 94,000	8	10% of the samples shall not exceed 400 organisms/ 100 mL	2,400 – 93,600 (85.7 – 99.6)
Multifamily Residential	2,200 – 31,000	8		1,800 – 30,600 (81.8 – 98.8)
Commercial	680 – 28,000	8		280 – 27,600 (41.2 - 98.6)

[1] Class B Standard: Shall not exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms. Used 400 to illustrate required reductions since a geometric mean of the samples were not provided.

Table 5-3. Storm Water Event Mean Fecal Coliform Concentrations (as reported in MASSDEP 2002; original data provided in Metcalf & Eddy, 1992) and Necessary Reductions to Meet Class B WQS.

Land Use Category	Fecal Coliform[1] Organisms / 100 mL	Class B WQS[2]	Reduction to Meet WQS (%)
Single Family Residential	37,000	10% of the samples shall not exceed 400 organisms/ 100 mL	36,600 (98.9)
Multifamily Residential	17,000		16,600 (97.6)
Commercial	16,000		15,600 (97.5)
Industrial	14,000		13,600 (97.1)

[1] Derived from NURP study event mean concentrations and nationwide pollutant buildup data (USEPA 1983).

[2] Class B Standard: Shall not exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms. Used 400 to illustrate required reductions since a geometric mean of the samples were not provided.

6.0 Prioritization and Known Sources

This section is intended to provide guidance for setting implementation priorities to identify and eliminate bacteria sources within the Charles River Watershed and to briefly describe on-going efforts within the watershed. Guidance is provided by prioritizing both impaired segments as well as specific sources where known.

Table 6.1 provides a prioritized list of pathogen-impaired **segments** that will require additional bacterial source tracking work and implementation of structural and non-structural Best Management Practices (BMP's). Since limited source information and data are available in each impaired segment a simple scheme was used to prioritize segments based on ambient fecal coliform concentrations. High priority was assigned to those segments where either dry or wet weather concentrations were equal to or greater than 10,000 col /100 ml since such high levels generally indicate a direct sanitary source. Medium priority was assigned to segments where concentrations ranged from 1,000 to 9,999 col/100ml since this range of concentrations generally indicates a direct sewage source that may get diluted in the conveyance system. Low priority was assigned to segments where concentrations were observed less than 1,000 col/100 ml. It should be noted that in all cases waters exceeding the water quality standards identified in Table 4-3 are considered impaired.   Also prioritization can and should be adjusted based on more specific information such as proximity of each source to sensitive areas such as water supply intakes, beaches, and where applicable shellfish areas or the amount of flow from each specific source.

Table 6-1:   Charles River - Priority Segments

Segment ID	Segment Name	Length (miles)	Segment Description	Priority "Dry"	Priority "Wet"
MA72-01	Charles River	2.4	Source, outlet Echo Lake, Hopkinton to Dilla Street, Milford.	Low	Low
MA72-02	Charles River	3.1	Dilla Street, Milford-to-Milford WWTP, Hopedale.	High	High
MA72-03	Charles River	3.1	Milford WWTP, Hopedale to outlet Box Pond, Bellingham.	Medium	Medium
MA72-04	Charles River	11.4	Outlet Box Pond, Bellingham to outlet Populatic Pond, Norfolk/Medway.	Medium	Medium
MA72-05	Charles River	17.9	Outlet Populatic Pond, Norfolk/Medway to South Natick Dam, Natick.	Medium	Medium
MA72-10	Stop River	4.1	Norfolk-Walpole MCI, Norfolk to confluence with Charles River, Medfield.	Medium	Medium
MA72-16	Bogastow Brook	9.3	Outlet Factory Pond, Holliston to inlet South End Pond, Millis.	Low	Low

MA72-06	Charles River	8.0	South Natick Dam, Natick to Chestnut Street, Needham.	Medium	Medium
MA72-18	Fuller Brook	4.4	Headwaters south of Route 135, Needham to confluence with Waban Brook, Wellesley.	Medium	Medium
MA72-07	Charles River	23.2	Chestnut Street, Needham to Watertown Dam, Watertown.	Medium	Medium
MA72-21	Rock Meadow Brook	3.8	Headwaters in Fisher Meadow, Westwood through Stevens Pond and Lee Pond, Westwood to confluence Charles River, Dedham.	Low	Low
MA72-23	Sawmill Brook	2.7	Headwaters, Newton to confluence with Charles River, Boston.	Medium	Medium
MA72-24	South Meadow Brook	2.1	Isolated, interrupted, urban brook with 'headwaters' south of Route 9, Newton to confluence of Charles River, Newton.	Medium	Medium
MA72-25	Rosemary Brook	3.2	Headwaters, outlet Rosemary Lake, Needham to confluence with Charles River, Wellesley.	Low	Low
MA72-28	Beaver Brook	8.0	Headwaters, south of Route 2, Lexington through culverting to Charles River, Waltham.	High	Medium
MA72-29	Cheesecake Brook	1.4	Headwaters, West Newton to confluence with Charles River, Newton.	High	High
MA72-08	Charles River	8.6	(Charles Basin) Watertown Dam, Watertown to Science Museum, Boston.	Medium	High
MA72-30	Unnamed Tributary	0.1	Unnamed tributary locally known as Laundry Brook. Emerges north of California Street, Watertown and flows north to confluence with Charles River, Watertown.	Medium	High
MA72-32	Unnamed tributary	0.5	Locally known as Sawins Brook. Headwaters east of Elm Street to confluence with Charles River, Watertown (sections culverted).		
MA72-11	Muddy River	4.2	Outlet of unnamed pond, Olmstead Park, Boston to confluence with Charles River, Boston.	Medium	High

Table 6-2 provides a list of high priority pathogen **sources,** which have been identified within the watershed.
For over a decade, a watershed advocate (Roger Frymire – Charles River Hot spot Monitoring Data 2002 – 2005) has systematically searched the shoreline of the Lower Charles River for bacterial sources of pollution. Since 2002 and continuing through 2005, several hundred storm drain outfalls have been sampled following the procedures outlined in the CRWA approved Quality Assurance Project Plan[1] in the Lower Charles basin for fecal coliform bacteria during both dry and wet weather events. EPA's Environmental Lab in Chelmsford performed all the fecal bacteria analysis for on-going targeted monitoring efforts. The Charles River Hot Spot Data (2002 –2005) has become a critical source of information for finding and prioritizing episodic bacterial discharges. As a result of this investigative and targeted monitoring work, the following table provides a summary of 31 storm water outfalls that should be considered a "high" priority for additional bacterial source tracking and remediation. This prioritization table is based on level of fecal concentrations within the sample (analyzed by EPA) and observed flow observations (both dry and wet weather). Note- a link to the summary of the entire bacterial hot spot monitoring work (2002 – 2005) can be found in Appendix E.

Table 6-2: Charles River – "High" Priority Outfalls

River Segment No.	Operator	Site ID (s)	Site Description	"Dry / Wet"	Site Information / Actions
MA72-08	Watertown	D11	Watertown Square – (Galen St.)	Wet	High fecal counts ranging from 10,000 – 100,000 with grey plume; outfall is under water. Watertown has conducted preliminary testing to find source.
MA72-08	Boston / MBTA		Fleet Center Drainage (~36" outfall)	Wet	High fecal counts ranging from 60,000 to 100,000; possible bacterial source from gulls and pigeons.
MA72-08	Boston	BWSC 04-2	Muddy River Conduit (~11'x14' diversion chamber)	Dry & Wet	Brown plume requires further investigation.
MA72-28	Waltham	Beaver, B001, BEB01E, BEB01W (26)	Beaver Brook: by Newton St., by Charles, east culvert, west side	Dry	Waltham is currently investigating the Beaver Brook drainage system; one illicit connection has been identified. Initial source tracking should focus on BEB01W.
	Boston	BOS032	Fanueil Valley Brook Conduit		Boston has partially addressed this problem by finding and fixing (64) illicit connections – thus removing ~28,000

[1] Charles River Watershed Association, 2001. Quality Assurance Project Plan for the Charles River Watershed Integrated Monitoring, Modeling and Management Project. Newton, MA.

River Segment No.	Operator	Site ID (s)	Site Description	"Dry / Wet"	Site Information / Actions
MA72-08				Dry	gallons per day (gpd).
MA72-08	Boston	BOS034	Downstream of River St, upstream of BU bridge (~ 30" outfall)	Dry & Wet	A potentially large bacterial source (~ 6' diameter pipe) that is submerged and negatively pitched back –causing Charles River backflow during dry weather and high bacterial outflows during wet weather events (9/05 wet sampling result 172,000 colonies). Boston has performed some initial source tracking work on this outfall, which has resulted in the illicit removal of ~ 2,000 gpd.
MA72-08	Boston / Brookline	BOS035	Salt Creek conduit (Smelt Brook-Brookline (middle boomed outfall)	Dry & Wet	Boston has performed recent investigative work to find possible sources and Brookline has prioritized this outfall in its EPA illicit action plan.
MA72-08	Boston / Brookline	BOS132	Upstream of BU bridge	Wet	Boston and Brookline are investigating. September 2005 wet weather sampling events revealed bacterial pipe counts at 85,000 and 151,000 colonies.
MA72-07	Waltham	BOSBARK	Downstream of Moody Street Dam, adjacent to Elm St.	Wet	Potential bacterial impacts from high volume non-point sources (overland runoff) directly into the Charles River.
MA72-07	Belmont	BPAIRS	Two (~42'') drainage outfalls for sections of Watertown, Belmont, MBTA.	Dry & Wet	

River Segment No.	Operator	Site ID (s)	Site Description	"Dry / Wet"	Site Information / Actions
MA72-11	Brookline	BROD002, BROD04, BROD1A, BRODx1, BRODx2	Tannery Brook outlet (7'x121), storm drain #4 (5'x5.5'),near Netherlands Rd. @ USGS station, Village Brook outlet (9'x12') to Leverett Pond, Old Tannery Brook (ex-CSO), Pearl Street drain outlet (7'x12') – original Village Brook.	Dry & Wet	These outfalls represent a major portion of Brookline's drainage area. Brookline has initiated investigative actions to find and fix illicit connections in these outfalls. Brookline is currently following up on approximately 50 suspected illicit connections in these drainage areas.
MA72-29	Newton	CHEE16	South side of Washington St. where Cheesecake Brook exits after passing beneath Turnpike.	Dry & Wet	Newton has partially fixed dry weather flow problem (under drain #2); high counts during wet weather (120,000 colonies in 10/05). Newton has spent millions of dollars in under drain repairs for Cheesecake and Laundry Brooks.
MA72-08	Newton	HYDE01	Hyde Brook at mouth of Charles River.	Dry	Upstream of Newton Yacht Club.
MA72-30	Newton / Watertown	LAUD01	Laundry Brook near mouth of Charles	Dry	Newton has performed recent dye testing and TV inspection of area discharge drains; some offset joints were found and will be sealed and fixed. Newton has spent millions of dollars in under drain repairs for Cheesecake and Laundry Brooks.
MA72-11	Boston / Brookline	MUD253, MUD273	Downstream side of Brookline Avenue.	Wet	Centerline Muddy samples – NOT sources
	Boston	MWR023	Stony Brook outfall	Dry	Boston's Sewer Separation project is on going; grey plume requires further investigation.
	Newton	NEW76L, NEW76R	Derby Brook- double 40" outfall pipes (L)- upstream pipe at drainage #76 California Rd., (R) – downstream pipe at drainage area #76.	Dry	Newton has conducted investigative work to locate bacterial pollution sources; source-tracking work is on going.
	Watertown	WAT21A, WAT21B	Watertown drainage 21A and 21B to Sawins Brook.	Dry	Intermittent dry weather exceedances. April 2005 sample at drainage 21B showed fecal concentrations in excess of

River Segment No.	Operator	Site ID (s)	Site Description	"Dry / Wet"	Site Information / Actions
MA72-32					200,000 colonies.
MA72-32	Watertown	SAW01	Sawins Brook near mouth of Charles River at Arsenal and Greenough.	Dry	Intermittent dry weather exceedances. April 2005 sample in Brook showed fecal counts in excess of 6,600 colonies.
MA72-28	Waltham	Drainage Area 1	Upstream of Beaver Brook.	Dry	Intermittent dry weather exceedances. August 2005 sample showed fecal concentrations at several thousand colonies.
MA72-07	Waltham	CR018 (CR10)	Upstream of Moody Street Dam – Maple/Prospect Sts. (next to Gold Star Mother Bridge) (~40")	Dry	Waltham has performed dry weather testing on this outfall pipe showing high fecal concentrations in 100,000 – 200,000 range. Sampling by Mr. Frymire on a steady dry weather pipe flow (8/17/05) showed fecal levels in excess of 12,000 colonies.

On-Going Efforts:
In Nov. 2004, EPA issued administrative orders to Watertown, Waltham, Newton and Brookline based on data that those communities still had illicit discharges to the Charles or its tributaries. The orders require these communities to develop a comprehensive Illicit Discharge Detection and Elimination (IDDE) Plan. Once EPA approves the plan, the plan will be incorporated into the MS4 stormwater permit for each community, and the EPA order will be withdrawn. EPA withdrew Brookline's order as a result of amendments to its storm water management plan. Newton is close to amending its storm water management plan to address these concerns, at which point its order will be withdrawn.

The communities are being asked to address their illicit discharges in a two multi-phase approach. Under initial phases, the communities must complete mapping of their systems, and address known illicit connections or known problem areas on an expedited schedule.

Under subsequent phases, the communities will conduct routine monitoring of their outfalls, and will conduct a comprehensive "top-down" examination of their systems that would seek to identify any sanitary sources of pollution to their drainage systems at any point and remove all discharges by May 1, 2008.This work is high priority because there are significant bacterial loadings that the communities should be addressing in a prompt fashion.

In January of 2005, MassDEP negotiated an enforcement (consent) order with the City of Waltham for its failure to handle repeated sewer overflows / discharges and non-reporting of sewer inflows into its sewer lines. This regulatory order requires the City to create an action plan on how to meet the state Clean Water requirements. The

City has requested $650,000 in State Revolving Funds (SRF) - which appears on MassDEP's FY 06 Clean Water SRF Intended Use Plan- to conduct a comprehensive sewer system evaluation and wastewater management plan study.

The detection and elimination of "illicit" bacterial discharges into the Charles River is a high priority for EPA, MassDEP and local communities. Tracking down episodic illicit connections in storm drainage systems can be a challenging endeavor that requires repeated water quality monitoring, aggressive source tracking techniques, and committed local resources. On-going and targeted bacterial monitoring during the last several years has resulted in greater community awareness and action. Highlighted below are a few examples where persistent local municipal action has resulted in the elimination and cleanup of several critical bacterial discharges into the Charles River watershed.

City of Boston
(2005) BOS233, Drain #233 to south end of Leverett Pond – in the fall of 2005, the City of Boston successfully removed (6) illegal connections, resulting in the removal of approximately 1,640 gallons per day (GPD) of untreated sewage into this outfall pipe. Work is proceeding on (1) additional illicit connection, which is expected to remove an additional 128 (GPD). Confirmatory sampling will be performed in 2006.

(2001) Nashua Street, Prison / Park Outfall – a 36", high-flowing outfall pipe whereby dry weather bacterial flows have been completely removed from the outfall and wet weather bacterial concentrations have been reduced dramatically.

BOS174, Beginning of Nonantum Rd. - untreated sewage was discharging into this outfall pipe; the City of Boston successfully tracked down and removed (6) illegal connections. Recent water quality sampling has confirmed that the dry weather bacterial discharges have been completely removed and wet weather bacterial concentrations have been reduced dramatically.

City of Waltham
(2005) WALRR1, South bank, downstream of Bleachery Dam (unmapped pipe)– in early 2005, targeted hot spot bacteria monitoring revealed "dry" weather fecal coliform discharges in this unmapped outfall pipe at several hundred thousand colonies. As a result, the City of Waltham initiated investigative actions. In April of 2005, the City successfully tracked down and removed an illicit connection into this outfall pipe. Recent water quality sampling in July of 2005 has confirmed that the dry weather bacterial discharges have been completely removed.

City of Cambridge
(2000) CAMD2, Lechmere Canal - a 42", high flowing "dry weather" outfall pipe whereby (6) illicit connections, multiple leaky sewer connections, and a collapsed storm drain were found and repaired. Recent water quality sampling has confirmed that the dry weather bacterial discharges have been completely removed and wet weather bacterial concentrations have been reduced dramatically.

Guidance for developing specific bacterial implementation controls can be retrieved from the companion pathogen TMDL document- "Mitigation Measures to Address Pathogen Pollution in Surface Waters: A TMDL Implementation Guidance Manual (2005)".

7.0 – Pathogen TMDL Development

Section 303 (d) of the Federal Clean Water Act (CWA) requires states to identify waters that do not meet the water quality standards on a list of impaired waterbodies. The most recent approved impairment list, *2002 List*, identifies 20 segments within the Charles River Watershed for use impairment caused by excessive indicator bacteria concentrations.

The CWA requires each state to establish Total Maximum Daily Loads (TMDLs) for listed waters and the pollutant contributing to the impairment(s). TMDLs determine the amount of a pollutant that a waterbody can safely assimilate without violating the water quality standards. Both point and non-point pollution sources are accounted for in a TMDL analysis. EPA regulations require that point sources of pollution (those discharges from discrete pipes or conveyances) subject to NPDES permits receive a waste load allocation (WLA) specifying the amount of a pollutant they can release to the waterbody. Non-point sources of pollution (and point sources not subject to NPDES permits) receive load allocations (LA) specifying the amount of a pollutant that they can release to the waterbody. In the case of stormwater, it is often difficult to identify and distinguish between point source discharges that are subject to NPDES regulation and those that are not. Therefore, EPA has stated that it is permissible to include all point source storm water discharges in the WLA portion of the TMDL. MassDEP has taken this approach. In accordance with the CWA, a TMDL must account for seasonal variations and a margin of safety, which accounts for any lack of knowledge concerning the relationship between effluent limitations and water quality. Thus:

TMDL = WLAs + LAs + Margin of Safety

Where:

WLA = Waste Load Allocation which is the portion of the receiving water's loading capacity that is allocated to each existing and future point sources of pollution.

LA = Load Allocation which is the portion of the receiving water's loading capacity point source not subject to NPDES permits.

7.1 – General Approach: Development of TMDL Targets

For this TMDL the MassDEP developed three types of daily TMDL targets. First, MassDEP set daily concentration TMDL (WLA/LA) targets for each one of the Charles River discharge sources by category (i.e., storm water, CSO, etc). MassDEP recommends that the concentration targets be used as the primary guide for implementation. Second, MassDEP provided an estimate of the necessary percent reductions needed in each segment using a conservative analysis based on comparing ambient bacteria concentrations to water quality criteria. Third, maximum daily loads were developed as a function of streamflow and percentage of time a given streamflow is expected to occur using a flow duration approach. Each methodology is described in greater detail in the following sections, however, all assure loading capacities are equal to or less than the Water Quality Standards.

MassDEP believes that expressing a loading capacity for bacteria in terms of concentrations set equal to the Commonwealth's adopted criteria, as provided in Table 7-1, provides the clearest and most understandable expression of water quality goals to the public and to groups that conduct water quality monitoring. MassDEP considers that the percentage reduction targets are the next most useful TMDL expressions for guiding implementation and from a public education understanding perspective. MassDEP believes that expressing the loading capacity for bacteria in terms of loadings (e.g., numbers of organisms per day) although provided, is more difficult for the public to interpret and understand because the "allowable" loading number varies over the course of the day and season and is very large (i.e. billions or trillions of organisms per day) and therefore cannot be easily understood in the context of the State Water Quality Standards or public health criteria.

To ensure attainment with water quality standards throughout the waterbody, MassDEP emphasizes the simplest and most readily understood way of meeting the TMDL is to have a goal of bacteria sources not exceeding the criteria at the point of discharge. However, determination of meeting the TMDL will be determined by the results from an adequate number of valid samples collected from the waterbody.

7.2 Waste Load Allocations (WLAs) and Load Allocations (LAs) As Daily Concentration (Colonies/100mL).

Sources of indicator bacteria in the Charles River Watershed were found to be many and varied. Most of the bacteria sources are believed to be storm water related. Table 7-1 presents the TMDL indicator bacteria WLAs and LAs for the various source categories as daily concentration targets for the Charles River Basin. For the illicit sources including, illicit discharges to stormwater systems and sewer system overflows (SSO's) the goal is complete elimination (100% reduction). The specific goal for controlling combined sewer overflows (CSO's) is meeting water quality standards. There are also several wastewater treatment plants (WWTPs) and other NPDES-permitted wastewater discharges within the Charles River Watershed. NPDES wastewater discharges WLAs are set at the water quality standards. It is recommended that these concentration targets be used to guide implementation. Conformance with the TMDL will be determined through a sufficient number of valid samples from the receiving water.

Table 7-1: Waste Load Allocations (WLAs) and Load Allocations (LAs) as Daily Concentrations (Colonies/100mL)

Surface Water Classification	Pathogen Source	Waste Load Allocation Indicator Bacteria (CFU/100 mL)[1]	Load Allocation Indicator Bacteria (CFU/100 mL)[1]
A & B	Illicit discharges to storm drains	0	N/A
A & B	Leaking sanitary sewer lines	0	N/A
A & B	Failing septic systems	N/A	0
A	Non-storm water NPDES permitted facilities	Not to exceed an arithmetic mean of 20 organisms in any set of representative samples, nor shall 10% of the samples exceed 100 organisms[2,6]	N/A
A	Storm water runoff Phase I and II	Not to exceed an arithmetic mean of 20 organisms in any set of representative samples, nor shall 10% of the samples exceed 100 organisms[3]	N/A
A	Nonpoint Source Storm water Runoff	N/A	Not to exceed an arithmetic mean of 20 organisms in any set of representative samples, nor shall

Surface Water Classification	Pathogen Source	Waste Load Allocation Indicator Bacteria (CFU/100 mL)[1]	Load Allocation Indicator Bacteria (CFU/100 mL)[1]
			10% of the samples exceed 100 organisms[3]
B	CSOs	Shall not exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms[4]	N/A
B	NPDES – WWTP	Shall not exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms[2,6]	N/A
B	Storm water runoff Phase I and II	Not to exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms[3]	N/A
B	Nonpoint Source Storm water Runoff	N/A	Not to exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms[3]
Fresh Water Beaches[5]	All Sources	Enterococci not to exceed a geometric mean of 33 colonies of the five most recent samples within the same bathing season, nor shall any single sample exceed 61 colonies OR *E. coli* not to exceed a geometric mean of 126 colonies of the five most recent samples within the same bathing season, nor shall any single sample exceed 235 colonies	Enterococci not to exceed a geometric mean of 33 colonies of the five most recent samples within the same bathing season, nor shall any single sample exceed 61 colonies OR *E. coli* not to exceed a geometric mean of 126 colonies of the five most recent samples within the same bathing season, nor shall any single sample exceed 235 colonies

N/A means not applicable

[1] Waste Load Allocation (WLA) and Load Allocation (LA) refer to fecal coliform densities unless specified in table.

[2] Or shall be consistent with the Waste Water Treatment Plant (WWTP) National Pollutant Discharge Elimination System (NPDES) permit.

[3]The expectation for WLAs and LAs for storm water discharges is that they will be achieved through the implementation of BMPs and other controls.

[4] Or other applicable water quality standards.

[5] Massachusetts Department of Public Health regulations (105 CMR Section 445)

[6] Seasonal disinfection may be allowed by the Department on a case-by-case basis.

Note: this table represents waste load and load allocations based on water quality standards current as of the publication date of these TMDLs. If the pathogen criteria change in the future, MassDEP intends to revise the TMDL by addendum to reflect the revised criteria.

7.2.1 Potential Sources of Bacterial Contamination

Some insight on potential sources of bacteria is gained using dry or wet weather bacteria concentrations as a benchmark for reductions. Where a segment is identified as having high dry weather concentrations sources such as permitted discharges, failing septic tanks, illicit sanitary sewers connected to storm drains, and/or leaking sewers may be the primary contributors. Where elevated levels are observed during wet weather potential sources may include flooded septic systems, surcharging sewers (combined sewer overflows or sanitary sewer overflows, and/or stormwater runoff. In urban areas sources of elevated bacteria concentrations can include runoff in areas with high populations of domestic animals or pets. In agricultural areas sources may include runoff from farms, poorly managed manure piles or areas where wild animals or birds congregate. Other potential sources include sanitary sewer connected to storm drains that result in flow that is retarded until the storm drain is flushed during wet weather. Sections 4, 5 and 6 of this document discuss in more detail the types of sources identified as well as their prioritization for implementation.

Table 7-1 presents the indicator bacteria WLAs and LAs for the various source categories. MassDEP intends to update the WLAs and LAs through an addendum to reflect the revised indicator organisms (*E. coli* and enterococci) with the expected update of the WQS once approved by EPA (See Section 3.0 of this report). Source categories representing discharges of untreated sanitary sewage to receiving waters are prohibited, and therefore, assigned WLAs and LAs equal to zero. There are three sets of WLAs and LAs: Class A waters, Class B waters, and Freshwater Beaches.

7.3 – TMDLs As Percent Reduction

Overall wet weather indicator bacteria load reductions can be estimated using measured storm water concentrations, as presented in the *Charles River Basin Watershed 1997/1998 Water Quality Assessment Report* and additional data reports from the USGS, MASSDEP, EPA and MWRA (see Section 4.0 of this report for data resources). The necessary percent reductions needed to meet water quality standards can be calculated from comparison of observed ambient concentrations to water quality criteria. These data, as well as those in the above reports, indicate that reductions greater than 90% in storm water fecal coliform loadings generally will be necessary, especially in developed areas.

To calculate the estimated required reductions the highest concentration of fecal coliform was used to determine the percent reduction needed to ensure the standard of 200 FC/100mL is not exceeded. The highest observed concentration chosen was the largest value observed during either wet or dry weather. This approach ensures an implementation target reduction, which incorporates a significant margin of safety (MOS) since a single sample value is used for determining the reduction needed to meet the water quality criterion, which is actually based on a geometric mean. However, the percent reduction is a guide and determination of whether the WQS have been met will be based on the geometric mean of indicator bacteria concentrations collected over a season with a minimum of five valid samples from the receiving water.

Steps: To estimate the reduction needed to achieve the water quality standard in each segment:

1. Select highest indicator bacteria (fecal coliform in this case) concentration from all current samples taken at a location or within a segment.

2. For each station or segment, calculate the percent reduction needed to meet 200 FC/100ml

(e.g., if the highest value from the samples is 2000 FC/100mL, the reduction needed at that location is: (2000-200)/2000= 90% reduction

3. The highest percent reduction needed is the implementation target for that segment in which the samples were collected.

Example:

The following ambient data are available for segment number MA72-07, which is the Charles River mainstem from Chestnut St., Needham to the Watertown Dam, Watertown and is based on Table 4-13.

			Dry Weather (CFU/100 mL)			Wet Weather (CFU/100 mL)		
Site #	**Description**	**Town**	**Min**	**Max**	**n**	**Min**	**Max**	**N**
CRWA 1995-2003								
484S	Dedham Medical Center	Dedham	<10	1,690	28	20	2,500	20
521S	Ames St. Bridge	Dedham	<10	3,100	16	10	1,600	22
534S	Rt. 109 Bridge	Dedham	<10	3,600	29	30	1,600	23
567S	Nahanton Park	Newton	<10	2,200	17	10	900	22
591S	Rt. 9 Gaging Station	Newton	<10	520	12	10	1,800	17
609S	Washington St. Hunnewell Bridge	Wellesley	<10	1,800	26	10	1,600	23
621S	Leo J. Martin Golf Course/Park Rd.	Weston	<10	1,700	15	10	1,100	22
635S	2391 Commonwealth Ave.	Newton	<10	750	23	20	1,900	22
648S	Lakes Region	Waltham	<10	940	10	10	1,800	15
662S	Moody St. Bridge	Waltham	<10	1,200	28	20	580	23
675S	North St.	Waltham	20	2,200	14	70	1,100	21
012S	Watertown Dam Footbridge	Watertown	10	3,500	29	20	4,600	23
EPA 2002-2003								
CRBL02	Upstream Watertown Dam	Watertown	68	1,396	12	92	540	4
USGS 1999-2000 (mean, min & max reported for wet weather)								
01104615	Upstream Watertown Dam	Watertown	30	5,000	13	220	17,000	9
MADEP WQA 1997-1998								
CR01	Watertown Dam	Watertown	100	360	4			
Needed Reduction		**Percent**						
To reach 200 FC/100mL		**98.8**						

In this example the highest maximum observed concentration of fecal coliform was observed during wet weather conditions and was 17,000 CFU/100 ml. Given this the percent reduction necessary is calculated as follows:

(17,000 -200)/17,000 = 98.8% reduction.

As you can see this percent reduction is conservatively protective based on all the results and provides a large margin of safety since the maximum observed single value was used.

The individual percentage reductions are provided for each segment in the following summary table (Table 7-2). Detailed tables for each segment similar to the one provided in the example are provided in Appendix F.

Table 7-2: Estimated Reductions Needed to Meet WQS

Segment	Maximum Fecal Coliform Concentration/100mL	Estimated Required Reduction to meet Water Quality Standard (Criterion = geometric mean 200 fc/100mL)
MA72-01	No Sample exceeded	0
MA72-02	82000	99.8%
MA72-03	3200	93.8%
MA72-04	5600	96.4%
MA72-05	4800	95.9%
MA72-10	4700	95.7%
MA72-16	600	66.7%
MA72-06	3100	93.5%
MA72-18	4400	95.4%
MA72-07	17000	98.8%
MA72-21	600	66.7%
MA72-23	7000	97.1%
MA72-24	4200	95.2%
MA72-25	450	55.5%
MA72-28	12000	98.3%
MA72-29	50000	99.6%
MA72-08	30000	99.3%
MA72-30	44000	99.5%
MA72-32	No data	
MA72-11	38000	99.5%

7.4 – TMDL Expressed as Daily Load (Colonies/Day)

Flow in rivers and streams is highly variable. Nearly all are familiar with seeing the same river as a raging, flooding torrent and at another time as a tame and calm stream. In many areas, seasonal patterns are evident. A common pattern is high flow in the spring when winter snow melts and spring rains swell rivers. Summer time generally is a period of low flows except for the extreme events of heavy rainfall storms up the scale to hurricanes. Across the United States, the US Geological Survey and others maintain a network of stream gages that measure these flows on a continuous basis thus providing quantitative values to the qualitative scenes described above. These flow measurements are reported in terms of a volume of water passing the gage in a given time period. Often the reported values are in cubic feet per second. A cubic foot of water is 7.48 gallons, and flows can range from less that a cubic foot per second to many thousands of cubic feet per second depending on the time of year and the size of the river or stream. The size of the river or stream and the amount of water that it usually carries is determined by the area of land it drains (known as a watershed), the type of land in the watershed, and the amount of precipitation that falls on the watershed. A common way that USGS reports flow is the cubic feet per second (cfs) averaged over a day since flow can vary even over the course of a day.

Flow at a gage or other location can be characterized in part by the percentage of time the flow is higher than a certain value based on the entire number of days that the flow has been monitored. Some gaging stations have been in operation for many decades, so the length of the record is quite long. As an example, if a gage has been in operation for 30 years, approximately 10,957 days of measurements would be represented in the entire record depending on how many leap years are present. Assuming the record is for 10, 957 days, the number of days that a certain flow was exceeded divided by 10, 957 would be the percent exceedence. Hence, if 343 days had average flows greater than 100 cfs, the percent of time that this flow was exceeded would be 343/10,957, which equals 3.1 percent of the time. This calculation can be done for a variety of flows, which can be plotted on a graph so that one can see what percent of the time any particular flow is exceeded. Based on the assumption that the characteristics of the watershed and precipitation patterns remain relatively constant, one can use such a plot to estimate how frequently a flood or drought of a certain size (i.e., flow) will occur. This is expressed as a percentage exceeding that amount of flow. The plot of the individual flows and percent of time they are exceeded is called a flow duration curve. So if a certain flow is equaled or exceeded 97% of the time, one also knows that flow is less than the given value three percent of the time.

In addition to quantity, there is of course a quality aspect to water. Most chemical constituents are measured in terms of weight per volume, generally using the metric system with milligrams (mg) per liter (L) as the units. A milligram is one thousandth of a gram, 28 of which weigh one ounce. A liter is slightly more than a quart, so there are 3.76 L in a gallon. The total amount of material is called mass and is the quantity in a given volume of water. For instance, if a liter of water had 16 milligrams of salt and one evaporated all of the water, the 16 milligrams of salt would remain. A volume of two liters with the same 16 mg/L of salt would yield 32 milligrams of salt upon evaporation of the water. So, the total amount of material in a volume of water is the combination of the amount (volume) of water and the concentration of the substance being assessed. These two characteristics, in compatible units, are multiplied to determine the quantity of the material present. In the case of a river or stream, the total amount of material passing a gaging station in a day is the total volume multiplied by the concentration of the chemical being assessed. This quantity often is referred to as “load”, and if the time frame is a day, the quantity is called the “daily load”. If another time frame is used, such as a year, the term used is “yearly” or “annual” load.

Bacteria also can be discussed in terms of concentrations and loads. However, the common way of expressing concentrations of bacteria is in terms of numbers rather than weight (although one could use weight). Bacteria standards for water are written in terms of concentrations, and while the method of determining the concentrations can be by direct count or estimated through the outcome of some reaction, it is numbers that are judged to be in a given volume of water. Once again, the load is determined by the concentration multiplied by the volume of water. As can be seen, changes in concentration and/or changes in flow result in changes in the loads. Also, maximum loads can increase and if flow increases in proportion, the concentration will remain the same. For instance, if the total number of bacteria entering a section of stream doubles, but the flow also doubles, the concentration remains the same. This means that as flow increases, load can increase so that concentration remains constant (or lower). In its simplest application, this is the concept of the flow duration curve approach. At each given flow, the maximum load that can enter and still meet the concentration criterion is set. If the numbers of bacteria entering are higher than this allowable number, then a reduction is needed. The conditions that result in the largest percent reduction needed, if achieved, will also cause the other exceedances to be met assuming similar processes are causing the violations.

As a practical matter, determining the flow at each sampling point is resource intensive, expensive and generally is not done. Given this however some estimates of flow can be derived from USGS gages in the watershed or in a nearby similar.

The pollutant loading that a waterbody can safely assimilate is expressed as either mass-per-time, toxicity or some other appropriate measure (40 CFR § 130.2). Typically, TMDLs are expressed as total maximum daily loads. As previously noted, expressing storm water pathogen TMDLs in terms of daily loads is difficult to interpret given the very high numbers of indicator bacteria and the magnitude of the allowable load is dependent on flow conditions and, therefore, will vary as flow rates change. For example, a very high load of indicator bacteria is allowable if the volume of water that transports indicator bacteria is also high. Conversely, a relatively low load of indicator bacteria may exceed the water quality standard if flow rates are low. Given the intermittent nature of storm water related discharges, MassDEP believes it is appropriate to express storm water-dominated indicator bacteria TMDLs proportional to flow for flows greater than 7Q10 (the lowest flow that is expected to occur for seven consecutive days over a ten year period). This approach is appropriate for storm water TMDLs because of the intermittent nature of storm water discharges. However, the WLAs for continuous discharges are not set based on the receiving water’s proportional flow, but rather, are based on the criteria multiplied by the permitted effluent flow (applying the appropriate conversion factor). Because the water quality standard is also expressed in terms of the concentration of organisms per 100 mL, the acceptable in-stream daily load or TMDL is the product of that flow and the criterion.

In recognition that bacteria loads from storm water are flow dependent, varying flow rather than a single value is used to calculate the TMDL as reflected in the following equation:

$$\text{TMDL} = \text{State Standard}*Q_T = \text{WLA}_{(p1)} + \text{LA}_{(n1)} + \text{WLA}_{(p2)} + \text{etc.}$$

Where:

$WLA_{(p1)}$ = allowable load for storm water point source category (1)[1]
$LA_{(n1)}$ = allowable load for nonpoint source category (1)
$WLA_{(p2)}$ = allowable load for point source category (2) etc.
Q_T= stream flow on any given day so long as >7Q10.

For Class A surface waters (1) the arithmetic mean of a representative set of fecal coliform samples shall not exceed 20 organisms per 100 mL; and (2) no more than 10% of the samples shall exceed 100 organisms per 100 mL.

For Class B surface waters (1) the geometric mean of a representative set of fecal coliform samples shall not exceed 200 organisms per 100 mL; and (2) no more than 10% of the samples shall exceed 400 organisms per 100 mL.

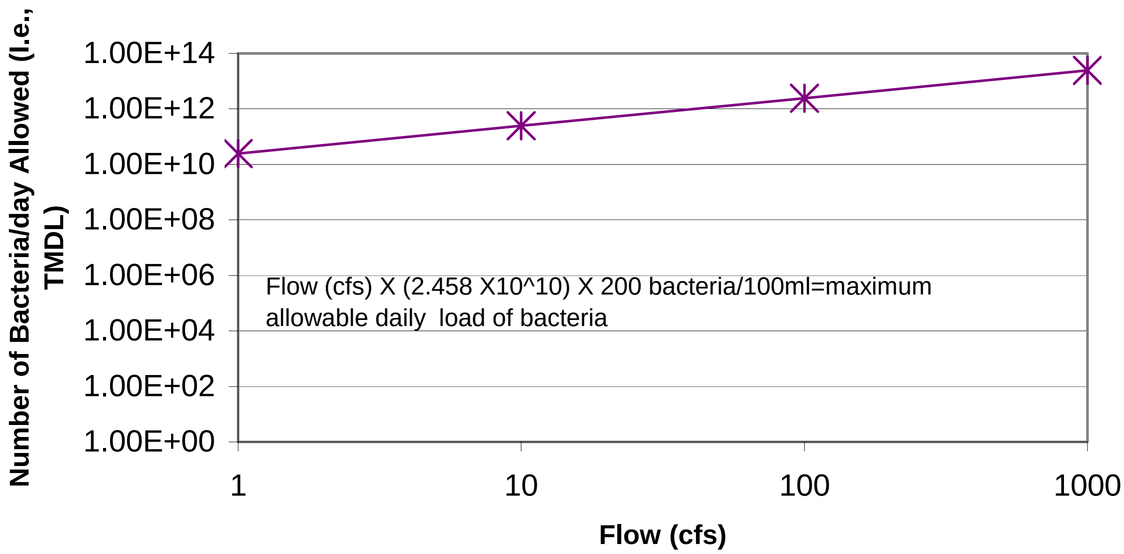
For freshwater bathing beaches (MADPH standard) (1) the geometric mean of the most recent five enterococci levels within the same bathing season shall not exceed 33 colonies per 100 mL and (2) no single enterococci sample shall exceed 61 colonies per 100 mL. – OR – (1) the geometric mean of the most recent five E. coli levels within the same bathing season shall not exceed 126 colonies per 100 mL and (2) no single E. coli sample shall exceed 235 colonies per 100 mL.

7.4.1 – Calculating the TMDL as Daily Loads (Colonies/Day)

The TMDL is calculated based on flow and the criterion for bacteria concentration in the river. The following plot depicts the number or amount of bacteria per day that can be in the river at any given location or segment depending on flow:

[1] For discussion of WLAs for POTWs, see Section 7.4.3.

FIGURE 7-1
Total Allowable Bacteria Load for any Flow
(TMDL: Colonies/Day)



For a specific river, such as the Charles, where one or more stream gages are present, flow can be estimated for a segment in proportion to the drainage area for the segment versus the drainage area to the gage. Hence, if the drainage area to a segment is 25% of the area to the gage, then whatever flow statistic there is for the gage will be 25% of that figure for the segment. So, if the median August monthly flow at the gage is 60 cfs, the (estimated) median August flow for the segment is 15 cfs (i.e., 0.25 x 60= 15). Once the flow is estimated, the total maximum daily load of bacteria, in numbers per day, is derived by multiplying the estimated flow by the criterion for bacteria. Thus, for any segment or location on a river, the TMDL can be calculated used the estimated flow based on drainage area multiplied by the acceptable maximum in-stream concentration of indicator bacteria. For the indicator organism, the criterion for the geometric mean concentration of the indicator bacteria will be used to calculate the acceptable maximum daily load (i.e., the TMDL). This is more conservative than the method used to determine that water quality standards have been achieved, which is based on a geometric mean of bacteria concentrations in samples from the waterbody over the course of the recreational season. A minimum of 5 valid samples is required so that there is a degree of confidence in the results and in the validity of any assessment. These samples normally are scheduled for collection regardless of the weather, so dry and wet conditions may be encountered. Concentrations above any applicable single sample maximum, except for beaches, where they are used for closure decisions, are used as a basis for further investigations and/or setting priorities when additional monitoring is scheduled during implementation. The protocol as just described above is being applied to the Charles River Basin, which follows.

Several segments in the Charles River Basin are listed as being impaired by pathogens based on the indicator, fecal coliform bacteria.

The actual allowable load of bacteria, in numbers of bacteria per day, varies with flow at or above 7Q10 in each segment as presented in Figure 7-1. This approach sets a target for reducing the loads so that water quality criteria for indicator bacteria are met at all flows equal to or greater than 7Q10.

7.4.2 - Stormwater Contribution

Part of the stormwater overland flow comes from point sources and is included in the waste load allocation, and part comes from non-point sources and is included in the load allocation of the TMDL. The fraction of the runoff load attributed to the waste load allocation is estimated from the fraction of the watershed that has impervious cover because storm water from impervious cover is more likely to be diverted, collected and conveyed to the receiving water by storm water collection systems than non-impervious areas. Based on information from MassGIS and the algorithm within it used to estimate the extent of impervious surface, the Upper Charles River watershed above the USGS gage is 20.3% impervious and 79.7% pervious. Thus, 20.3% of the acceptable bacteria load at a given flow is assigned as waste load allocation while 79.7% of the total load represents the load allocation. For instance, in a segment for which the average daily flow is 10 cfs, the allowable bacteria load for that day and location or segment is $3x10^{11}$ fecal coliform/day (from Figure 1). Therefore, for that flow, the waste load allocation is $0.6x10^{11}$ bacteria per day[1] (i.e., (0.203) x ($3x10^{11}$ bacteria/day) and the load allocation is $2.4x10^{11}$ bacteria per day (i.e., (0.797) x ($3x10^{11}$ bacteria/day). This is consistent with requiring the greatest reduction in bacteria to impervious areas because they generate the largest impact.

Also as previously indicated, the allowable storm water load for bacteria varies with receiving water flow. In order to calculate the allowable daily load, flow must be taken into account. To estimate the frequency of flow for a given location or segment, flows at a gage in the watershed or nearby watershed can be prorated based on drainage area. For each segment in the Charles River Watershed, the drainage area to each segment was used to estimate the 10%, 50% and 90% (high, average and low stream flow) average daily flows using the USGS records from the Dover gage (Figure 7-2). This was done for the Charles River Watershed by dividing the drainage area to the segment by the drainage to the Dover gage and multiplying this result by the flow at the Dover gage for each of the three frequencies (10% (high stream flow), 50% (median), and 90% (low) exceedence values). The frequency of the allowable daily loads is thus tied to the frequency of the flow duration curve. Unless more specific information is available, the frequency of flow at a given location or in a given segment can be estimated by a straight line interpolation between the 10% and 50% values and then between the 50% and 90% values since the slope between each of the two sets of points generally is different. Since the maximum allowable daily load is the flow times the constant value of the water quality criterion (200 FC/100mL in this case), one can use the linear interpolation between the TMDLs for the 10% 50% and 90% maximum allowable daily load per square mile of drainage area (Figures 7-2 and 7-3). The TMDL then becomes the drainage area to the location or segment times the value for one square mile.

The Total Maximum Daily Load of bacteria (in total numbers) is developed and presented in the following graphs and table.

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[1] Note that the example waste load allocation includes the contribution from any point source stormwater discharges and CSO discharges. For discussion of the WLAs for POTWs, see Section 7.4.3. For the purposes of this TMDL the stormwater contribution is estimated from the amount of flow contributed from impervious surfaces.

Figure 7-2 provides an estimate of the percent of time a specified flow is exceeded plotted against the amount of flow contributed per square mile of watershed at the Dover gage for the period of record between 1937 and 2003.

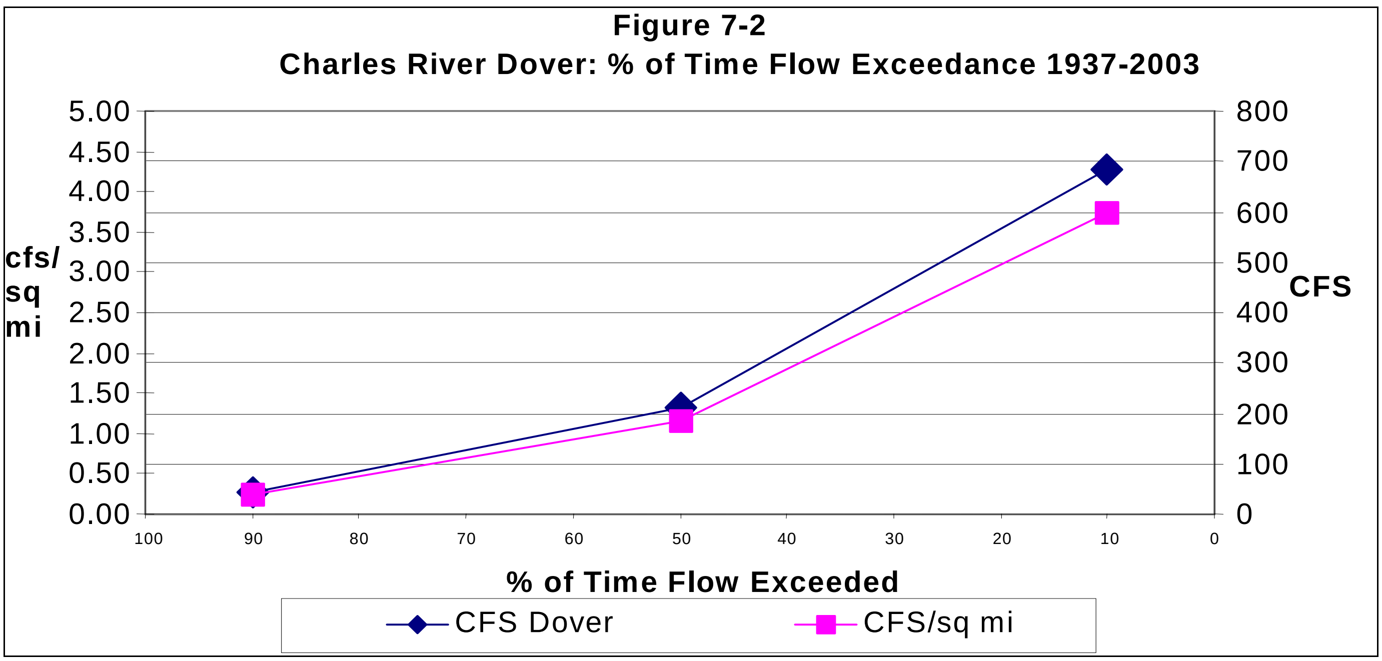
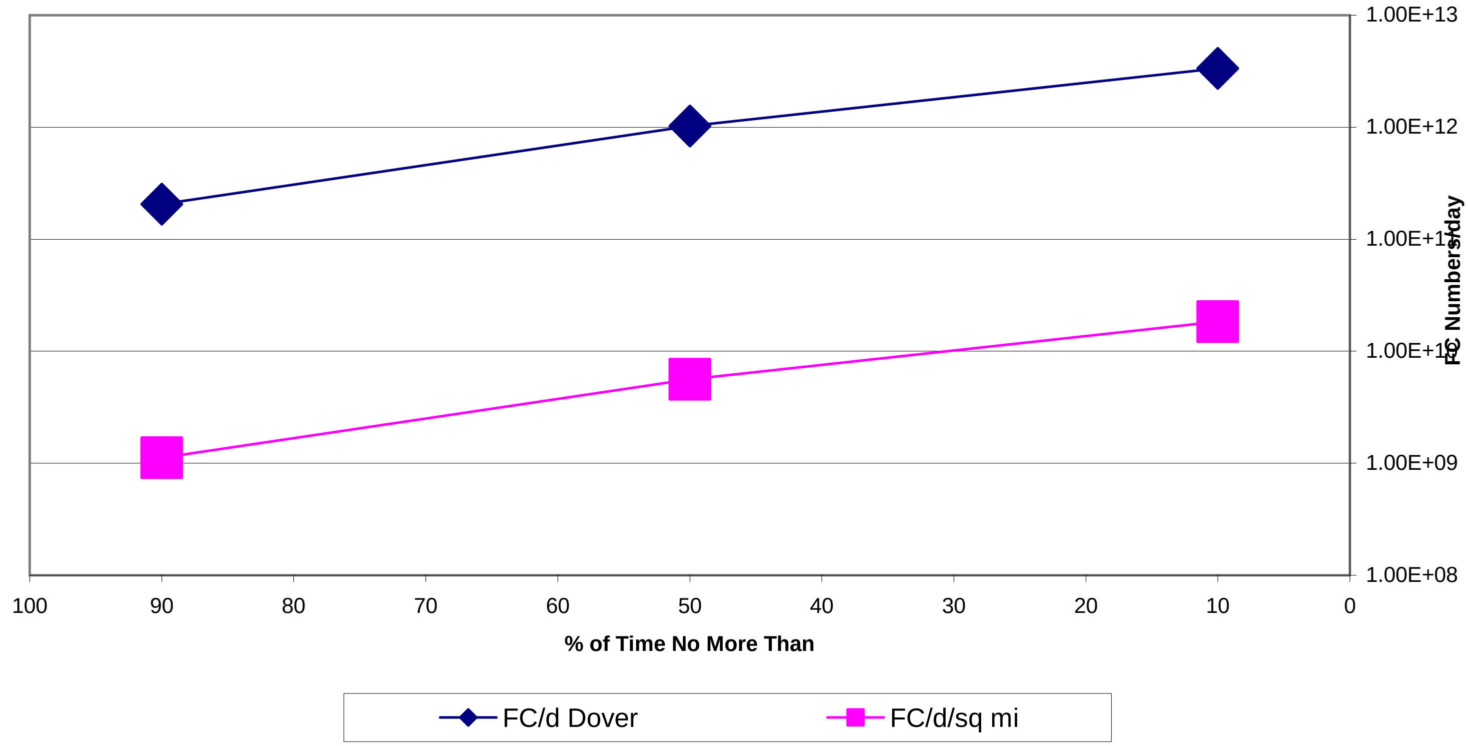


Figure 7-3 provides an estimate of the allowable daily load of fecal coliform plotted against the percent of time flow is exceeded for both the Dover flow gage and for the estimated percentage of flow per square mile of watershed.

Figure 7-3

Allowable Fecal Coliform Daily Loadsvs % Flow Exceeded



The information developed from Figure 7-2 and upper line (FC/d) of Figure 7-3 are then used to develop the lower line on Figure 7-3 (FC/d/Sq. Mi), which provides the maximum fecal coliform daily load per square mile plotted against the % of time flow exceeded.

Using the information identified above the total maximum daily loads for each of the 20 impaired segments were calculated for low, median and high flows and provided in Table 7-3 below.

Table 7-3: Total Maximum Daily Load for High, Median, and Low Flows <u>By Segment</u> (Colonies/Day)

Segment	Drainage	Low Flow 90% of all flows are greater than	Median 50% of all flows are greater than	High Flow 10%of all flows are greater than	TOTAL MAXIMUM ALLOWABLE DAILY BACTERIA LOADS AS DAILY NUMBER OF FECAL COLIFORM (Number of Bacteria per day based on % Flow Exceedance)		
	sq mi	DAILY CFS	DAILY CFS	DAILY CFS	Low Flow -90%	Median Flow -50%	High Flow-10%
MA72-01	0.26	0.1	0.3	1.0	2.87E+08	1.44E+09	4.68E+09
MA72-02	11.76	2.7	13.5	44.0	1.32E+10	6.60E+10	2.15E+11
MA72-03	10	2.3	11.5	37.4	1.12E+10	5.62E+10	1.83E+11
MA72-04	15	3.4	17.2	56.1	1.68E+10	8.42E+10	2.75E+11
MA72-05	25	5.7	28.7	93.6	2.81E+10	1.40E+11	4.58E+11
MA72-10	1.37	0.3	1.6	5.1	1.54E+09	7.70E+09	2.51E+10
MA72-16	2.45	0.6	2.8	9.2	2.75E+09	1.38E+10	4.49E+10
MA72-06	19.50	4.5	22.4	73.0	2.19E+10	1.10E+11	3.57E+11
MA72-18	0.81	0.2	0.9	3.0	9.15E+08	4.58E+09	1.49E+10
MA72-07	37.13	8.5	42.6	139.0	4.17E+10	2.09E+11	6.80E+11
MA72-21	0.28	0.1	0.3	1.1	3.17E+08	1.59E+09	5.18E+09
MA72-23	0.74	0.2	0.9	2.8	8.35E+08	4.18E+09	1.36E+10
MA72-24	38.38	8.8	44.0	143.6	4.31E+10	2.16E+11	7.03E+11
MA72-25	0.74	0.2	0.8	2.8	8.27E+08	4.14E+09	1.35E+10
MA72-28	2.55	0.6	2.9	9.6	2.87E+09	1.43E+10	4.68E+10
MA72-29	0.88	0.2	1.0	3.3	9.89E+08	4.94E+09	1.61E+10
MA72-08	50.44	11.6	57.9	188.8	5.67E+10	2.83E+11	9.24E+11
MA72-30	37.15	8.5	42.6	139.1	4.17E+10	2.09E+11	6.81E+11
MA72-32	0.28	0.1	0.3	1.0	3.13E+08	1.56E+09	5.10E+09
MA72-11	1.93	0.4	2.2	7.2	2.17E+09	1.08E+10	3.54E+10

Total Maximum Daily Loads are based on % flow and expressed as number of bacteria

7.4.3 – TMDL WLA/LA, 50% Flow Example (Colonies/Day)

There are numerous storm water discharges from storm drainage systems throughout the watershed. As discussed in Section 7.0, MassDEP has included all point source storm water discharges in the WLA portion of the TMDL. The WLA assigned to storm water and CSOs varies proportionally to flow, as does the LA. .

WLA: (Impervious area of segment) x (Allowable Load @ a specific flow)
LA: (Pervious area of segment) x (Allowable Load @ a specific flow)

WLAs and LAs are identified for all known source categories including both dry and wet weather sources for Class A and Class B segments within the Charles River Watershed. Illicit dry weather discharges are illegal and therefore are not given a WLA. POTW discharges, which discharge continuously in both dry and wet weather, are given WLAs that do not vary with the receiving water flow, but rather, are based on meeting WQS at the end-of-pipe. See footnote 1 of Table 7.4.

Table 7.4 provides the estimated wasteload and load allocations for each segment addressed in this TMDL using the 50 percent flow exceedance value for each segment.

Table 7-4: WLA and LA TMDL By Segment (Colonies/Day)

Segment	Drainage	Impervious Cover	Pervious Cover	TMDL @ average flow (50%)	Stormwater	
	sq mi	%	%	Fecal Coliform per day	WLA[1]	LA
MA72-01	0.26	7.5	92.5	1.44E+09	1.1E+08	1.3E+09
MA72-02	11.76	15.5	84.5	6.60E+10	1.0E+10	5.6E+10
MA72-03	10	14.4	85.6	5.62E+10	8.1E+09	4.8E+10
MA72-04	15	12.4	87.6	8.42E+10	1.0E+10	7.4E+10
MA72-05	25	10.4	89.6	1.40E+11	1.4E+10	1.3E+11
MA72-10	1.37	7.8	92.2	7.70E+09	6.0E+08	7.1E+09
MA72-16	2.45	9.7	90.3	1.38E+10	1.3E+09	1.2E+10
MA72-06	19.50	10.5	89.5	1.10E+11	1.1E+10	9.8E+10
MA72-18	0.81	15.3	84.7	4.58E+09	7.0E+08	3.9E+09
MA72-07	37.13	13.7	86.3	2.09E+11	2.9E+10	1.8E+11
MA72-21	0.28	10.4	89.6	1.59E+09	1.7E+08	1.4E+09
MA72-23	0.74	25.9	74.1	4.18E+09	1.1E+09	3.1E+09
MA72-24	38.38	30.1	69.9	2.16E+11	6.5E+10	1.5E+11
MA72-25	0.74	19.0	81.0	4.14E+09	7.9E+08	3.4E+09
MA72-28	2.55	22.4	77.6	1.43E+10	3.2E+09	1.1E+10
MA72-29	0.88	32.2	67.8	4.94E+09	1.6E+09	3.3E+09
MA72-08	50.44	16.3	83.7	2.83E+11	4.6E+10	2.4E+11
MA72-30	37.15	21.2	78.9	2.09E+11	4.4E+10	1.6E+11
MA72-32	0.28	48.7	51.3	1.56E+09	7.6E+08	8.0E+08
MA72-11	1.93	29.5	70.5	1.08E+10	3.2E+09	7.6E+09

[1] The WLA for CSOs varies with flow like storm water. There is insufficient information to develop individual WLA, therefore CSOs are grouped in the WLA with other storm water. The WLA for POTWs is the permitted flow multiplied by the water quality criterion and an appropriate conversion factor.

7.5 – Application of the TMDL To Unimpaired or Currently Unassessed Segments

This TMDL applies to the 20 pathogen impaired segments of the Charles River Watershed that are currently listed on the CWA § 303(d) list of impaired waters. MassDEP recommends however, that the information contained in this TMDL guide management activities for all other waters throughout the watershed to help maintain and protect existing water quality. For these non-impaired waters, Massachusetts is proposing "pollution prevention TMDLs" consistent with CWA § 303(d)(3).

The analyses conducted for the pathogen-impaired segments in this TMDL would apply to the non-impaired segments, since the sources and their characteristics are equivalent. The concentration waste load and/or load allocation for each source and designated use would be the same as specified herein. Therefore, the pollution prevention TMDLs would have identical waste load and load allocations based on the sources present and the designated use of the water body segment (see Table ES-1 and Table 7.2). Any discharge would need to be consistent with the applicable waste load allocations, as well as the antidegradation provision of the Massachusetts Water Quality Standards.

This Charles River Watershed TMDL may, in appropriate circumstances, also apply to segments that are listed for pathogen impairment in subsequent Massachusetts CWA § 303(d) Integrated List of Waters. For such segments, this TMDL may apply if, after listing the waters for pathogen impairment and taking into account all relevant comments submitted on the CWA § 303(d) list, the Commonwealth determines with EPA approval of the CWA § 303(d) list that this TMDL should apply to future pathogen impaired segments.

7.6 – Margin of Safety

This section addresses the incorporation of a Margin of Safety (MOS) in the TMDL analysis. The MOS accounts for any uncertainty or lack of knowledge concerning the relationship between pollutant loading and water quality. The MOS can either be implicit (i.e., incorporated into the TMDL analysis through conservative assumptions) or explicit (i.e., expressed in the TMDL as a portion of the loadings). This TMDL uses an implicit MOS, through inclusion of two conservative assumptions. First, the TMDL does not account for mixing in the receiving waters and assumes that zero dilution is available. Realistically, influent water will mix with the receiving water and become diluted below the water quality standard, provided that the receiving water concentration does not exceed the TMDL concentration. Second, the goal of attaining standards at the point of discharge does not account for losses due to die-off and settling of indicator bacteria that are known to occur.

7.7 – Seasonal Variability

In addition to a Margin of Safety, TMDLs must also account for seasonal variability. Pathogen sources to Charles River waters arise from a mixture of continuous and wet-weather driven sources, and there may be no single critical condition that is protective for all other conditions. This TMDL has set WLAs and LAs for all known and suspected source categories equal to the Massachusetts WQS independent of seasonal and climatic conditions. This will ensure the attainment of water quality standards regardless of seasonal and climatic conditions. Controls that are necessary will be in place throughout the year, protecting water quality at all times. However, for discharges that do not affect shellfish beds, intakes for water supplies and when primary contact recreation is not taking place (i.e., during the winter months) seasonal disinfection is permitted for NPDES point source discharges.

8.0 IMPLEMENTATION PLAN

Setting and achieving TMDLs should be an iterative process, with realistic goals over a reasonable timeframe and adjusted as warranted based on ongoing monitoring. The concentrations set out in the TMDL represent reductions that will require substantial time and financial commitment to be attained. A comprehensive control strategy is needed to address the numerous and diverse sources of pathogens in the Charles River Watershed.

Controls on several types of pathogen sources will be required as part of the comprehensive control strategy. Many of the sources in the Charles River Watershed including sewer connections to drainage systems, leaking sewer pipes, sanitary sewer overflows, and failing septic systems, are prohibited and must be eliminated. Individual sources must be first identified in the field before they can be abated. Pinpointing sources typically requires extensive monitoring of the receiving waters, and tributary storm water drainage systems during both dry and wet weather conditions. A comprehensive program is needed to ensure illicit sources are identified and that appropriate actions will be taken to eliminate them. The MASSDEP, EPA, MWRA and the CRWA have been successful in carrying out such monitoring, identifying sources, and, in some cases mobilizing the responsible municipality and other entities to begin to take corrective actions.

Storm water runoff represents another major source of indicator bacteria to the Charles River and tributaries, and the current level of control is inadequate for standards to be attained. Improving storm water runoff quality is essential for restoring water quality and recreational uses. At a minimum, intensive application of non-structural BMPs is needed throughout the watershed to reduce pathogen loadings as well as loadings of other storm water pollutants (e.g., nutrients and sediments) contributing to use impairment in the Charles River Watershed. Depending on the degree of success of the non-structural storm water BMP program, structural controls may become necessary.

For these reasons, a basin-wide implementation approach is recommended. Such a strategy would include a combination of mandatory and voluntary programs for implementing storm water BMPs and eliminating illicit sources. The "*Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts*" was developed to support implementation of pathogen TMDLs. TMDL implementation-related tasks are shown in Table 8-1. The MASSDEP working with the CRWA, MWRA, EPA, BWSC and other team partners shall make every reasonable effort to assure implementation of this TMDL. These stakeholders can provide valuable assistance in defining hot spots and sources of pathogen contamination as well as the implementation of mitigation or preventative measures.

Table 8-1. Tasks

Task	Organization
Writing TMDL	MASSDEP with assistance from ENSR International and EPA
TMDL public meeting	MASSDEP
Response to public comment	MASSDEP
Organization, contacts with volunteer groups	MASSDEP/CRWA
Development of comprehensive storm water management programs including identification and implementation of BMPs	Charles River Basin Communities
Illicit discharge detection and elimination	Charles River Basin Communities with CRWA, MWRA and BWSC
Leaking sewer pipes and sanitary sewer overflows	Charles River Basin Communities
CSO management	MWRA/BWSC
Inspection and upgrade of on-site sewage disposal systems as needed	Homeowners, CRWA and Charles River Basin Communities (Boards of Health)
Organize implementation; work with stakeholders and local officials to identify remedial measures and potential funding sources	MASSDEP, CRWA and Charles River Basin Communities
Organize and implement education and outreach program	MASSDEP, CRWA and Charles River Basin Communities
Write grant and loan funding proposals	CRWA, Charles River Basin Communities and Planning Agencies with guidance from MASSDEP
Inclusion of TMDL recommendations in Executive Office of Environmental Affairs (EOEA) Watershed Action Plan	EOEA
Surface Water Monitoring	MASSDEP, EPA, MWRA and CRWA
Provide periodic status reports on implementation of remedial activities	CRWA, MWRA, Charles River Watershed Communities

8.1 Summary of Activities within the Charles River Watershed

The CRWA has been active stewards of the watershed for 40 years. In that time the CRWA has:

- been actively involved with the development of Community Development Plans while emphasizing the growth impacts on the protection of natural resources,
- been a partner in the Earth Day Charles River Cleanup mobilizing over 1,000 volunteers,
- partnered with the USGS for data phase and modeling of nutrients in an effort to improve water quality management in the upper watershed,
- co-sponsored with the EPA conference on pathogen risks in recreational waters and provided outreach and education to schools and community groups,
- reviewed 30 building plans that have the potential to impact the Charles River and was able to institute changes to these plans to minimize pollution and to recharge aquifers,
- provided 80 volunteers to conduct and complete four years of monthly water quality monitoring,
- provided flag postings indicating bacteria conditions, where red flags indicate dangerous bacteria levels and blue flags indicate signal suitable conditions for boating over the past seven seasons,
- completed zoning plans for the Towns of Littleton and Holliston illustrating areas critical for aquifer recharge and showing potential impacts of development on water resources, and
- increased public appreciation of the Charles River through outreach and education, organizing an annual canoe and kayak race (Run of the Charles), and has published a waterproof pocket-sized Charles River Canoe and Kayak Guide with maps and access information.

The EPA Region I, together with federal, state, and local agencies and participation from citizens and watershed stewards including the CRWA, continues to strive to restore the Charles River so that it is fishable and swimmable. This ambitious effort has utilized cutting edge technologies and strict law enforcement for the reduction or elimination of CSOs, illicit storm sewer connections, and other sources of pollutants to improve the water quality of the Charles River. "On May 2, 2003, EPA graded the river's water quality as a "B", the same grade as last year [2002] but a dramatic improvement from the "D" we gave the river seven years ago [1995]" (USEPA 2004c). In 2003, the CRWA received a $400,000 grant for continued cleanup efforts within the Charles River watershed. More information on the Charles River program is provided on the EPA Region I website located at http://www.epa.gov/region1/charles/.

The BWSC, working together with the MWRA, has taken on a five-year sewer separation project in the Charles River Watershed. The Stony Brook Sewer Separation Project will separate storm water from sanitary waste piping, eliminating discharge of untreated sewage into Stony Brook. Wastewater will then be directed to MWRA Deer Island Waste Water Treatment Plant and storm water will discharge to the Muddy River, eventually discharging to the Charles River. More information regarding this project is available at the BWSC website located at http://www.bwsc.org/tab_menus/6frameset1.htm.

Significant improvements have been made in the Charles River Watershed; additional improvements are expected with implementation of new technology and additional controls. The "*Evaluation of Stormwater Management Benefits to the Lower Charles River*" (link provided in Appendix B of this document) illustrates the "improvements in water quality in the Lower Charles River that have already been achieved and could be expected from the implementation of the CSO control plan developed by the Massachusetts Water Resources Authority (MWRA) and different levels of storm water control including illicit connection removal and Best Management Practices (BMPs)"

(Metcalf and Eddy 2004). It has been estimated that the average percent exceedance of the Class B WQS for fecal coliform has been reduced from 65% in 1995 to 34% in 2002. Additional improvements with implementation of a CSO recommended plan and basic storm water BMPs are predicted to result in an average percent exceedance of 20%, and an even lower predicted average percent exceedance with implementation of a CSO Recommended Plan and aggressive storm water BMPs of 7%.

Data supporting this TMDL indicate that indicator bacteria enter the Charles River from a number of contributing sources, under a variety of conditions. Activities that are currently ongoing and/or planned to ensure that the TMDL can be implemented include and are summarized in the following subsections. The "*Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts*" provides additional details on the implementation of pathogen control measures summarized below as well as additional measures not provided herein, such as by-law, ordinances and public outreach and education.

8.2 Agriculture

A number of techniques have been developed to reduce the contribution of agricultural activities to pathogen contamination. There are also many methods intended to reduce sediment loads from agricultural lands. Since bacteria are often associated with sediments, these techniques are also likely to result in a reduction in bacterial loads in run off as well. Brief summaries of some of these techniques are provided in the "*Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts*". Techniques generally include BMPs for field application of manure, animal feeding operations, barnyards, and managing animal grazing areas.

8.3 Illicit Sewer Connections, Failing Infrastructure and CSOs.

Elimination of illicit sewer connections, repairing failing infrastructure and controlling impacts associated with CSOs are of extreme importance. Several steps are currently underway in this regard. The CRWA, USGS, EPA, MWRA, BWSC and towns in the Charles River Watershed have been active in the identification and mitigation of these sources. "Between 1986, when the Commission's Illegal Sanitary Connection Remediation Program started and the end of 2004, a total of 931 illegal connections have been identified and 893 have been corrected. During 2004, the Commission's program removed an estimated 7,762 gallons per day of wastewater from the storm drainage system and receiving waters" (BWSC 2004). It is estimated by EPA New England that over one million gpd of illicit discharges were removed in the last decade. CSO discharges have decreased due to the MWRA CSO Control Plan (MWRA 2004). "To date, 21 CSO outlets have been closed [includes areas outside the Charles River Watershed], CSO volumes have been reduced by 70% and a minimum of 60% of the remaining flow is now treated" (MWRA 2004).

The MWRA developed a Three-Phase CSO Plan in 1994. Table 8-2 provides a summary of the planned activities (note: this plan includes CSOs discharging to other basins in addition to the Charles River). Details regarding CSO projects by community can be found at http://www.mwra.state.ma.us/03sewer/html/sewcso.htm. In addition, MWRA's 2005 Annual Progress Report on its long-term Combined Sewer Overflow plan can be found at this same site.

Guidance for illicit discharge detection and elimination has been developed by EPA New England (USEPA 2004d). The guidance document provides a plan, available to all Commonwealth communities, to identify and eliminate illicit discharges (both dry and wet weather) to their separate storm sewer systems. Implementation of the protocol outlined in the guidance document satisfies the Illicit Discharge Detection and Elimination requirement of the NPDES program. A copy of the guidance document is provided in Appendix C.

Table 8-2. The MWRA CSO Plan: 1988 – 2008
(from http://www.mwra.state.ma.us/03sewer/html/sewcso.htm)

1988 — 1992	PHASE I	▪ Add CSO treatment facilities. ▪ Improve Deer Island Treatment Plant's ability to pump wet weather sewage flows.
	Results	▪ A reduction of CSO volume by 55% (over 1988 levels) ▪ Treatment of 50% of remaining CSO flows
1992 — 2000	PHASE 2	▪ System optimization plans ▪ Further increase the Deer Island Treatment Plant's ability to achieve full planned pumping and treatment capacity
	Results	▪ A reduction of CSO volume by 70% (over 1988 levels) ▪ Treatment of 60% of remaining CSO flows
1996 — 2015	PHASE 3	▪ Separate combined sewers in some areas ▪ Increase hydraulic capacity of the system in certain areas ▪ Screening/ disinfection/ dechlorination for Fort Point Channel ▪ Construct storage facilities ▪ Upgrade CSO facilities to improve treatment performance
	Goals	▪ Close 36 of 84 CSOs ▪ Eliminate CSO discharges to swimming and shellfishing areas ▪ Reduce CSO volumes by 88% over 1988 levels ▪ Minimize untreated discharges ▪ Treat 95% of remaining flow

8.4 Storm Water Runoff

Storm water runoff can be categorized in two forms; 1) point source discharges (from piped systems) and 2) non-point source discharges (includes sheet flow or direct runoff). Many point source storm water discharges are regulated under the NPDES Phase I and Phase II permitting programs when discharged to a Waters of the United States. Municipalities that operate regulated municipal separate storm sewer systems (MS4s) must develop and implement a storm water management plan (SWMP) which must employ, and set measurable goals for the following six minimum control measures:

1. public education and outreach particularly on the proper disposal of pet waste,
2. public participation/involvement,
3. illicit discharge detection and elimination,
4. construction site runoff control,
5. post construction runoff control, and
6. pollution prevention/good housekeeping.

Portions of towns in this watershed are classified as Urban Areas by the United States Census Bureau and are subject to the Stormwater Phase II Final Rule. This rule requires the development and implementation of an illicit discharge detection and elimination plan.

The NPDES permit does not, however, establish numeric effluent limitations for storm water discharges. Maximum extent practicable (MEP) is the statutory technology standard for MS4s that establishes the level of pollutant reductions that regulated municipalities must achieve. The MEP standard is a narrative effluent limitation that is satisfied through implementation of SWMPs and achievement of measurable goals. The bacteria quality of storm water discharges must be such that water quality criteria are met in the waterbody.

Some stormwater sources may not be the responsibility of the municipal government and may have to be addressed through other regulatory vehicles available to MASSDEP and EPA including, but not limited to, EPA's exercise of its residual designation authority to require NPDES permits, depending upon the severity of the source. The data included in this TMDL, including wasteload allocations, demonstrates that additional controls may well be needed on many storm water discharges, in particular in segments with high bacteria concentrations during wet weather.

Non-point source discharges are generally characterized as sheetflow runoff and are not categorically regulated under the NPDES program and can be difficult to manage. However, some of the same principles for mitigating point source impacts may be applicable. Individual municipalities not regulated under the Phase I or II should implement the exact same six minimum control measures minimizing storm water contamination. The CRWA has been active in this regard, producing a plethora of literature for watershed protection and conservation, including a monthly email newsletter.

In an effort to better manage community storm water, municipal implementation of the EPA Phase I and II programs is being done. All (35) communities in the Charles watershed have submitted storm water management plans and annual progress reports on their activities to prevent and control polluted runoff from their municipal drainage systems. A list of the municipalities in Massachusetts regulated by the Phase II Rule, as well as the Notices of Intent for each municipality can be viewed at http://www.epa.gov/region01/npdes/stormwater/ma.html.

8.5 Failing Septic Systems

Septic system bacteria contributions to the Charles River and its tributaries may be reduced in the future through septic system maintenance and/or replacement. Additionally, the implementation of Title 5, which requires inspection of private sewage disposal systems before property ownership may be transferred, building expansions, or changes in use of properties, will aid in the discovery of poorly operating or failing systems. Because systems, which fail, must be repaired or upgraded, it is expected that the bacteria load from septic systems will be significantly reduced in the future. Regulatory and educational materials for septic system installation, maintenance and alternative technologies are provided by the MASSDEP on the worldwide web at http://mass.gov/dep/water/wastewat.htm.

8.6 Wastewater Treatment Plants

WWTP discharges are regulated under the NPDES program when the effluent is released to surface waters. Each WWTP has an effluent limit included in its NPDES or groundwater permit. Some NPDES permits are listed on the following website: www.epa.gov/region1/npdes/permits_listing_ma.html. Groundwater permits are available at http://www.mass.gov/dep/brp/gw/gwhome.htm.

8.7 Recreational Waters Use Management

Recreational waters receive pathogen inputs from swimmers. To reduce swimmers' contribution to pathogen impairment, shower facilities can be made available, and bathers should be encouraged to shower prior to swimming. In addition, parents should check and change young children's diapers when they are dirty.

8.8 Funding/Community Resources

A complete list of funding sources for implementation of non-point source pollution is provided in Section VII of the Massachusetts Nonpoint Source Management Plan Volume I (MASSDEP 2000b) available on line at http://www.mass.gov/dep/brp/wm/nonpoint.htm. This list includes specific programs available for non-point source management and resources available for communities to manage local growth and development. The State Revolving Fund (SRF) provides low interest loans to communities for certain capital costs associated with building or improving wastewater treatment facilities. In addition, many communities in Massachusetts sponsor low cost loans through the SRF for homeowners to repair or upgrade failing septic systems.

8.9 Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts

For a more complete discussion on ways to mitigate pathogen water pollution, see the "*Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts*" accompanying this document.

9.0 Monitoring Plan

The long term monitoring plan for the Charles River Watershed includes several components:

1. continue with the current monitoring of the Charles River Watershed (CRWA, MWRA, and EPA),
2. continue with MASSDEP watershed five-year cycle monitoring,
3. monitor areas within the watershed where data are lacking or absent to determine if the waterbody meets the use criteria,
4. continue and expand implementation of a bacteria source-tracking program to locate, quantify, and prioritize specific sources to be remediated.
5. monitor areas where BMPs and other control strategies have been implemented or discharges have been removed to assess the effectiveness of the modification or elimination,
6. assemble data collected by each monitoring entity to formulate a concise report where the basin is assessed as a whole and an evaluation of BMPs can be made, and
7. add/remove/modify BMPs as needed based on monitoring results.

The monitoring plan is an ever-changing document that requires flexibility to add, change or delete sampling locations, sampling frequency, methods and analysis. At the minimum, all monitoring should be conducted with a focus on:

- capturing water quality conditions under varied weather conditions,
- establishing sampling locations in an effort to pin-point sources,
- researching new and proven technologies for separating human from animal bacteria sources, and
- assessing efficacy of BMPs.

10.0 Reasonable Assurances

This TMDL does not include less stringent WLAs for point sources based on anticipation of LA reductions from nonpoint sources, and therefore, a reasonable assurance demonstration is not required. Nevertheless, the reasonable assurance that the TMDL will be implemented is discussed in this section.

Reasonable assurances that the TMDL will be implemented include both application and enforcement of current regulations, availability of financial incentives including low or no-interest loans to communities for wastewater treatment facilities through the State Revolving Fund (SRF), and the various local, state and federal programs for pollution control. Storm water NPDES permit coverage is designed to address discharges from municipal owned storm water drainage systems. Some stormwater sources may not be the responsibility of the municipal government. These, and in cases in which efforts under phases Phases I and II fail to achieve water quality standards, may have to be addressed through other regulatory vehicles available to MASSDEP and EPA through federal and state Clean Water Acts depending upon the severity of the impact. MassDEP also is evaluating monitoring data collected by it and others in order to help set priorities for abating impacts from storm water. Enforcement of regulations controlling non-point discharges includes local enforcement of the state Wetlands Protection Act and Rivers Protection Act; Title 5 regulations for septic systems and various local regulations including zoning regulations. Financial incentives include Federal monies available under the CWA Section 319 Nonpoint Source program and the CWA Section 604 and 104b programs, which are provided as part of the Performance Partnership Agreement between MassDEP and the EPA. Additional financial incentives include state income tax credits for Title 5 upgrades, and low interest loans for Title 5 septic system upgrades through municipalities participating in this portion of the state revolving fund program.

A brief summary of many of DEP's tools and regulatory programs to address common bacterial sources is presented below.

Overarching Tools

Massachusetts Clean Water Act: The MA Clean Water Act (M.G.L. Chapter 21, sections 26-53) provides MassDEP with specific and broad authority to develop regulations to address both point and non-point sources of pollution. There are numerous regulatory and financial programs, including those identified in the preceding paragraph, that have been established to directly and indirectly address pathogen impairments throughout the state. Several of them are briefly described below. The MA Clean Water Act can be found at the following URL. http://www.mass.gov/legis/laws/mgl/gl-21-toc.htm.

Surface Water Quality Standards (314 CMR 4.0): The MA Water Quality Standards (WQS) assign designated uses and establish water quality criteria to meet those uses. Water body classifications (Class A, B, and C, for freshwater and SA, SB, and SC for marine waters) are established to protect each class of designated uses. In addition, bacteria criteria are established for each individual classification. The MA Surface Water Quality Standards can be found at http://www.mass.gov/dep/water/laws/regulati.htm#wqwal.

Ground Water Quality Standards (314 CMR 6.0): These standards consist of groundwater classifications, which designate and assign the uses for various groundwaters of the Commonwealth that must be maintained and protected. Like the surface water quality standards the groundwater standards provide specific ground water quality criteria necessary to sustain the designated uses and/or maintain existing groundwater quality. The MA Ground Water Quality Standards can be found at http://www.mass.gov/dep/water/laws/regulati.htm#gwp.

River Protection Act: In 1996 MA passed the Rivers Protection Act. The purposes of the Act were to protect the private or public water supply; to protect the ground water; to provide flood control; to prevent storm damage; to prevent pollution; to protect land containing shellfish; to protect wildlife habitat; and to protect the fisheries. The provisions of the Act are implemented through the Wetlands Protection Regulations, which establish up to a 200-foot setback from rivers in the Commonwealth to control construction activity and protect the items listed above. Although this Act does not directly reduce pathogen discharges it indirectly controls many sources of pathogens close to water bodies. More information on the Rivers Protection Act can be found on DEPs web site at http://www.mass.gov/dep/water/laws/laws.htm.

Additional Tools to Address Combined Sewer Overflows (CSO's)

CSO Program/Policy: Massachusetts, in concert with EPA Region 1, have established a detailed CSO abatement program and policy. CSO discharges are regulated by the Commonwealth in several ways. Like any discharge of pollutants, CSOs must have an NPDES/MA Surface Water Discharge Permit under federal and state regulations. Municipalities and districts seeking funding for wastewater treatment, including CSO abatement, must comply with the facilities planning process at 310 CMR 41.00. Entities obtaining funding or exceeding specific thresholds must also comply with the Massachusetts Environmental Policy Act (MEPA) regulations at 301 CMR 11.00. Each of these regulations contain substantive and procedural requirements. Because both MEPA and facilities planning require the evaluation of alternatives, these processes are routinely coordinated.

All permits for a CSO discharge must comply with Massachusetts Surface Water Quality Standards at 314 CMR 4.00. The water quality standards establish goals for waters of the Commonwealth, and provide the basis for water quality-based effluent limitations in NPDES permits. Any discharge, including CSO discharges, is allowed only if it meets the criteria and the antidegradation standard for the receiving segment. EPA's 1994 CSO Control Policy revised some features of its 1989 version to provide greater flexibility by allowing a minimal number of overflows, which are compatible with the water quality goals of the Clean Water Act. DEP's 1995 regulatory revisions correspondingly decreased reliance on partial use designation as the sole regulatory vehicle to support CSO abatement plans[1].

In all cases, NPDES/MA permits require the nine minimum controls necessary to meet technology-based limitations as specified in the 1994 EPA Policy. The nine controls may be summarized as; operate and maintain properly; maximize storage, minimize overflows, maximize flows to Publicly Owned Treatment Works (POTW), prohibit dry weather CSO's, control solids and floatables, institute pollution prevention programs, notify the public of impacts, and observe monitoring and reporting requirements. The nine minimum controls may be supplemented with additional treatment requirements, such as screening and disinfection, on a case-by-case basis. The Department's goal is to eliminate adverse CSO impacts and attain the highest water quality achievable. Separation or relocation of CSOs is required wherever it can be achieved based on an economic and technical evaluation.

As untreated CSOs cause violations of water quality standards, and thus are in violation of NPDES permits, all of the state's CSO permittees are under enforcement orders to either eliminate the CSO or plan, design, and construct CSO abatement facilities. Each long-term control plan must identify and achieve the highest feasible level of control. The process also requires the permittee to comply with any approved TMDL.

Presently, there are twenty–four (24) CSO communities in the Commonwealth. In the Charles River Watershed, the MWRA, and the communities of Boston, Cambridge, Chelsea and Somerville have a number of CSO's but all are under consent order to address each discharge. All have completed long-term control plans. In most cases work is underway and consists of partial or full sewer separation or providing hydraulic relief.

Additional Tools to Address Failed Septic Systems

<u>Septic System Regulations (Title 5):</u> The MassDEP has regulations in place that require minimum standards for the design of individual septic systems. Those regulations ensure, in part, protection for nearby surface and groundwaters from bacterial contamination. The regulations also provide minimum standards for replacing failed and inadequate systems. The Department has established a mandatory requirement that all septic systems must be inspected and upgraded to meet Title 5 requirements at the time of sale or transfer of the each property.

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[1] DEP's 1990 CSO Policy was based on EPA's 1989 CSO Control Policy and established the goal of eliminating adverse impacts from CSOs, using partial use designation where removal or relocation was not feasible. The three month design storm was identified as the minimum technology-based effluent limitation, which would result in untreated overflows an average of four times a year. Abatement measures to meet these minimum standards were necessary for a CSO discharge to be eligible for partial use designation. Presumably, all CSOs exceeding this standard required downgrading to Class C or SC status. No partial use designations or downgrades to Class C were actually made, but the process was perceived as administratively cumbersome.

Additional Tools to Address Stormwater

Stormwater is regulated through both federal and state programs. Those programs include, but are not limited to, the federal and state Phase I and Phase II NPDES stormwater program, and, at the state level, the Wetlands Protection Act MGL Chapter 130, Section 40), the state water quality standards, and the various permitting programs previously identified.

Federal Phase 1 & 2 Stormwater Regulations: Existing stormwater discharges are regulated under the federal and state Phase 1 and Phase II stormwater program. In Massachusetts there are two Phase 1 communities, Boston and Worcester. Both communities have been issued individual permits to address stormwater discharges. In addition, 237 communities in Massachusetts, and all 35 communities in the Charles River Watershed are covered by Phase II (the only exception is Boston which is covered under Phase 1). Phase II is intended to further reduce adverse impacts to water quality and aquatic habitat by instituting use controls on the unregulated sources of stormwater discharges that have the greatest likelihood of causing continued environmental degradation including those from municipal separate storm sewer systems (MS4s) and discharges from construction activity. Other storm water discharges regulated under Phases I and II include storm water associated with industrial activities and storm water associated with construction activities. In addition, EPA has the authority to require non-regulated point source storm water discharges to obtain NPDES permits if it determines that such storm water discharge causes or contributes to a water quality violation, or is a significant contributor of pollutants, or where controls are needed based on a waste load allocation in an EPA approved TMDL (See 40 CFR § 122.26(a)(9)(i)).

The Phase II Final Rule, published in the Federal Register on December 8, 1999, requires permittees to determine whether or not stormwater discharges from any part of the MS4 contribute, either directly or indirectly, to a 303(d) listed waterbody. Operators of regulated MS4s are required to design stormwater management programs to 1) reduce the discharge of pollutants to the “maximum extent practicable” (MEP), 2) protect water quality, and 3) satisfy the appropriate water quality requirements of the Clean Water Act. Implementation of the MEP standard typically requires the development and implementation of BMPs and the achievement of measurable goals to satisfy each of the six minimum control measures. Those measures include 1) public outreach and education, 2) public participation, 3) illicit discharge detection and elimination, 4) construction site runoff control, 5) post-construction runoff control, and 6) pollution prevention/good housekeeping. In addition, each permittee must determine if a TMDL has been developed and approved for any water body into which an MS4 discharges. If a TMDL has been approved then the permittee must comply with the TMDL including the application of BMPs or other performance requirements. The permittees must report annually on all control measures currently being implemented or planned to be implemented to control pollutants of concern identified in TMDLs. The data included in this TMDL, including wasteload allocations, demonstrates that additional controls may well be needed on many storm water discharges, in particular in segments with high bacteria concentrations during wet weather. Finally, the Department has the authority to issue an individual permit to achieve water quality objectives. Links to the MA Phase II permit and other stormwater control guidance can be found at http://www.mass.gov/dep/water/wastewater/stormwat.htm. A full list of Phase II communities in MA can be found at http://www.mass.gov/dep/water/laws/p2help.htm.

The DEP Wetlands regulations (310 CMR 10.0) direct issuing authorities to enforce the DEP Stormwater Management Policy, place conditions on the quantity and quality of point source discharges, and to control erosion and sedimentation. The Stormwater Management Policy was issued under the authority of the 310 CMR 10.0. The policy and its accompanying Stormwater Performance Standards apply to new and redevelopment projects where there may be an alteration to a wetland resource area or within 100 feet of a wetland resource (buffer zone). The policy requires the application of structural and/or non-structural BMPs to control suspended solids, which have associated co-benefits for bacteria removal. A stormwater handbook was developed to promote consistent interpretation of the Stormwater Management Policy and Performance Standards: Volume 1: Stormwater Policy Handbook and Volume 2: Stormwater Technical Handbook can be found along with the Stormwater Policy at http://www.mass.gov/dep/water/resources/nonpoint.htm.

Financial Tools

Nonpoint Source Control Program: MassDEP has established a non-point source program and grant program to address non-point source pollution sources statewide. The Department has developed a Nonpoint Source Management Plan that sets forth an integrated strategy and identifies important programs to prevent, control, and reduce pollution from nonpoint sources and more importantly to protect and restore the quality of waters in the Commonwealth. The Clean Water Act, Section 319, specifies the contents of the management plan. The plan is an implementation strategy for BMPs with attention given to funding sources and schedules. Statewide implementation of the Management Plan is being accomplished through a wide variety of federal, state, local, and non-profit programs and partnerships. It includes partnering with the Massachusetts Coastal Zone Management on the implementation of Section 6217 program. That program outlines both short and long term strategies to address urban areas and stormwater, marinas and recreational boating, agriculture, forestry, hydro modification, and wetland restoration and assessment. The CZM 6217 program also addresses TMDLs and nitrogen sensitive embayments and is crafted to reduce water quality impairments and restore segments not meeting state standards.

In addition, the state is partnering with the Natural Resource Conservation Service (NRCS) to provide implementation incentives through the national Farm Bill. As a result of this effort, NRCS now prioritizes its Environmental Quality Incentive Program (EQIP) funds based on DEP's list of impaired waters. The program also provides high priority points to those projects designed to address TMDL recommendations. In 2005 approximately $5 million in EQIP funds are available to address water quality goals through the application of structural and non-structural BMPs.

MassDEP, in conjunction with EPA, also provides a grant program to implement nonpoint source BMPs that address water quality goals. The section 319 funding provided by EPA is used to apply needed implementation measures and provide high priority points for projects that are designed to address 303d listed waters and to implement TMDLs. For example, since 2002 DEP has funded 68 projects and awarded approximately $10.2 million through 319 that were designed to address stormwater and bacteria related impairments. On an average about 75% of all projects were designed to address bacteria related impairments.

Specifically in the Charles River Watershed, since 2001 the Department has issued 319 grants totaling $449,720 (not including local match) to develop and implement stormwater treatment systems and collect additional data for TMDL development. The projects will result in the installation of stormwater treatment systems to protect Hammond Pond in Newton and to treat and reduce discharges to the Charles River off Plymouth Road in Bellingham and to Cold Spring Brook in Wellesley. In addition, the Department has provided a grant to the Charles River Watershed to collect data (including bacteria) and develop a mathematical model for future TMDL development.

The 319 program also provides additional assistance in the form of guidance. The Department is in the process of updating the Massachusetts' Nonpoint Source Management Manual that will provide detailed guidance in the form of BMPs by land use to address various water quality impairments and associated pollutants.

Finally, it should be noted that the approach and process outlined for implementing this TMDL has been previously demonstrated with documented success. A previous TMDL, which utilized this approach was developed and approved by EPA for the Neponset River Watershed. The recommendations outlined in that TMDL were similar to the current proposal. Since the time of approval, MassDEP worked closely with a local watershed group (Neponset River Watershed Association) to develop a 319 project to implement the recommendations of the TMDL. The total project cost was approximately $472,000 of which $283,000 was provided through federal 319 funds and the additional 40% provided by the watershed association and two local communities. Although the project is not yet completed, the Towns and watershed association have worked closely together to identify and install several new structural BMPs (enhanced wetland and bioretention cells) to reduce stormwater and bacterial inputs into Pine Tree Brook, which was impaired due to pathogens. Additional BMPs are being evaluated for future implementation at this time.

Other examples include the Little Harbor in Cohasset and the Shawsheen River. Similar TMDLs were developed in these areas. In Little Harbor, the TMDL was used as the primary tool to obtain local approval and funding to design and install sewers around Little Harbor and other additional areas of Town impacted by sewerage contamination. Presently, the Town is seeking additional state funding to construct the sewers. In the Shawsheen Watershed the TMDL was used to obtain a state grant to identify and prioritize specific stormwater discharges for remediation. In addition, MassDEP has received an EPA Region 1 grant to enhance its bacterial source tracking toolbox in the Shawsheen watershed. The refinement of new cost effective field and laboratory techniques to track down and differentiate between human and non-human sources will be extremely useful statewide. Recognizing the increasing need to find and eliminate sources of bacterial contamination in surface waters, the Massachusetts DEP/ Division of Watershed Management (DWM) developed a bacterial source tracking protocol for rivers and streams. A targeted source tracking pilot study was conducted in five selected subwatersheds of the Blackstone and Sudbury Watersheds from April to October 2004 (http://www.mass.gov/dep/water/priorities/priorities.htm). The study applied and evaluated bacterial source tracking strategies that employed a combination of relatively simple and cost-effective methods that included comprehensive land use characterization, in-depth field reconnaissance, sampling streams and pipes for bacteria and other indicators of human sewage, and coordination with local and state authorities. The field study demonstrated that the protocol is a powerful method for finding – then working with towns to eliminate – illicit discharges in first and second order streams. MassDEP has recognized that this new bacterial source tracking protocol is of potentially great value, both because of the many bacterial impaired stream segments, and because it is cost effective and likely transferable to local watershed groups. MassDEP and EPA Region 1 are also working on a compliance and enforcement strategy to address the worst sources.

Additional information related to the non-point source program, including the Management Plan can be found at http://www.mass.gov/dep/brp/wm/nonpoint.htm

State Revolving Fund: The State Revolving Fund (SRF) Program provides low interest loans to eligible applicants for the abatement of water pollution problems across the Commonwealth. Since July 2002 the MASSDEP has issued loans totaling over $258 Million dollars for the planning and construction of CSO facilities. Also since that time the SRF has issued loans of more than $11.6 Million to address stormwater pollution and another $ 44.4 Million has been distributed to 142 municipal governments statewide to upgrade and replace failed Title 5 systems. These programs all demonstrate the State’s commitment to assist local governments in implementing the TMDL recommendations.

Watershed Specific Strategies

In summary, MassDEP's approach and existing programs set out a wide variety of tools both MassDEP and communities can use to address pathogens, based on land use and the commonality of pathogen sources (e.g., combined sewer overflows (CSOs), failing septic systems, storm water and illicit connections, pet waste, etc.) Since there are only a few categories of sources of pathogens, the necessary remedial actions to address these sources are well established.

The specific strategy that MassDEP will use to find and eliminate bacterial sources will be based on the amount of source-specific data available in each watershed, the nature and extent of stormwater discharges in the watershed, and the nature and extent of water quality standard exceedances. It is MassDEPs goal to work closely with EPA, municipalities, and watershed associations to find and address significant pollutant contributors. To accomplish this, MassDEP will consult our own internal databases, as well as local data that are available and review Phase II annual submittals to identify major violations. We have the authority under M.G.L. c.21 to designate a source where necessary (or use EPA's authority) to require quicker action than would otherwise be achieved under existing schedules or require additional controls if it is determined that Phase II activities are insufficient to solve the problem. In watersheds where data is insufficient MassDEP will rely on our 5-year cycle monitoring program, watershed association data, and provide grant opportunities to collect the data necessary to quantify and qualify major sources. MassDEP has also recently hired new regional compliance monitoring staff to assist with data collection activities. Once a significant source is found MassDEP will coordinate with the owner of the discharge to "go up the pipe" to identify remote connections and undertake additional controls as necessary.

EPA and MASSDEP intend that these TMDLs be used a basis for regulatory decisions. MASSDEP's and EPA's authority combined with the programs identified above provide sufficient reasonable assurance that implementation of remedial actions will take place.

11.0 Public Participation

Two public meetings were held at 2 p.m. and 7pm. at the Elm Bank Reservation, Wellesley on 8/23/2005 to present the Bacteria TMDL and to collect public comments. The public comment period began on August 10, 2005 and closed on September 15, 2005. The attendance list, public comments, and the MassDEP responses are attached as Appendix H. The final TMDL and response to all comments will be sent to U.S. EPA Region 1 in Boston for final approval.

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Appendix A

MWRA Recommended Control Plan and Status of Implementation (MWRA 2004 Annual Report, includes CSO outfall location map to the Lower Charles River)

Links to MWRA Monitoring Data

The Charles River 1989-2005

http://www.mwra.state.ma.us/harbor/html/cr_wq.htm

Summary of CSO Receiving Water Quality Monitoring in Upper Mystic River/Alewife Brook and Charles River, 2005.

http://www.mwra.state.ma.us/harbor/enquad/trlist.html

Select Data from: Summary of CSO Receiving Water Quality Monitoring in Boston Harbor and Tributary Rivers, 1989-2001

http://www.mass.gov/dep/water/resources/tmdls.htm#draft

Links to USGS Monitoring Data

***Measured and Simulated Runoff to the Lower Charles River, Massachusetts, October 1999–September 2004* (USGS 2002b)**

http://www.epa.gov/boston/charles/2005.html

FIGURE 1

MWRA Recommended CSO Control Plan and Status of Implementation

(1) East Boston Project reassessment completed; final plan pending.

Appendix B

Evaluation of Stormwater Management Benefits to the Lower Charles River (Metcalf and Eddy 2004)

Appendix B can be accessed on MassDEP's web site at:

http://www.mass.gov/dep/water/resources/tmdls.htm#draft

Appendix C

Lower Charles River Illicit Discharge Detection & Elimination (IDDE) Protocol
Guidance for Consideration - November 2004

Lower Charles River Illicit Discharge Detection & Elimination (IDDE) Protocol
Guidance for Consideration - November 2004

Purpose/Goal

This document provides a common framework from which lower Charles River communities can develop and implement a comprehensive plan to identify and eliminate dry and wet weather illicit discharges to their separate storm sewer systems. Adopted from BWSC (2004) and Pitt (2004), the protocol relies primarily on visual observations and the use of field test kits and portable instrumentation during dry weather to complete a thorough inspection of the communities' storm sewers in a prioritized manner. The protocol is applicable to most typical storm sewer systems, however modifications to materials and methods may be required to address situations such as open channels, systems impacted by sanitary sewer overflows or sanitary sewer system under drains, or situations where groundwater or backwater conditions preclude adequate inspection. The primary focus of the protocol is sanitary waste, however, toxic and nuisance discharges may also be identified. Implementation of the protocol would satisfy the relevant conditions under Minimum Control Measure No. 3 (IDDE) of the communities' NPDES Small MS4 General Permit.

Drainage Area/Outfall Prioritization

Areas to consider for prioritizing investigative work include:

- Areas suspected to have significant problems (documented by EPA, the community, or others)
- Direct discharges to sensitive or critical waters (e.g. water supplies, town beach)
- Areas with inadequate sewer LOS or subject of numerous/chronic customer complaints
- Areas served by common manholes or underdrains
- Remaining areas prioritized through an outfall screening & ranking process

Drainage Area Investigations

1. Public Notification/Outreach Program

Provide letter/mailer to residents and building owners located within subject drainage basin and/or sewershed notifying them of scope and schedule of investigative work, and the potential need to gain access to their property to inspect plumbing fixtures. Where necessary, notification of property owners through letter, door hanger, or otherwise will be required to gain entry. Assessors' records will provide property owner identification.

2. Field verification and correction of subarea storm sewer mapping

Adequate storm and sanitary sewer mapping is a prerequisite to properly execute an illicit discharge detection and elimination program. As necessary and to the extent possible, infrastructure mapping should be verified in the field and corrected prior to investigations. This effort affords an opportunity to collect additional information such as latitude and longitude coordinates using a global position system (GPS) unit if so desired. To facilitate subsequent investigations (see Part 5. below), tributary area delineations should be confirmed and junction manholes should be identified during this process. Orthophoto coverages (available from source sources as MassGIS, MapQuest, and TerraServer) will also facilitate investigations by providing building locations and land use features.

3. Infrastructure cleaning requirements

To facilitate investigations, storm drain infrastructure should be evaluated for the need to be cleaned to remove debris or blockages that could compromise investigations. Such material should be removed to the extent possible prior to investigations, however, some cleaning may occur concurrently as problems manifest themselves.

4. Dry weather criteria

In order to limit or remove the influence of stormwater generated flows on the monitoring program, antecedent dry weather criteria need to be established. An often used rule of thumb is to wait two (2) days after cessation of a precipitation event prior to monitoring activities. This duration can be adjusted to shorter or longer periods dependent upon the relative extent, slope, and storage of the system under investigation.

5. Manhole inspection and flow monitoring methodology

Beginning at the <u>uppermost</u> junction manhole(s) within each tributary area, drainage manholes are opened and inspected for visual evidence of contamination after antecedent dry weather conditions are satisfied (e.g. after 48 hours of dry weather). Where **flow is observed**, and determined to be contaminated through visual observation (e.g. excrement or toilet paper present) or field monitoring (see Parts 5. & 6. below), the tributary storm sewer alignment is isolated for investigation (e.g. dye testing, CCTV; see Part 7. below). No additional downstream manhole inspections are performed unless the observed flow is determined to be uncontaminated or until all upstream illicit connections are identified and removed. Where **flow is not observed** in a junction manhole, all inlets to the structure are partially dammed for the next 48 hours when no precipitation is forecasted. Inlets are damned by blocking a minimal percentage (approximately 20% +/- depending on pipe slope) of the pipe diameter at the invert using sandbags, caulking, weirs/plates, or other temporary barriers. The manholes are thereafter reinspected (prior to any precipitation or snow melt) for the capture of periodic or intermittent flows behind any of the inlet dams. The same visual observations and field testing is completed on any captured flow, and where contamination is identified, abatement is completed prior to inspecting downstream manholes.

In addition to documenting investigative efforts in written and photographic form, it is recommended that information and observations regarding the construction, condition, and operation of the structures also be compiled.

6. Field Measurement/Analysis:

Where flow is observed and does not demonstrate obvious olfactory evidence of contamination, samples are collected and analyzed with field instruments identified in Table 1. Measured values are then compared with benchmark values using the flow chart in Figure 1 to determine the likely prominent source of the flow. This information facilitates the investigation of the upstream stormsewer alignment described in Part 7. Benchmark values may be refined over the course of investigations when compared with the actual incidences of observed flow sources.

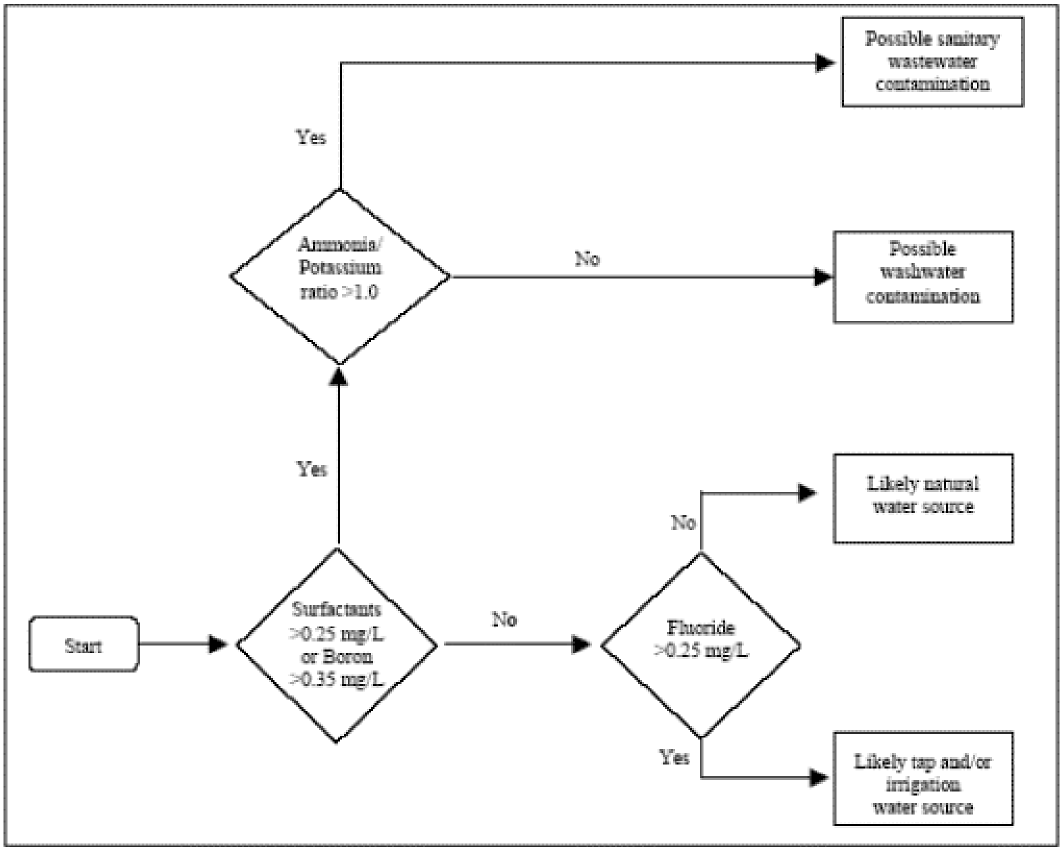
In those manholes where periodic or intermittent flow is captured through damming inlets, additional laboratory testing (e.g. toxicity, metals, etc.) should be considered where an industrial batch discharge is suspected for example.

Table 1 - Field Measurements, Benchmarks, and Instrumentation

Analyte	Benchmark	Instrumentation[1]
Surfactants (as MBAS)	>0.25 mg/L	MBAS Test Kit (e.g. CHEMetrics K-9400)
Potassium (K)	(ratio below)	Portable Ion Meter (e.g. Horiba Cardy C-131)
Ammonia (NH_3)	$NH_3/K > 1.0$	Portable Colorimeter or Photometer (e.g. Hach DR/890, CHEMetrics V-2000)
Fluoride (F)	>0.25 mg/L	Portable Colorimeter or Photometer (e.g. Hach DR/890, CHEMetrics V-2000)
Temperature	Abnormal	Thermometer
pH	Abnormal	pH Meter

[1] Instrumentation manufacturers and models provided for informational purposes only. Mention of specific products does not constitute or imply EPA endorsement of same.

Figure 1. Flow Chart for Determining Likely Source of Discharge (Pitt, 2004)



7. Isolation and confirmation of illicit sources

Where field monitoring has identified storm sewer alignments to be influence by sanitary flows or washwaters, the tributary area is isolated for implementation of more detailed investigations. Additional manholes along the tributary alignment are inspected to refine the longitudinal location of potential contamination sources (e.g. individual or blocks of homes). Targeted internal plumbing inspections/dye testing or CCTV inspections are then employed to more efficiently confirm discrete flow sources.

Post-Removal Confirmation

After completing the removal of illicit discharges from a subdrainage area and before beginning the investigation of downstream areas, the subdrainage area is reinspected to verify corrections. Depending on the extent and timing of corrections, verification monitoring can be done at the initial junction manhole or the closet downstream manhole to each correction. Verification is accomplished by using the same visual inspection, field monitoring, and damming techniques as described above.

Work Progression & **Schedule**

Since the IDDE Protocol requires the verified removal of illicit discharges prior to progressing downstream through the storm sewer system, preparations should be made to initiate investigations in other subareas to facilitate progress while awaiting completion of corrections. Since work progress will be further constrained by the persistence of precipitation and snow melt events, consideration must be given to providing adequate staffing and equipment resources to perform concurrent investigations in several subareas.

Program Evaluation

The progress of the IDDE Program should be evaluated by tracking metrics such as:

- Number/% of manholes/structures inspected
- Number/% of outfalls screened
- Number/% of illicit discharges identified through:
    - visual inspections
    - field testing results
    - temporary damming
- Number/% of homes inspected/dye tested
- Footage/% of pipe inspected by CCTV
- Number/% of illicit discharges removed
- Estimated flow/volume of illicit discharges removed
- Footage and location of infrastructure jetting/cleaning required
- Infrastructure defects identified and repaired
- Water main breaks identified and repaired
- Cost of illicit discharge removals (total, average unit costs)

References Cited

Boston Water & Sewer Commission, 2004, *A systematic Methodology for the Identification and Remediation of Illegal Connections.* 2003 Stormwater Management Report, chap. 2.1.

Pitt, R. 2004 *Methods for Detection of Inappropriate Discharge to Storm Drain Systems. Internal Project Files*. Tuscaloosa, AL, *in* The Center for Watershed Protection and Pitt, R., *Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments*: Cooperative Agreement X82907801-0, U.S. Environmental Protection Agency, variously paged. Available at: http://www.cwp.org.

Instrumentation Cited (Manufacturer URLs)

MBAS Test Kit - CHEMetrics K-9400: http://www.chemetrics.com/Products/Deterg.htm

Portable Photometer - CHEMetrics V-2000: http://www.chemetrics.com/v2000.htm

Portable Colorimeter - Hach DR/890: http://www.hach.com/

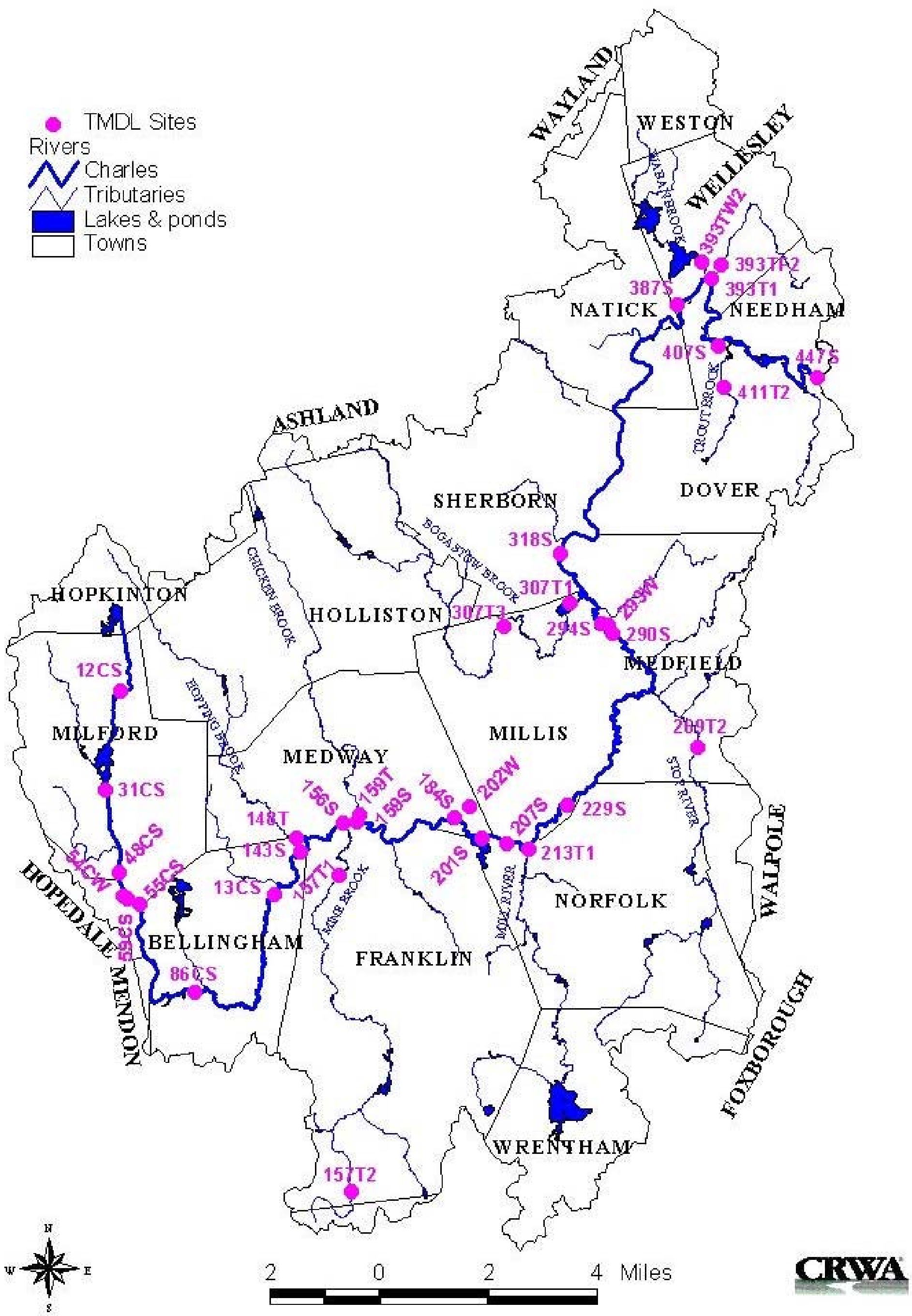
Portable Ion Meter: Horiba Cardy C-131: http://www.wq.hii.horiba.com/c.htm

Appendix D

Charles River Watershed Association (CRWA): Upper Charles River Nutrient TMDL Project

Sampling Locations

CRWA Upper Charles Nutrient TMDL Sampling Locations



Appendix E

Charles River Hot Spot Monitoring Data (2002-2005)

Appendix E can be accessed on MassDEP's web site at:

http://www.mass.gov/dep/water/resources/tmdls.htm#draft

Appendix F

Estimated Percent Reductions Required by Segment

Estimated Percent Reductions Required by Segment

Charles River Basin Bacteria TMDL

Several segments in the upper Charles River Basin are listed as being impaired by pathogens based on the indicator, fecal coliform bacteria. An estimate of the amount of reduction necessary can be made in accordance with the protocol outlined in Section 7.o of this TMDL. For each location or segment for which data are available, the highest concentration of fecal coliform is used to determine the percent reduction needed to ensure the standard of 200 FC/100mL is not exceeded. The sample used can be either from what is considered dry or wet weather. This approach ensures a target reduction, which incorporates a significant margin of safety (MOS) since a single sample value is used for determining the reduction needed to meet the water quality criterion, which is based on a geometric mean. However, the percent reduction is a guide and determination of whether the TMDL has been met will be based on the geometric mean of indicator bacteria concentrations collected over a season with a minimum of 5 valid samples as previously stated.

This approach sets a target for reducing the loads so that water quality criteria for indicator bacteria are met at all flows equal to or greater than 7Q10. The individual percentage reductions are noted for each segment in the following tables:

Note: The shaded value is the concentration upon which the reduction needed to reach 200 FC/100 mL is based. Tables are based on those in Section 4 and the numbers have been retained to facilitate comparisons.

MA72-01 Charles River Fecal Coliform Data Summary.

			Dry Weather (CFU/100 mL)			Wet Weather (CFU/100 mL)		
Site #	**Description**	**Town**	**Min**	**Max**	**n**	**Min**	**Max**	**n**
MASSDEP WQM 2002								
CR72.1	W. of Rte 85, Downstream of Wildcat Pond	Milford	<10	71	4	<20	20	2
	Needed Reduction To reach 200 FC/100mL	**Percent** **0**						

MA72-02 Charles River Fecal Coliform Data Summary.

Site #	Description	Town	Dry Weather (CFU/100 mL) Min	Max	n	Wet Weather (CFU/100 mL) Min	Max	n
CRWA 1995-2005								
35CS	Central Street Bridge	Milford	<10	8,700	28	120	12,300	22
35CD	Discharge Pipe @ Central St.	Milford	290	49,000	28	490	37,000	21
35C2	2nd Discharge Pipe @ Central St.	Milford	<10	82,000	16	10	53,000	19
	Needed Reduction	**Percent**						
	To reach 200 FC/100mL	**99.8**						

MA72-03 Charles River Fecal Coliform Data Summary

Site #	Description	Town	Dry Weather (CFU/100 mL) Min	Max	n	Wet Weather (CFU/100 mL) Min	Max	n
CRWA 1995-2005								
59CS	Mellen St. Bridge	Bellingham	60	3,200	25	40	2,400	20
	Needed Reduction	**Percent**						
	To reach 200 FC/100mL	**93.8**						

MA72-04 Charles River Fecal Coliform Data Summary

Site #	Description	Town	Dry Weather (CFU/100 mL) Min	Max	n	Wet Weather (CFU/100 mL) Min	Max	n
CRWA 1995-2005								
90CS	Rt. 126, N. Main St.	Bellingham	<10	3,400	28	8	1,090	19
13CS	Maple St. Bridge	Bellingham	<10	1,100	29	10	1,200	23
165S	Shaw St. Bridge	Franklin	10	2,400	15	20	3,500	19
199S	Populatic Pond Boat Launch	Norfolk	<10	5,600	18	40	500	16
MADEP WQA 1997-1998								
CR03	Walker Street	Medway	<20	500	6	80	120	2
	MASSDEP WQM 2002							
CR03	Walker Street	Medway	52	120	4	59	59	1
	Needed Reduction	**Percent**						
	To reach 200 FC/100mL	**96.4**						

MA72-05 Charles River Fecal Coliform Data Summary

			Dry Weather (CFU/100 mL)			Wet Weather (CFU/100 mL)		
Site #	Description	Town	Min	Max	n	Min	Max	n
CRWA 1995-2005								
229S	Rt. 115, Baltimore St.	Norfolk/Millis	<10	2,800	27	10	2,000	23
267S	Dwight St. Bridge	Millis	<10	4,900	11	10	2,700	17
290S	Old Bridge St.	Medfield	<10	3,200	29	10	2,850	23
318S	Rt. 27 Bridge	Medfield	<10	2,100	28	10	1,600	20
343S	Farm Rd./Bridge St.	Sherborn/Dover	<10	3,000	15	10	720	
MASSDEP WQM 2002								
CR36.3	Rte 16-upstream Davis Brook	Natick	20	100	**3**	**39**	59	2
	Needed Reduction	**Percent**						
	To reach 200 FC/100mL	**95.9**						20

MA72-10 Stop River Fecal Coliform Data Summary.

			Dry Weather (CFU/100 mL)			Wet Weather (CFU/100 mL)		
Site #	Description	Town	Min	Max	n	Min	Max	n
CRWA 1995-2005								
269T	Causeway St.	Medfield	<10	2,800	15	10	4,700	21
	MASSDEP WQM 2002							
SR03	Noon Hill Rd.	Medfield	97	130	4			
	Needed Reduction	**Percent**						
	To reach 200 FC/100mL	**95.7**						

MA72-16 Bogastow Brook Fecal Coliform Data Summary.

Site #	Description	Town	Dry Weather (CFU/100 mL)			Wet Weather (CFU/100 mL)		
			Min	Max	n	Min	Max	n
MADEP WQA 1997								
BB03	Lowland St.	Holliston	140	140	1	160	160	1
BB04	Fiske St.	Holliston				600	600	1
BB04A	Central St.	Holliston	180	180	1	300	300	1
BB05	Orchard St.	Holliston	160	160	1	460	460	1
BB06	Middlesex St.	Holliston	120	120	1	220	220	1
BB08	Bogastow Pond outlet	Millis	100	100	1	80	80	1
	Needed Reduction	**Percent**						
	To reach 200 FC/100mL	**66.7**						

MA7-06 Charles River Fecal Coliform Data Summary.

Site #	Description	Town	Dry Weather (CFU/100 mL)			Wet Weather (CFU/100 mL)		
			Min	Max	n	Min	Max	n
CRWA 1995-2005								
387S	Cheney Bridge	Wellesley	<10	2,100	26	10	500	22
400S	Charles River Road Bridge	Dover	<10	2,800	13	30	1,500	19
447S	Dover Gage	Dover	<10	3,100	18	10	310	17
EPA 2002-2003								
CRBL01	Downstream S. Natick Dam	Natick	20	60	5			
MADEP WQA 1997-1998								
CR02	Unnamed St northeast of Schaller St	Dover/Wellesley	20	200	5	60	160	2
Needed Reduction		**Percent**						
To reach 200 FC/100mL		**93.5**						

MA72-18 Fuller Brook Fecal Coliform Data Summary.

			Dry Weather (CFU/100 mL)			Wet Weather (CFU/100 mL)		
Site #	**Description**	**Town**	**Min**	**Max**	**n**	**Min**	**Max**	**n**
MADEP WQA 1997-1998								
FB01	Dover St.	Wellesley	40	4,000	6	300	1,500	3
FB02	Cameron St. (100 m upstream)	Wellesley				200	200	1
FB03	Cameron St. (102 m upstream)	Wellesley				1,600	1,600	1
	MASSDEP WQM 2002							
FB01	Dover St.	Wellesley	700	4,400	3	370	370	1
	Needed Reduction	**Percent**						
	To reach 200 FC/100mL	**95.4**						

MA72-07 Charles River Fecal Coliform Data Summary.

			Dry Weather (CFU/100 mL)			Wet Weather (CFU/100 mL)		
Site #	**Description**	**Town**	**Min**	**Max**	**n**	**Min**	**Max**	**n**
CRWA 1995-2005								
484S	Dedham Medical Center	Dedham	<10	1,690	28	20	2,500	20
521S	Ames St. Bridge	Dedham	<10	3,100	16	10	1,600	22
534S	Rt. 109 Bridge	Dedham	<10	3,600	29	30	1,600	23
567S	Nahanton Park	Newton	<10	2,200	17	10	900	22
591S	Rt. 9 Gaging Station	Newton	<10	520	12	10	1,800	17
609S	Washington St. Hunnewell Bridge	Wellesley	<10	1,800	26	10	1,600	23
621S	Leo J. Martin Golf Course/Park Rd.	Weston	<10	1,700	15	10	1,100	22
635S	2391 Commonwealth Ave.	Newton	<10	750	23	20	1,900	22
648S	Lakes Region	Waltham	<10	940	10	10	1,800	15
662S	Moody St. Bridge	Waltham	<10	1,200	28	20	580	23
675S	North St.	Waltham	20	2,200	14	70	1,100	21
012S	Watertown Dam Footbridge	Watertown	10	3,500	29	20	4,600	23
EPA 2002-2003								
CRBL02	Upstream Watertown Dam	Watertown	68	1,396	12	92	540	4
USGS 1999-2000 (mean, min & max reported for wet weather)								
01104615	Upstream Watertown Dam	Watertown	30	5,000	13	220	17,000	9
MADEP WQA 1997-1998								
CR01	Watertown Dam	Watertown	100	360	4			
Needed Reduction		**Percent**						
To reach 200 FC/100mL		**98.8**						

MA72-21 Rock Meadow Brook Fecal Coliform Data Summary.

			Dry Weather			Wet Weather		
			(CFU/100 mL)			(CFU/100 mL)		
Site #	**Description**	**Town**	**Min**	**Max**	**n**	**Min**	**Max**	**n**
MADEP WQA 1997-1998								
RM01	Summer St.	Westwood	<20	600	4	<20	60	2
		MASSDEP WQM 2002						
RM01A		750m downstream Westfield St.	Dedham	<20	310	4	98	98
Needed Reduction		**Percent**						
To reach 200 FC/100mL		**66.7**						

MA72-23 Sawmill Brook Fecal Coliform Data Summary.

			Dry Weather			Wet Weather		
			(CFU/100 mL)			(CFU/100 mL)		
Site #	**Description**	**Town**	**Min**	**Max**	**n**	**Min**	**Max**	**n**
MADEP WQA 1997-1998								
SB01	Baker St.(10 m upstream)	Boston	520	7,000	4	780	3,000	2
SB02	Baker St.(100-200 m upstream)	Boston				200	200	1
SBE1	Baker St. storm pipe (100-200 m upstream)	Boston				4,000	4,000	1
	MASSDEP WQM 2002							
SB02	Baker St.(100-200 m upstream)-St. Joseph's Cemetery	Boston	320	960	3	480	480	1
SB01	Baker St.(10 m upstream) – St. Joseph's Cemetery	Boston	1,400	4,000	4	760	780	2
	Needed Reduction	**Percent**						
	To reach 200 FC/100mL	**97.1**						

MA72-24 South Meadow Brook Fecal Coliform Data Summary.

			Dry Weather			Wet Weather		
			(CFU/100 mL)			(CFU/100 mL)		
Site #	**Description**	**Town**	**Min**	**Max**	**n**	**Min**	**Max**	**n**
MADEP WQA 1997-1998								
SM01	Neeham St.	Newton	200	3,600	6	1,800	2,000	2
SM02	Winchester St.	Newton				320	320	1
SME1	Winchester St. Storm pipe (3 m upstream)	Newton	200	200	1			
	MASSDEP WQM 2002							
SM01B	150 m downstream Needham St (upstream of storm pipe)	Newton				680	680	1
SM01	190 m downstream Needham St (downstream of storm pipe)	Newton	1,700	4,200	5			
	Needed Reduction	**Percent**						
	To reach 200 FC/100mL	**95.2**						

MA72-25 Rosemary Brook Fecal Coliform Data Summary.

			Dry Weather			Wet Weather		
			(CFU/100 mL)			(CFU/100 mL)		
Site #	**Description**	**Town**	**Min**	**Max**	**n**	**Min**	**Max**	**n**
MADEP WQA 1997-1998								
RB01	Barton Rd.	Wellesley	<20	200	6	40	180	2
MASSDEP WQM 2002								
RB02		Barton Rd.	Wellesley	20	450	5	59	59
Needed Reduction		**Percent**						
To reach 200 FC/100mL		**55.5**						

MA72-28 Beaver Brook Fecal Coliform Data Summary.

			Dry Weather (CFU/100 mL)			Wet Weather (CFU/100 mL)		
Site #	**Description**	**Town**	**Min**	**Max**	**n**	**Min**	**Max**	**n**
MADEP WQA 1997-1998								
BE00	River St.	Waltham	480	4,400	4	2,000	2,000	1
BE01	Route 60 (upstream)	Waltham	2,000	2,000	2	1,400	1,400	1
BEE1	Route 60 Storm pipe (downstream)	Waltham				480	480	1
BEE2	Route 60 Storm pipe (upstream)	Waltham				240	240	1
	MASSDEP WQM 2002							
BE03	Inlet to Mill Pond	Waltham/Belmont	310	1,100	4	260	260	1
BE02	Beaver St., Clematis Brook (downstream)	Waltham	290	12,000	5	250	250	1
	Needed Reduction	**Percent**						
	To reach 200 FC/100mL	**98.3**						

MA72-29 Cheese Cake Brook Fecal Coliform Data Summary.

			Dry Weather (CFU/100 mL)			Wet Weather (CFU/100 mL)		
Site #	**Description**	**Town**	**Min**	**Max**	**n**	**Min**	**Max**	**n**
MADEP WQA 1997-1998								
CB01	10 m upstream of confluence	Newton	360	4,000	6	340	1,800	2
CB02	Crafts St.	Newton				1,200	1,200	1
CB05	Eddy St. (upstream)	Newton				1,200	1,200	1
CBE0	Crafts St. Storm pipe	Newton				<20	<20	1
CBE1	Watertown St. Storm pipe	Newton	50,000	50,000	1			
CBE2	Eddy St. Storm pipe (downstream)	Newton				260	260	1
	MASSDEP WQM 2002							
CB03	50 m upstream of confluence	Newton	400	1,600	4			
CB03A	Rte. 16 downstream of storm pipe	Newton				350	350	
CB01	10 m upstream of confluence	Newton	190	890	4	520	520	1
	Needed Reduction	**Percent**						
	To reach 200 FC/100mL	**99.6**						

MA72-08 Charles River Fecal Coliform Data Summary.

			Dry Weather (CFU/100 mL)			Wet Weather (CFU/100 mL)		
Site #	Description	Town	Min	Max	n	Min	Max	n
CRWA Lower Charles 2004 Flagging								
NBS	N. Beacon St	Newton	140	660	9	250	3,300	4
LARZ	Larz Anderson Bridge	Boston	10	170	9	50	450	4
BU	Boston University Bridge	Boston	290	1,600	9	190	1,100	4
LONG	Longfellow Bridge	Boston	<10	310	9	45	150	4
CRWA 1995-2005								
700S	N. Beacon St.	Newton	40	4,700	22	90	6,000	21
715S	Arsenal St.	Brighton	60	7,800	34	100	24,000	23
729S	Eliot Bridge	Cambridge	<10	3,500	20	10	20,000	20
743S	Western Ave.	Cambridge	30	5,500	35	30	2,200	23
763S	Mass. Ave. at Harvard Bridge	Boston	10	3,800	32	10	30,000	24
773S	Longfellow Bridge	Boston	<10	4,600	21	10	11,000	22
784S	New Charles River Dam	Boston	10	8,150	35	10	1,700	25
EPA 2002-2003								
CRBL03	Daly Park	Boston	48	694	9			
CRBL04	Herter East Park	Boston	4	1,100	8			
CRBL05	Magazine Beach	Boston	44	2,400	12	330	1,099	4
CRBL06	Downstream Boston University Bridge	Boston	12	874	12	128	1,500	4
CRBL07	Downstream Stony Bk & Mass. Ave	Boston	4	315	12	8	56	4
CRBLA8	Off the Esplanade	Boston	<4	208	12	4	28	4
CRBL09	Upstream Longfellow Bridge	Boston	<4	76	12	8	100	4
CRBL10	Community Boating Area	Boston	4	50	9			
CRBL11	Between Longfellow Bridge & Old Dam	Boston	<4	52	12	12	44	4
CRBL12	Upstream of Railroad Bridge	Boston	8	360	9			
USGS 1999-2000 (mean min & max reported for wet weather)								
01104710	Charles River at Science Museum	Boston	<10	100	13	<10	200	6
MASSDEP WQA 1997-1998								
CR00	100 ft. Downstream of Watertown Dam	Watertown	200	500	2	920	1,800	2
Needed Reduction			**Percent**					
	To reach 200 FC/100mL		**99.3**					

MA72-30 Unnamed Tributary Fecal Coliform Data Summary

			Dry Weather			Wet Weather		
			(CFU/100 mL)			(CFU/100 mL)		
Site #	**Description**	**Town**	**Min**	**Max**	**n**	**Min**	**Max**	**n**
USGS 1999-2000 (mean, min & max reported for wet weather)								
01104640	Mouth of Laundry Brook	Watertown	50	5,500	13	1,200	44,000	9
MADEP WQA 1997-1998								
LB01	California St. (Laundry Bk)	Watertown	20	2,600	6	270	5,500	2
	Needed Reduction	Percent						
	To reach 200 FC/100mL	**99.5**						

MA72-11 Muddy River Fecal Coliform Data Summary.

			Dry Weather			Wet Weather		
			(CFU/100 mL)			(CFU/100 mL)		
Site #	**Description**	**Town**	**Min**	**Max**	**n**	**Min**	**Max**	**n**
USGS 1999-2000 (mean, min & max reported for wet weather)								
01104683	Mouth of Muddy River	Boston	<10	4,200	12	3,100	38,000	
	Needed Reduction	Percent						
	To reach 200 FC/100mL	**99.5**						9

Appendix G

November 2002 Memorandum from Robert Wayland and James Hanlon "Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Stormwater Sources and NPDES Permit Requirements based on Those WLA's"

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

NOV 22 2002

OFFICE OF WATER

MEMORANDUM

SUBJECT: Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs

FROM: Robert H. Wayland, III, Director
Office of Wetlands, Oceans and Watersheds

James A. Hanlon, Director
Office of Wastewater Management

TO: Water Division Directors
Regions 1 - 10

This memorandum clarifies existing EPA regulatory requirements for, and provides guidance on, establishing wasteload allocations (WLAs) for storm water discharges in total maximum daily loads (TMDLs) approved or established by EPA. It also addresses the establishment of water quality-based effluent limits (WQBELs) and conditions in National Pollutant Discharge Elimination System (NPDES) permits based on the WLAs for storm water discharges in TMDLs. The key points presented in this memorandum are as follows:

NPDES-regulated storm water discharges must be addressed by the wasteload allocation component of a TMDL. See 40 C.F.R. § 130.2(h).

NPDES-regulated storm water discharges may not be addressed by the load allocation (LA) component of a TMDL. See 40 C.F.R. § 130.2 (g) & (h).

Storm water discharges from sources that are not currently subject to NPDES regulation may be addressed by the load allocation component of a TMDL. See 40 C.F.R. § 130.2(g).

It may be reasonable to express allocations for NPDES-regulated storm water discharges from multiple point sources as a single categorical wasteload allocation when data and information are insufficient to assign each source or outfall individual WLAs. See 40 C.F.R. § 130.2(i). In cases where wasteload allocations are developed for categories of discharges, these categories should be defined as narrowly as available information allows.

The WLAs and LAs are to be expressed in numeric form in the TMDL. See 40 C.F.R. § 130.2(h) & (i). EPA expects TMDL authorities to make separate allocations to NPDES- regulated storm water discharges (in the form of WLAs) and unregulated storm water (in the form of LAs). EPA recognizes that these allocations might be fairly rudimentary because of data limitations and variability in the system.

NPDES permit conditions must be consistent with the assumptions and requirements of available WLAs. See 40 C.F.R. § 122.44(d)(1)(vii)(B).

WQBELs for NPDES-regulated storm water discharges that implement WLAs in TMDLs may be expressed in the form of best management practices (BMPs) under specified circumstances. See 33 U.S.C. §1342(p)(3)(B)(iii); 40 C.F.R. §122.44(k)(2)&(3). If BMPs alone adequately implement the WLAs, then additional controls are not necessary.

EPA expects that most WQBELs for NPDES-regulated municipal and small construction storm water discharges will be in the form of BMPs, and that numeric limits will be used only in rare instances.

When a non-numeric water quality-based effluent limit is imposed, the permit's administrative record, including the fact sheet when one is required, needs to support that the BMPs are expected to be sufficient to implement the WLA in the TMDL. See 40 C.F.R. §§ 124.8, 124.9 & 124.18.

The NPDES permit must also specify the monitoring necessary to determine compliance with effluent limitations. See 40 C.F.R. § 122.44(i). Where effluent limits are specified as BMPs, the permit should also specify the monitoring necessary to assess if the expected load reductions attributed to BMP implementation are achieved (e.g., BMP performance data).

The permit should also provide a mechanism to make adjustments to the required BMPs as necessary to ensure their adequate performance.

This memorandum is organized as follows:

(I). Regulatory basis for including NPDES-regulated storm water discharges in WLAs in TMDLs;

(II). Options for addressing storm water in TMDLs; and

(III). Determining effluent limits in NPDES permits for storm water discharges consistent with the WLA

(I). Regulatory Basis for Including NPDES-regulated Storm Water Discharges in WLAs in TMDLs

As part of the 1987 amendments to the CWA, Congress added Section 402(p) to the Act to cover discharges composed entirely of storm water. Section 402(p)(2) of the Act requires permit coverage for discharges associated with industrial activity and discharges from large and medium municipal separate storm sewer systems (MS4), i.e., systems serving a population over 250,000 or systems serving a population between 100,000 and 250,000, respectively. These discharges are referred to as Phase I MS4 discharges.

In addition, the Administrator was directed to study and issue regulations that designate additional storm water discharges, other than those regulated under Phase I, to be regulated in order to protect water quality. EPA issued regulations on December 8, 1999 (64 FR 68722), expanding the NPDES storm water program to include discharges from smaller MS4s (including all systems within "urbanized areas" and other systems serving populations less than 100,000) and storm water discharges from construction sites that disturb one to five acres, with opportunities for area-specific exclusions. This program expansion is referred to as Phase II.

Section 402(p) also specifies the levels of control to be incorporated into NPDES storm water permits depending on the source (industrial versus municipal storm water). Permits for storm water discharges associated with industrial activity are to require compliance with all applicable provisions of Sections 301 and 402 of the CWA, i.e., all technology-based and water quality-based requirements. See 33 U.S.C. §1342(p)(3)(A). Permits for discharges from MS4s, however, "shall require controls to reduce the discharge of pollutants to the maximum extent practicable ... and such other provisions as the Administrator or the State determines appropriate for the control of such pollutants." See 33 U.S.C. §1342(p)(3)(B)(iii).

Storm water discharges that are regulated under Phase I or Phase II of the NPDES storm water program are point sources that must be included in the WLA portion of a TMDL. See 40 C.F.R. § 130.2(h). Storm water discharges that are not currently subject to Phase I or Phase II of the NPDES storm water program are not required to obtain NPDES permits. 33 U.S.C. §1342(p)(1) & (p)(6). Therefore, for regulatory purposes, they are analogous to nonpoint sources and may be included in the LA portion of a TMDL. See 40 C.F.R. § 130.2(g).

(II). Options for Addressing Storm Water in TMDLs

Decisions about allocations of pollutant loads within a TMDL are driven by the quantity and quality of existing and readily available water quality data. The amount of storm water data available for a TMDL varies from location to location. Nevertheless, EPA expects TMDL authorities will make separate aggregate allocations to NPDES-regulated storm water discharges (in the form of WLAs) and unregulated storm water (in the form of LAs). It may be reasonable to quantify the allocations through estimates or extrapolations, based either on knowledge of land use patterns and associated literature values for pollutant loadings or on actual, albeit limited, loading information. EPA recognizes that these allocations might be fairly rudimentary because of data limitations.

EPA also recognizes that the available data and information usually are not detailed enough to determine waste load allocations for NPDES-regulated storm water discharges on an outfall-specific basis. In this situation, EPA recommends expressing the wasteload allocation in the TMDL as either a single number for all NPDES-regulated storm water discharges, or when information allows, as different WLAs for different identifiable categories, e.g., municipal storm water as distinguished from storm water discharges from construction sites or municipal storm water discharges from City A as distinguished from City B. These categories should be defined as narrowly as available information allows (e.g., for municipalities, separate WLAs for each municipality and for industrial sources, separate WLAs for different types of industrial storm water sources or dischargers).

(III). Determining Effluent Limits in NPDES Permits for Storm Water Discharges Consistent with the WLA

Where a TMDL has been approved, NPDES permits must contain effluent limits and conditions consistent with the requirements and assumptions of the wasteload allocations in the TMDL. See 40 CFR § 122.44(d)(1)(vii)(B). Effluent limitations to control the discharge of pollutants generally are expressed in numerical form. However, in light of 33 U.S.C. §1342(p)(3)(B)(iii), EPA recommends that for NPDES-regulated municipal and small construction storm water discharges effluent limits should be expressed as best management practices (BMPs) or other similar requirements, rather than as numeric effluent limits. See *Interim Permitting Approach for Water Quality-Based Effluent Limitations in Storm Water Permits*, 61 FR 43761 (Aug. 26, 1996). The Interim Permitting Approach Policy recognizes the need for an iterative approach to control pollutants in storm water discharges. Specifically, the policy anticipates that a suite of BMPs will be used in the initial rounds of permits and that these BMPs will be tailored in subsequent rounds.

EPA's policy recognizes that because storm water discharges are due to storm events that are highly variable in frequency and duration and are not easily characterized, only in rare cases will it be feasible or appropriate to establish numeric limits for municipal and small construction storm water discharges. The variability in the system and minimal data generally available make it difficult to determine with precision or certainty actual and projected loadings for individual dischargers or groups of dischargers. Therefore, EPA believes that in these situations, permit limits typically can be expressed as BMPs, and that numeric limits will be used only in rare instances.

Under certain circumstances, BMPs are an appropriate form of effluent limits to control pollutants in storm water. See 40 CFR § 122.44(k)(2) & (3). If it is determined that a BMP approach (including an iterative BMP approach) is appropriate to meet the storm water component of the TMDL, EPA recommends that the TMDL reflect this.

EPA expects that the NPDES permitting authority will review the information provided by the TMDL, see 40 C.F.R. § 122.44(d)(1)(vii)(B), and determine whether the effluent limit is appropriately expressed using a BMP approach (including an iterative BMP approach) or a numeric limit. Where BMPs are used, EPA recommends that the permit provide a mechanism to require use of expanded or better-tailored BMPs when monitoring demonstrates they are necessary to implement the WLA and protect water quality.

Where the NPDES permitting authority allows for a choice of BMPs, a discussion of the BMP selection and assumptions needs to be included in the permit's administrative record, including the fact sheet when one is required. 40 C.F.R.§§ 124.8, 124.9 & 124.18. For general permits, this may be included in the storm water pollution prevention plan required by the permit. See 40 C.F.R. § 122.28. Permitting authorities may require the permittee to provide supporting information, such as how the permittee designed its management plan to address the WLA(s). See 40 C.F.R. § 122.28. The NPDES permit must require the monitoring necessary to assure compliance with permit limitations, although the permitting authority has the discretion under EPA's regulations to decide the frequency of such monitoring. See 40 CFR § 122.44(i). EPA recommends that such permits require collecting data on the actual performance of the BMPs. These additional data may provide a basis for revised management measures. The monitoring data are likely to have other uses as well. For example, the monitoring data might indicate if it is necessary to adjust the BMPs. Any monitoring for storm water required as part of the permit should be consistent with the state's overall assessment and monitoring strategy.

The policy outlined in this memorandum affirms the appropriateness of an iterative, adaptive management BMP approach, whereby permits include effluent limits (e.g., a combination of structural and non-structural BMPs) that address storm water discharges, implement mechanisms to evaluate the performance of such controls, and make adjustments (i.e., more stringent controls or specific BMPs) as necessary to protect water quality. This approach is further supported by the recent report from the National Research Council (NRC), *Assessing the TMDL Approach to Water Quality Management* (National Academy Press, 2001). The NRC report recommends an approach that includes "adaptive implementation," i.e., "a cyclical process in which TMDL plans are periodically assessed for their achievement of water quality standards" . . . and adjustments made as necessary. *NRC Report* at ES-5.

This memorandum discusses existing requirements of the Clean Water Act (CWA) and codified in the TMDL and NPDES implementing regulations. Those CWA provisions and regulations contain legally binding requirements. This document describes these requirements; it does not substitute for those provisions or regulations. The recommendations in this memorandum are not binding; indeed, there may be other approaches that would be appropriate in particular situations. When EPA makes a TMDL or permitting decision, it will make each decision on a case-by-case basis and will be guided by the applicable requirements of the CWA and implementing regulations, taking into account comments and information presented at that time by interested persons regarding the appropriateness of applying these recommendations to the particular situation. EPA may change this guidance in the future.

If you have any questions please feel free to contact us or Linda Boornazian, Director of the Water Permits Division or Charles Sutfin, Director of the Assessment and Watershed Protection Division.

cc:
Water Quality Branch Chiefs
Regions 1 - 10

Permit Branch Chiefs
Regions 1 - 10

Appendix H

Public Meeting Information and Response to Comments

Public Meeting Information and Response to Comments
Pathogen TMDL for the Charles Watershed

Public Meeting Announcement Published in the Monitor	8/10/2005
Date of Public Meeting	8/23/2005
Location of Public Meeting	Elm Bank Reservation 900 WashingtonStreet Wellesley, MA
Times of Public Meeting	2 P.M. and 7 P.M.

Public Meeting Attendees

Date 8/23/2005 Time 2 P.M.

Name	Organization
1. Roger Frymire	Watershed Advocate
2. Anna Eleria	Charles River Watershed Association
3. Sona Petrossian	Waban Resident
4. Carol Lee Rawn	Conservation Law Foundation
5. Owen O'Riordan	City of Cambridge
6. Catherine Woodbury	City of Cambridge
7. Nancy Hammett	Watertown Conservation Commission
8. Mike Hill	EPA Region 1
9. Steven Halterman	MassDEP
10. Michael DiBara	MassDEP

Date 8/23/2005 Time 7 P.M.

Name	Organization
1. Elizabeth Bourque-Theiler	Holliston Board of Health
2. Mike Schwab	Holliston Resident
3. Don MacAdams	Hopkinton Conservation Commission
4. Steven Halterman	MassDEP
5. Michael DiBara	MassDEP

Charles Watershed Response to Comments

This appendix provides detailed responses to comments received during the public comment period. MASSDEP received many comments/questions that were of a general nature (i.e. related to terminology, statewide programs, the TMDL development process and regulations, etc.) while others were watershed specific. Responses to both are presented in the following sections.

General Questions and Comments:

1. Question: On the slide titled "components of a TMDL" what does "WLA" and "LA" stand for.

Response: Waste load allocation (WLA) refers to pollutants discharged from pipes and channels that require a discharge permit (point sources). Load allocation refers to pollutants entering waterbodies through overland runoff (non point sources). A major difference between the two categories is the greater legal and regulatory control generally available to address point sources while voluntary cooperation added by incentives in some cases is the main vehicle for addressing non-point sources.

2. Question: What is the Septic System Program?

Response: Cities and Towns can establish a small revolving fund to help finance repairs and necessary upgrades to septic systems. The initial funding is from the Commonwealth's State, Revolving Fund Program (SRF). These programs generally offer reduced interest rate loans to homeowners to conduct such improvements. Many communities have taken advantage of this effort. A discussion of the septic system programs may be seen in the TMDL companion document "A TMDL Implementation Guidance Manual for Massachusetts" under Section 3.2.

3. Question: What is the WQS for non-contact recreation in terms of bacteria?

Response: EPA does not have specific guidance for a bacteria criterion for secondary contact. The agency notes that 5 times the swimming standard has been used in the case of fecal coliform. EPA suggests that this remains one option for states and designated tribes to adopt. Massachusetts has proposed 5 times the geometric mean for swimming waters as the limit in fresh water as the criterion based on a geometric mean of at least 5 samples over a year.

4. Question: On the topic of DNA testing for bacterial source tracking what is DEP doing or planning to do?

Response: DNA testing is a promising but as yet not fully reliable tool in distinguishing between human and other sources of fecal bacteria. When perfected, this tool will be extremely valuable in helping target remedial actions. At the same time, one needs to recognize that the source of the bacteria is identified as non-human, any concentrations exceeding the criteria still impair the use, such as swimming or shellfishing, associated with those criteria. DNA testing has been conducted in the Charles River Watershed but we found we could not duplicate the results thus raising questions as to its reliability. MassDEP and the USGS presently are conducting a source-tracking project in the Shawsheen River Watershed. Part of that project is to use alternative field and laboratory methods in an effort to standardize testing and to be able to separate human from non-human sources. If this effort is successful it could be used to in the future in watersheds across the Commonwealth.

5. Question: What is the current thought on e-coli/entero bacteria survival and reproduction in the environment, especially in wetlands?

Response: There are reports that indicator bacteria can survive in sediment longer than they can in water. This may be a result of being protected from predators. Also, there is some indication that reproduction may occur in wetlands, but until wildlife sources can be ruled out through, say, a reliable DNA testing, this possibility needs to be treated with caution. Also, die off of indicator bacteria tends to be more rapid in warm water than in cold.

6. Question: For the implementation phase of TMDLs who will do the regular progress reporting and who will pay for it?

Response: Phase I and II municipalities already conduct regular reporting. For non-Phase II municipalities it gets more difficult. Reporting will depend on the approach ultimately used to achieve compliance. The TMDL however does not require volunteer groups, watershed organizations or towns to submit periodic reports. The Department is relying on self interest and a sense of duty for communities and others to move ahead with the needed controls facilitated by some state aid. While the legal authority for enforcement of water quality standards exists, the Department feels that the cooperative approach is the most desirable and effective at this time. Hence, regulatory actions for activities that do not require a federal or state discharge permit will be tapped only for those cases in which the cooperative approach ultimately fails.

7. Question: How does the Phase II program and TMDL program coordinate with each other?

Response: The NPDES Stormwater Phase II General Permit Program became effective in Massachusetts in March 2003. The permit requires the regulated entities to develop, implement and enforce a stormwater management program (SWMP) that effectively reduces or prevents the discharge of pollutants into receiving waters to the Maximum Extent Practicable (MEP). Stormwater discharges must also comply with meeting state water quality standards. The Phase II permit uses a best management practice framework and measurable goals to meet MEP and water quality standards. A requirement of the permit is that if a TMDL has been approved for any water body into which the small municipal separate storm sewer system (MS4) discharges, the permittee must determine whether the approved TMDL is for a pollutant likely to be found in stormwater discharges from the MS4. If the TMDL includes a pollutant waste load allocation, best management practices (BMPs) or other performance standards for stormwater discharges, the permittee must incorporate them into their SWMP. The permittee must also assess whether the pollutant reduction required by the TMDL is being met by existing stormwater management control measures in their SWMP or if additional control measures are necessary. As TMDLs are developed and approved, permittees' stormwater management programs and annual reports must include a description of the BMPs that will be used to control the pollutant(s) of concern, to the maximum extent practicable. Annual reports filed by the permittee should highlight the status or progress of control measures currently being implemented or plans for implementation in the future. Records should be kept concerning assessments or inspections of the appropriate control measures and how the pollutant reductions will be met.

8. Question: Will Communities be liable for meeting bacteria water quality standards for bacteria at the point of discharge?

Response: While this is the goal stated in the TMDL, compliance with the water quality standards is judged by in-stream measurements. For instance, in an extreme case, it could be possible for a community to meet this criterion in their storm drains and yet still be responsible for reducing the impacts of overland runoff if the in-stream concentrations of bacteria exceeded the water quality standard. So no matter how the TMDL is expressed, compliance is measured by the concentrations in the ambient water.

A more detailed discussion / explanation of this response can be found in a memorandum titled “Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs” by Robert H. Wayland and James A. Hanlon of EPA (11/22/02) which provided in Appendix G of the TMDL.

9. Question: What are the regulatory hooks for this TMDL in regards to non-point sources?

Response: In general, the Massachusetts Department of Environmental Protection is pursuing a cooperative approach in addressing non-point sources of contamination by bacteria. A total of 237 cities and towns in Massachusetts do have legal requirements to implement best management practices under their general NPDES storm-water permits. In addition, failing septic systems are required to be corrected once the local Board of Health becomes aware of them and at the time of property transfer should required inspections reveal a problem. Other activities, such as farming involving livestock, are the subject of cooperative control efforts through such organizations as the Natural Resources Conservation Service (NRCS), which has a long history of providing both technical advice, and matching funds for instituting best management practices on farms. While MassDEP has enforcement tools available for use for cases of egregious neglect, it intends to fully pursue cooperative efforts, which it feels offer the most promise for improving water quality.

10. Question: Why is there little mention in the draft TMDL reports on incorporation of LID (Low Impact Development) principles as a way through implementation to control Bacteria pollution?

Response: Part of the Statewide TMDL project was to produce an accompanying TMDL implementation guidance document for all the TMDL reports, ‘Mitigation Measures to Address Pathogen Pollution in Surface Waters: A TMDL Implementation Guidance Document for MA’. There is an entire section in that document (Section D.4) that discusses LID principles and TMDL implementation in detail.

11. Question: What about flow issues and TMDL requirements?

Response: Although flow can have both positive and negative impacts on water quality, flow is not a pollutant and therefore is not covered by a TMDL. TMDLs are required for each "pollutant" causing water quality impairments.

12. Question: Is there a way that the TMDL can be integrated with grants, and can the grants be targeted at TMDL implementation?

Response: Several years ago MassDEP revised both its SRF and 319 Nonpoint Source Grant Programs to provide higher priority points for projects designed to address water quality impairments and/or where TMDLs have been developed.

The 319 Grant program is a major funding program providing up to $2 million per year in grants in MA. TMDL implementation is a high priority in that program.

The 319 grant program RFP includes this language: "Category 4a Waters: TMDL and draft TMDL implementation projects – The 319 program prioritizes funding for projects that will implement Massachusetts' Total Maximum Daily Load (TMDL) analyses. Many rivers, streams and water bodies in the Commonwealth are impaired and thus do not meet Massachusetts' Surface Water Quality Standards. The goal of the TMDL Program is to determine the likely cause(s) of those impairments and develop an analysis (the TMDL) that lists those cause(s)."

Several comments were also directed towards the complications associated with applying for and reporting details that are required with state grant programs. The MassDEP is sympathetic to the paper work requirements of state and federal grant programs. The Department will review the body of requirements to assess what streamlining may be possible. At the same time the Department underscores that accountability for spending public funds continues to be an important and required component of any grant program.

13. Question: How will implementation of the TMDL address the major problem of post-construction run-off?

Response: This will be principally addressed as one of the six points or parts of the Phase II Stormwater program in municipalities that are required to be covered under this program. Most of the municipalities in the watersheds are covered under the Phase II Requirements.

14. Question: How does a pollution prevention TMDL work?

Response: Pollution prevention best management practices form the backbone of stormwater management strategies. Setting a target even if a water body segment is not impaired will define how new activities should be conducted to prevent water quality problems in the future. Limiting or preventing operation and maintenance problems should be an integral component of all stormwater management programs. This applies equally well with the Phase II Program as well as TMDLs. A detailed discussion of this subject and the BMPs involved can be found in the TMDL companion document “A TMDL Implementation Guidance Manual for Massachusetts” in Section 3.

15. Comment: The TMDL methodology uses concentrations based on water quality standards to establish TMDL loads, not traditional “loads”.

Response: The TMDL has been revised to provide not only a concentration based approach but also a loading approach. In addition, necessary percent reductions by segment have been added in order to provide the public with guidance on where to prioritize remediation activities. It should be noted however that MassDEP believes that a concentration-based approach is consistent with EPA regulations and more importantly more understandable to the public and easier to assess through monitoring activities. Clean Water Act Section 130.2(i) states that, “TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure”. The TMDL in this case is set at the water quality standard. Pathogen water quality standards (which are expressed as concentrations) are based on human heath, which is different from many of the other pollutants. It is important to know immediately when monitoring is conducted if the waterbody is safe for human use, without calculating a “load” by multiplying the concentration by the flow – a complex function involving variable storm flow, dilution, proximity to source, etc.

The expectation to attain water quality standards at the point of discharge is conservative and thus protective, and offers a practical means to identify and evaluate the effectiveness of control measures. In addition, this approach establishes clear objectives that can be easily understood by the public and individuals responsible for monitoring activities.

MassDEP believes that it is difficult to provide accurate quantitative loading estimates of indicator bacteria contributions from the various sources because many of the sources are diffuse and intermittent, and flow is highly variable. However, based on public comment we have included loads for each segment based on variable flow conditions and the water quality standards. Because of the high variability of bacteria and flows experienced over time, loads are extremely difficult to monitor and model. Therefore, “loadings” of bacteria are less accurate than a concentration-based approach and do not provide a way to quickly verify if you are achieving the TMDL.

16. Comment: There is concern with the “cookie-cutter” nature of the draft TMDL, particularly the lack of any determination about the causes and contributions to pathogen impairment for specific river and stream segments.

Response: The MassDEP feels the pathogen TMDL approach is justified because of the commonality of sources affecting the impaired segments and the commonality of best management practices used to abate and control those sources. The MassDEP monitoring efforts are targeted towards the in-stream ambient water quality and not towards tracking down the various sources causing impairment. It should be noted however that based on public comment MassDEP has conducted additional efforts to try to identify sources where information was available. Based on this additional information MassDEP added tables to help identify and prioritize important segments and sources where that information was known. Also MassDEP revised Section 7 of the document to include segment-by-segment load allocations and calculated the percent reduction required to meet standards. All of these actions were intended to provide additional guidance on potential sources and areas of concern and to help target future activities.

17. Comment: While Table 7-1 (now Table 8-1) of each TMDL lists the Tasks that the agencies (DEP/EPA) believe need to be achieved, it isn't clear exactly how these tasks line up with and address the eight sources of impairment listed in Table 6-1 (now Table 5-1). CZM recommends that the final TMDL be more specific and couple the Implementation Plan tasks with the known or expected sources of contamination. This would make the document more useful to a community.

Response: All of the sources of impairments listed in Table 5-1 are addressed in either Table 8-1, the text of Section 8, or both. Also the TMDL companion document "A TMDL Implementation Guidance Manual for Massachusetts" provides additional discussion and guidance on this issue. Because Table 5-1 and 8-1 serve slightly different purposes it was not felt that the tasks had to align with and exactly address the eight sources of impairment.

18. Comment: While the text in sections 7.1-7.7 (now Chapter 8.0) of each TMDL describes some actions that can address the sources in Table 6-1 (now Table 5-1), the issue of failing infrastructure is only mentioned in a sub-section title and in the text, but not addressed in any detail.

Response: Failing infrastructure is a very broad term, and is addressed, in part in such discussions as those on leaking sewer pipes, sanitary sewer overflows, and failed septic systems. It is outside of the scope of the TMDL documents to detail every possible type of infrastructure failure.

19. Comment: There is a need for more specific information about what individual communities are currently doing and how much more effort is required (e.g., how many more miles of pipe need to be inspected for illegal connections in a specific community).

Response: MassDEP and the EPA recognize that the municipalities have done, and are continuing to do, a tremendous amount of work to control bacterial contamination of surface waters. The TMDL has been expanded to provide additional examples of that overall effort. However, the additional discussion is not meant to include an exhaustive listing of all the work required nor being conducted to finalize this effort nor to provide a status of all activities. Programs, such as Phase II Storm water, require such status reports, and those will be very valuable in assessing priorities and future work.

20. Comment: There are no milestones to which individual communities should aim (e.g., all stormwater lines upstream of known contamination inspected for illegal connections in five years). As another example, Section 7.0 (now Section 8.0) of each TMDL states that "The strategy includes a mandatory program for implementing storm water BMPs and eliminating illicit sources" but it is not clear over what timeframe a community should be acting.

Response: The Department recognizes that the addition of timelines in the TMDLs would appear to strengthen the documents, however, it is outside the scope of any TMDL to include detailed timelines. There will be a wide variety of processes by which the TMDLs will be implemented. When timelines are required, it will be in the implementation of the TMDL, not the TMDL itself.

21. Comment: Under "Control Measures" does "Watershed Management" include NPDES permitting?

Response: Stormwater management includes NPDES Phase I and II and could include additional permitting actions where deemed necessary and appropriate. Properly functioning wastewater treatment plants already have permit limitations equal to the water quality standards and as such are not generally a source of bacteria that would result in water quality exceedences therefore they are not included as a control measure.

22. Comment: Absent from each report under "Who should read this document?" are the government agencies that provide planning, technical assistance, and funding to groups to remediate bacterial problems.

Response: The introduction was edited to include these groups in a general sense. It is beyond the scope of the TMDL to provide an exhaustive list of agencies that provide funding and support. Chapter 8.0 however provides a link to this information, which is provided in the Massachusetts Nonpoint Source Strategy.

23. Comment: For coastal watersheds the section that describes funding sources should include grant programs available through the Massachusetts Office of Coastal Zone Management.

Response: Please see response to comment #22.

24. Comment: Table ES-1 (now Table ES-3) and the similar tables throughout the report do not list B(CSO) or as a surface water classification – this classification and its associated loadings allocations are missing. Although the footnote to the table refers to Long term CSO Control Plans, the relationship between the TMDL, LTCP, and the B(CSO) water classification are unclear.

Response: No loadings are assigned to B(CSO) classified waters because each situation is addressed through site-specific limits and the long-term control plans associated with each CSO.

25. Comment: The implementation of new bacteria water quality criteria into NPDES permits should be determined during the permit writing process rather than by the TMDL process – and that should be made clear in the TMDL document.

Response: MassDEP agrees with this comment however because the TMDLs are based on the water quality criteria, it is necessary to list those criteria in the TMDLs. Readers / users of the bacteria TMDL reports should also be aware that new water quality standards are currently being developed.

26. Comment: Coastal resources are significantly impacted from storm water runoff from Mass. Highway roads. This goes beyond the control of municipalities to upgrade and is often beyond the capability of local groups to monitor. Mass. Highway Department (MHD) continues to evade storm water standards and it is thus our opinion that MHD deserves special recognition in the TMDL reports complete with an implementation strategy to upgrade the drainage systems along its web of asphalt.

Response: Mass. Highway is included in the Storm Water Phase II Program, and as such will be responsible for completing the six minimum controls mandated by that program, i.e., public education and outreach, public involvement and participation, illicit discharge detection and elimination, construction site storm water control, post construction storm water management, and good housekeeping in operations.

Watershed Specific Comments:

Comments of Catherine Woodbury, City of Cambridge

1. Comment: How will the City of Cambridge incorporate this TMDL into our existing Phase II Stormwater NPDES permit?

Response: The City must assess whether the pollutant reduction recommendations required by the TMDL are being met through existing stormwater management control measures in their Phase II Stormwater Management Program, or if additional control measures are necessary. Stormwater management programs and annual reports must include a description of the BMP's that will be used to control the pollutant(s) of concern, to the maximum extent practicable. Annual reports filed by the City should highlight the status or progress of control measures currently being implemented or plans for implementation in the future. Records should be kept concerning assessments or inspections of the appropriate control measures and how the pollutant reductions will be met.

MassDEP recommends that as permittees develop and implement their Stormwater Phase II programs that the implementation of local TMDL pollutant reduction plans be made a priority goal.

Comments of Mike Schwab, Holliston

2. Comment: How does this TMDL affect the transfer station operated by Casella Waste Management in Holliston? A stormwater pipe, loaded with bacteria, is emanating from the property.

Response: Casella Waste Management operates a solid waste transfer facility at 115 Washington Street in Holliston. Stormwater discharges from this facility are regulated under a U.S. EPA industrial multi-sector general (scrap recycling and waste recycling facilities) National Pollutant Discharge Elimination System (NPDES) permit (#MAR05B935). Upon EPA approval of this established bacteria TMDL, combined with EPA's new proposed multi-sector industrial general permit changes for stormwater, this facility will be required to both monitor for bacteria (pollutant of concern within this TMDL) and implement adequate stormwater Best Management Practices (BMP's) into its Stormwater Pollution Prevention Plan (SWPPP) to reach the water quality goals set out in this TMDL. If the stormwater discharge from the facility is in exceedence of the assigned wasteload allocation for indicator bacteria in this TMDL (i.e.," Not to exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms"), Casella Waste Management will be required to implement corrective BMP actions on a specific time schedule. As drafted the proposed industrial stormwater general permit will require new permitees (such as Casella Waste Management) to review and make appropriate corrections to its Stormwater Pollution Prevention Plan (SWPPP) within 14 days following the discovery of any deficiencies; and modify or implement corrective BMP's "no later than 60 days after discovering the deficiency." Failure to take the necessary corrective actions within the stipulated time frames constitutes a violation of the permit. In addition to these requirements, the facility is required, under the terms of a 2003 Operating Approval issued by MassDEP, to upgrade and improve its stormwater system. Improvements to the stormwater system have also been the subject of recent local permitting by the Holliston Conservation Commission, Board of Health and Planning Board.

Comments of Elizabeth Bourque-Theiler, Holliston Board of Health

3. Comment: Dopping Brook in Holliston is a tributary and a potential source of bacteria (p.38) of Bogastow Brook MA72-16 classified by DEP as an impaired segment of the Charles River Watershed due to indicator bacteria concentrations. The Casella Transfer Station in Holliston has an outfall pipe which is a short distance from Dopping Brook and less than ½ mile from Public Drinking water Well #6. The effluent from this outfall pipe has been consistently over the NPDES Benchmarks and has contained levels of fecal coliform as high as 1.3 million colonies/100 ml on June 16, 2005 and 500,000 colonies/100ml for July 6, 2005 reported by Casella to the Holliston Board of Health. These levels of fecal coliform appear to be above levels listed in the draft document and should receive DEP attention.

The draft document states that impaired Bogastow Brook has no NPDES wastewater discharges, yet its tributary Dopping Brook has a NPDES wastewater discharge, which consistently exceeds NPDES Benchmarks and contains high levels of fecal coliform. The MassDEP is requested to investigate and sample the discharges into Dopping Brook and to assure that Dopping Brook meets Class B water standards.

Response: The MassDEP Central Regional Office has been contacted and is working towards a resolution for the discharge from the Casella Transfer Station. Dopping Brook will be added to the list of issues to be investigated by MassDEP during our next round of sampling in the Charles River Watershed currently scheduled for 2007. In addition to these requirements, the facility is required, under the terms of a 2003 Operating Approval issued by MassDEP, to upgrade and improve its stormwater system. Improvements to the stormwater system have also been the subject of recent local permitting by the Holliston Conservation Commission, Board of Health and Planning Board.

<u>Comments of Carol Lee Rawn, Conservation Law Foundation (CLF)</u>

The Conservation Law Foundation submitted comments dated 10-13-05 in response to MassDEP's draft pathogen TMDLs for the following watersheds: the Blackstone, Concord, Nashua, Boston Harbor, North Coastal, Buzzards Bay, Taunton, South Coastal, Cape Cod, Islands, Charles, Merrimack, Parker, and Ipswich. While MassDEP is working on finalizing all of these watershed pathogen TMDLs, these comments apply to the Charles River Watershed TMDL.

4. Comment : The TMDLs Fail to Document the Sources of Bacteria

"DEP's statewide "cookie-cutter" approach to pathogen TMDLs is so general that the documents are operationally meaningless. Each of the 14 Drafts consists of virtually identical core narrative sections, supplemented by brief watershed-specific summaries of existing data. The Drafts do not contain any substantive discussions or watershed-specific findings based on the data presented. In some cases, such as the Charles, the Drafts even fail to include the most recent and complete water quality data available. The Drafts are devoid of any specific determinations about the sources of pathogen impairment in each of the watersheds."

Response:

In establishing the final Charles River Watershed Pathogen TMDL, MassDEP used and incorporated site-specific information, including information on specific sources of bacteria, wherever such information was available. (See 40 CFR §130.7(c)(1)(i) ("[s]ite-specific information should be used wherever possible.")) Because of the large volume of data and other information available for some of the watersheds like the Charles, it was not possible or useful for MassDEP to incorporate all of the information directly into the TMDL - although MassDEP is committed to utilizing all relevant data to support TMDL development and to ensuring that the public has access to and knowledge of relevant data and resources to support TMDL implementation.

For the future watershed pathogen TMDLs, MassDEP remains committed to establishing them as efficiently and effectively as possible. For some aspects of these TMDLs, similar methodologies will be applied, for example, the calculation of the daily loads. MassDEP believes that its approach of applying similar methodologies, while incorporating site-specific information for specific watersheds, is the most appropriate and effective method to address pathogen contamination in Massachusetts.

For the Charles River TMDL, extensive sets of pathogen data were reviewed from:

* the Charles River Watershed Association (CRWA),
* MassDEP -Water Quality Monitoring Data,
* EPA - Core Monitoring Program Charles River Water Quality Assessment Report,
* USGS – Streamflow, Water Quality and Contaminant Loads in the Lower Charles River Watershed,
* MWRA – Summary of CSO Receiving Water Quality Monitoring in Boston Harbor and Tributary Rivers, 1989-2001, and
* sampling data collected from citizen, Roger Frymire, and analyzed by EPA.

MassDEP has incorporated additional information into the Charles River TMDL as a result of public comments. MassDEP received CRWA's monthly monitoring data up to August 2005, sampling data collected from citizen Roger Frymire (and analyzed by EPA) and updated the individual summary segment tables in the Problem Assessment, Section 4.0 of the TMDL

Based on these data for the Charles, MassDEP revised the TMDL and identified additional existing and potential sources of pathogen impairment for wet and dry weather and prioritized the waterbody segments and outfall pipes. Specifically, a new Table 6-1 provides a prioritized list of pathogen-impaired segments that will require additional work and implementation of structural and non-structural best management practices. Table 6-2 sets forth the high priority pathogen sources, which have been identified within the Charles River Watershed. Specifically, this table includes a summary of 21 storm water outfall pipes that should be considered a high priority for remediation. A link to the entire bacterial hot spot monitoring work (2002-2005), from which this list of 21 sources is taken, is now provided in Appendix E of the Charles TMDL.

5. Comment: TMDLs must allocate loads to individual point sources, not to broad categories of sources.

"Applicable federal regulations clearly require TMDLs to allocate loads to individual point sources, not to broad categories of sources, and certainly not to broad categories of "potential sources." See 30 CFR § 130.2(h) (defining wasteload allocation as "[t]he portion of a receiving water's loading capacity that is allocated to *one* of its existing or future point sources of pollution" (emphasis added)). Rather than identify individual sources as required by 30 CFR 130.2 (h), each of the Drafts contains a generic discussion of "*Potential* Sources (section 5.0, emphasis added)…."

Response:

MassDEP believes that its approach is consistent with the regulatory requirements as set forth in 30 CFR **§** 130.2(h) and disagrees that the regulations require that every pathogen source be specifically identified. While the Charles River Pathogen TMDL categorizes pathogen sources into categories, it establishes waste load allocations (WLAs) and load allocations (LAs) for each individual pathogen source within these categories. (See Table 7-1).

While the TMDL does identify "potential" sources of pathogens (see Section 5.0) - language that the commenter identifies as indicative of vagueness in the TMDL - this does not equate to uncertainty as to the sources that are covered by the TMDL. In this TMDL, MassDEP clearly sets daily concentration WLA and LA targets for each one of the Charles River discharge sources by category (i.e., storm water, CSO, etc.). This approach is designed to give citizens and others charged with implementing the TMDL the clearest guidance possible on the precise WLA and LAs that will apply to the sources of pathogens. (Note that the TMDL also provides daily targets expressed as percent reductions and loadings of bacteria/day, however, MassDEP believes that the concentration-based approach provides the clearest and most understandable expression of water quality goals to the public and groups that conduct water quality monitoring.)

Finally, as stated in the previous response, MassDEP has incorporated source-specific information into the development of the Charles River TMDL, and has prioritized such sources for remediation, when such information is available.

6. Comment: The TMDLs Lack Specific Pathogen Abatement Requirements

"Given the Drafts' failure to identify individual sources of pathogen impairment, it is hardly surprising that they also lack specific abatement strategies and requirements. Instead, the Draft TMDLs contain a generic "Implementation Plan" section (section 7.0) and reference a companion document, "Mitigation Measures to Address Pathogen Pollution on Surface Waters: A TMDL Implementation Guidance Manual for Massachusetts." Each of the documents should address the pollution controls necessary to meet water quality standards in that watershed. They should also address the degree to which watershed-specific conditions, such as extremely low streamflow in the Ipswich River and its tributaries, may affect remediation."

Response:

MassDEP recognizes that implementation plans are not a required element of a TMDL. Nonetheless, MassDEP is committed to ensuring and facilitating the development of appropriate implementation measures. In addition to the specific and stringent TMDL loading targets provided by source category (see Table 7-1), the Charles River Pathogen TMDL specifically prioritizes high-priority segments for source abatement such as the elimination of illicit sanitary sewer connections to the storm water sewer. The TMDL also provides more general recommendations for remediation of all of the types of bacteria sources.

These more general recommendations can be found in the companion document titled, "Mitigation Measures to Address Pathogen Pollution in Surface Waters: A TMDL Implementation Guidance Manual for Massachusetts." With funding support from EPA, MassDEP was able to develop this guide in order to provide support to the public on pathogen remediation activities. The development of such a guide to accompany the release of a TMDL is unique and its broad scope is designed to provide support for all remediation activities that occur throughout Massachusetts to support implementation of the watershed pathogen TMDLs. MassDEP believes that the general suggestions in this document are appropriate because of the commonality of the pathogen sources affecting the impaired segments as well as the commonality of the best management practices used to abate and control those sources. Of course, such an approach does not preclude specific remediation responses to specific source situations, where such information is available.

7. Comment: The TMDLs Contain No Loading Calculations or Allocations

"DEP's Pathogen TMDL proposal is unconventional in that it simply sets an end-of-pipe limit equal to the water quality standard for bacteria (a concentration of 200 organisms per 100 ml for Class B waters), rather than actually calculating the allowable loading to a receiving water and the allocation of the allowable load to point sources, nonpoint sources and background, plus a margin of safety. The Clean Water Act requires establishment of a total maximum daily load "at a level necessary to implement the applicable water quality standards." 33 U.S.C. §1303(d)(1)(c). While the end-of-pipe application of water quality criteria is a useful tool for improving water quality and for *implementing* a TMDL, DEP's proposal does not establish a load and is not itself a TMDL.

We understand that DEP is relying on 40 CFR §130.2(i), which allows TMDLs to be expressed in terms of "mass per time, toxicity or *other appropriate measure*" (emphasis added) and that EPA in 2002 approved a similar concentration-based TMDL for bacteria in the Neponset. CLF remains skeptical about DEP's reliance on the "other appropriate measure" language in order to evade its obligation to calculate loads and allocate them to point and nonpoint sources. If DEP proceeds in this manner, it should limit the concentration-based approach to pathogen TMDLs."

Response:

MassDEP has revised the pathogen TMDLs to include three types of daily targets for the pathogen TMDLs. As set forth in the original drafts of the pathogen TMDLs, MassDEP is setting daily concentration TMDLs expressed as waste load and load allocations for each one of the discharge sources by point and nonpoint source category (i.e., storm water, CSO, etc.). MassDEP recommends that the concentration targets be used as the primary guide for implementation.   Second, Mass DEP has revised the pathogen TMDLs to now also provide an estimate of the necessary percent reductions needed in each segment using a conservative analysis based on comparing ambient bacteria concentrations to water quality criteria. The TMDL has also been revised to include maximum daily loads developed as a function of stream flow and percentage of time a given stream flow is expected to occur using the flow duration approach.

MassDEP believes that these expressions of the daily targets for the TMDL are consistent with its regulatory requirements to establish total maximum daily loads. 40 CFR § 130.2(i). Each methodology assures that the loading capacities are equal to or less than the Water Quality Standards. In addition, MassDEP believes that expressing a loading capacity for bacteria in terms of concentration set equal to the Commonwealth's adopted criteria, provides the clearest and most understandable expression of water quality goals to the public. The percent reduction targets are the next most useful TMDL expression for guiding implementation, followed by expressing the loading capacity in terms of loadings (e.g., numbers of organisms per day), which while provided, is more difficult for the public to interpret.

8. Comment: MassDEP Should Consider Utilizing a "4b" Approach

"EPA has expressly acknowledged that "the most effective method for achieving water quality standards for some water quality impaired segments may be through controls developed and implemented without TMDLs. EPA, Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d) and 305(b) of the Clean Water Act, at 54 (2005) ("2006 IR Guidance"). A TMDL is required only if attainment cannot be reached by use of (i) technology-based effluent limitations imposed by the Clean Water Act, (ii) more stringent effluent limitations required by state, local or federal authority, or (iii) other pollution control requirements required by state, local or federal authority. 40 C.F.R. §130.7(b)(i)-(iii). The so-called "4b alternative" to developing a TMDL is available when "there are 'other pollution control requirements' sufficiently stringent to achieve applicable water quality standards within a reasonable period of time." 2006 IR Guidance, at 54. In such instances, states may exclude certain water bodies from Category 5 (the 303(d) list), and instead list them in Category 4b… CLF would support characterizing DEP's end-of-pipe limit for bacteria as a "4b alternative' to addressing pathogen impairment in Massachusetts watersheds if DEP can demonstrate that water quality standards will be met through implementation and enforcement of specific state, local or federal "pollution control requirements."

Response:

As set forth in EPA's July 29, 2005, Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act, EPA interprets §130.7(b)(1) to allow the removal of a water from the 303(d) list, and its placement into the integrated list's §4(b) category of waters that are impaired but no TMDL is needed, if effluent limitations and/or other pollution control requirements are stringent enough to implement water quality standards within a reasonable period of time. See EPA Guidance, p 54. Neither the statute nor the regulations obligate states to implement all possible actions to control the full suite of point and nonpoint sources before establishing a TMDL. This is particularly true where there are many varied sources within a watershed that cumulatively result in the adverse effects on the watershed. In the case of pathogen impairments in Massachusetts, MassDEP believes that TMDLs are a valuable tool for establishing reasonable targets on which future implementation actions can be based.

Comments of Anna Eleria, Charles River Watershed Association (CRWA)

9. Comment: A major omission from the draft pathogen TMDL is the monitoring results from CRWA's Upper Charles River Watershed TMDL Project, in which CRWA monitored four events, two dry and two wet, over a three-year period, 2002-2005, at 31 sites in the upper watershed. Samples collected from the mainstem, tributaries and wastewater treatment plants (possible source of contamination) are analyzed for a suite of parameters including fecal coliform bacteria helps to characterize the bacteria problems in the upper watershed and identify which tributaries and WWTPs contribute bacteria to the Charles in both dry and wet conditions. The data from the first three monitoring events are attached to our formal comment letter (September 14th, 2005). CRWA staff conducted the fourth monitoring event at the end of August 2005 and the data is unavailable pending internal CRWA review (anticipated date of release, December 2005).

Response: MassDEP has retrieved this unpublished monitoring project data from the Charles River Watershed Association and included it in the final TMDL report. A brief summary of this project has been inserted and the monitoring locations are included in Appendix D for reference.

10. Comment: MassDEP also does not review end-of-pipe and in-stream sampling conducted in the middle and lower stretches of the Charles River and tributaries by Mr. Frymire since 1998, which would assist in identifying the location of possible illicit connections or failing sewer infrastructure. So far, a total of 700 samples have been collected, which have assisted decision makers and concerned parties in identifying the pipes contributing to the impairment and remediating the sources of pollutants to the Charles.

Response: As noted in comment #4 above, MassDEP has retrieved Mr. Frymire's stormwater outfall monitoring data from the Charles River Watershed Association and included it in the final TMDL report. Mr. Frymire has sampled many stormdrain outfalls in the Lower Charles basin for fecal coliform bacteria during both dry and wet weather events. As a result of Mr. Frymire's work, several of these problematic outfalls have been remediated by the responsible party. However, additional follow-up source tracking will be necessary. A link to this (2002) summary report has been included in Appendix E for reference.

11. Comment: Historically, combined sewer overflows to the Charles River were major contributor of bacteria to the river. Yet in the past ten years, MWRA has made significant efforts to eliminate CSO discharges by increasing wastewater treatment capacity at the new Deer Island facility and the hydraulic capacity of sewer lines and separating sewage and storm sewer lines, and to mitigate the remaining overflows to the Charles through screening and disinfection of the MWRA's Cottage farm facility in Cambridge prior to discharge. Despite these efforts, CSOs remain a significant source of bacteria to the last miles of the Charles and all available data from MWRA's Cottage farm outfall and any other CSO outfalls should be reviewed and included in this TMDL report. Also, MassDEP should include information provided in MWRA's Long Term CSO Control plan for the Charles River, dated August 2, 2005, as ultimately adopted.

Response: Please refer to response # 13 below. A web link to MWRA's 2004 Annual Progress Report on its long-term Combined Sewer Overflow plan has been included in Section 8.3 of the TMDL. This published report will help the general public to better understand both the issues and actions being taken by the MWRA to control bacterial pollution in the lower Charles watershed.

12. Comment: MassDEP fails to include in its review of water quality data the most recent bacteria information available from different organizations and agencies. This up-to-date information should be incorporated into the TMDL report. A major source for this pathogen TMDL is CRWA's monthly monitoring data, however, 2004, data was not included as part of the analysis. This is available from CRWA's website, www.charlesriver.org\water_quality\monthly\monthly.html.

Response: MassDEP has received CRWA's monthly monitoring data up to August 2005 and updated the individual summary segment tables in Section 4.0 Problem Assessment of the report.

13. Comment: Both US EPA and MWRA conduct regular monitoring of the Lower Charles River, the last nine-mile stretch of river from Watertown Dam to the New Charles River Dam, on an annual basis. Once again, MassDEP failed to include the most recent data: in this case, the 2004 data from EPA's Core Monitoring Program for the Charles River and the 2002-2004 data from MWRA's CSO Receiving Water Quality Monitoring Program.

Response: A brief summary of EPA's Clean Charles 2005 Core Monitoring Program has been included at the end of section 4.0 Problem Assessment. The web link to EPA's 1998-2003 Annual Monitoring Reports, http://www.epa.gov/NE/charles/2005.html, has also been included. In addition, a web link to MWRA's 2004 Annual Progress Report on its long-term Combined Sewer Overflow plan has been included in Section 8.3 of the TMDL. This published report will help the general public to better understand both the issues and actions being taken by the MWRA to control bacterial pollution in the lower Charles watershed.

14. Comment: MassDEP does not include the most up-to-date water quality monitoring data conducted by it in 2002. This data should also be included in the assessment of the problem and be used to assist in the identification of bacteria sources to the Charles River.

Response: MassDEP has included its 2002 QA/QC water quality monitoring data for the Charles watershed into the individual summary segment tables in Section 4.0 -Problem Assessment of the report.

15. Comment: The Charles River has been the focus of a major cleanup and water quality improvement efforts by various parties including federal and state regulators, municipalities, private business and institutions, non-profit organizations, and citizens since US EPA- Region 1 established the Clean Charles 2005 Initiative with the goal of a fishable and swimmable lower Charles River by Earth Day 2005. A major component of this initiative is a thorough understanding and assessment of the water quality and sediment quality conditions in the river, making it one of the most studied and widely recognized waterbodies in Massachusetts. CRWA, US EPA, MassDEP, Massachusetts Water Resources Authority (MWRA), municipalities, higher education institutions, and Roger Frymire, City of Cambridge resident and clean water activist, have been collecting samples from the river, tributaries and outfalls for bacteriological analysis over the past ten years.

Despite the large volume of bacteria data available from these groups, the draft pathogen TMDL fails to adequately describe the nature and extent of the bacteriological impairment in the watershed including in-stream and end-of-pipe problems and then identify the sources of the discharges of bacteria from illicit connections, failing septic systems, combined sewer overflows (CSOs), stormwater runoff, and/or other non-point sources of pollution. To describe the pathogen impairment to the Charles River watershed, MassDEP provides only a list of the data available and explicitly states that “since pathogen impairment has been previously established and documented, it is not necessary to provide detailed documentation of pathogen impairment herein (page 15, Section 4.0). It is imperative that MassDEP conduct a more thorough analysis of the water quality information available, for both in-stream and end-of-pipe, and a characterization of the extent and nature of the problem so as to provide specific determinations of the sources contributing to the pathogen impairment, which are necessary for guiding remediation and mitigation efforts to achieve water quality standards. CRWA then recommends that this data be used in conjunction with other Charles River specific-information available, such as land use data, stormwater sewer mapping, municipal information on storm sewer water quality, historical and recent EPA enforcement actions, etc., to identify both the known and possible sources of bacteria. More specific information about the potential sources of bacteria presented in Table 5-1 needs to be provided in this report.

Response: Because of the large volume of data and other information available it is not possible for MassDEP to incorporate all this data directly into the TMDL report. MassDEP has however provided additional language summarizing the findings of many of these reports and included a new section prioritizing segments and known sources for additional action.

MassDEP’s approach is consistent with current EPA guidance and regulations. As stated in the 2002 EPA Wayland/Hanlon memorandum, "WQBELs for NPDES-regulated storm water discharges that implement WLAs in TMDLs may be expressed in the form of best management practices (BMPs) under specified circumstances. See 33 U.S.C. 1342(p)(3)(B)(iii); 40 C.F.R. 122.44(k)(2)&(3)" (Wayland/Hanlon memo, page 2 in Appendix G of the TMDL. This memorandum goes on to state:

> "...because storm water discharges are due to storm events that are highly variable in frequency and duration and are not easily characterized, only in rare cases will it be feasible or appropriate to establish numeric limits for municipal and small construction storm water discharges. The variability in the system and minimal data generally available make it difficult to determine with precision or certainty actual or projected loadings for individual dischargers or groups of dischargers. Therefore, EPA believes that in these situations, permit limits typically can be expressed as BMPs, and that numeric limits will be used only in rare instances" (Wayland, Hanlon memorandum, November 22, 2002, page 4).

The TMDL attempts to be clear on the expectation that BMPs will be used to achieve WQS as stated in the Wayland/Hanlon memorandum: "If it is determined that a BMP approach (including an iterative BMP approach) is appropriate to meet the storm water component of the TMDL, EPA recommends that the TMDL reflect this." (Wayland, Hanlon memorandum, page 5). Consistent with this, the Massachusetts' pathogen TMDLs state that BMPs may be used to meet WQS. The actual WLA and LA for storm water is expressed as a concentration-based/WQS limit, a load, and a percent reduction by segment, which will be used to guide BMP implementation. The attainment of WQS, however, will be assessed through ambient monitoring.

In storm water TMDLs, the issue of whether WQSs will be met is an ongoing issue and can never be answered with 100% assurance. MassDEP believes that the BMP-based, iterative approach for addressing pathogens is appropriate for storm water. Indeed, "[t]he policy outlined in [the Wayland/Hanlon] memorandum affirms the appropriateness of an iterative, adaptive management BMP approach, whereby permits include effluent limits (e.g., a combination of structural and non-structural BMPs) that address storm water discharges, implement mechanisms to evaluate the performance of such controls, and make adjustments (i.e., more stringent controls or specific BMPs) as necessary to protect water quality" (Wayland, Hanlon memorandum, page 5).

The goal to attain water quality standards at the point of discharge is conservative and thus protective, and offers a practical means to identify and evaluate the effectiveness of control measures. In addition, this approach establishes clear objectives that can be easily understood by the public and individuals responsible for monitoring activities.

MassDEP believes that it is difficult to provide accurate quantitative loading estimates of indicator bacteria contributions from the various sources because many of the sources are diffuse and intermittent, and flow is highly variable. Thus, it is extremely difficult to monitor and accurately model. Therefore, "loadings" of bacteria (although provided) are less accurate than a concentration-based approach and do not provide a way to quickly verify if you are achieving the TMDL.

16. Comment: The elevation of the Charles River headwaters is 350 feet above sea level, not 500 feet above sea level (page 7, 1st paragraph).

Response: This correction has been made.

17. Comment: The website link to MA DPH's water quality beaches reports does not work (page 17, 4th paragraph).

Response: This correction has been made.

18. Comment: CRWA's monthly monitoring data for sites 35CS, 35CD, and 35C2 – which are currently listed under Charles River Segment MA72-01 and covers the headwaters to river mile 2.4 – are located at river mile 3.5 and should be placed in Charles River Segment MA72-02 (page 18, Charles River segment MA72-01).

Response: Table 4-5, which contains CRWA's fecal coliform data for sites 35CS, 35CD, and 35C2, has been placed in Charles River Segment MA72-02.

19. Comment: Change the CRWA Site # for 13CS to 130S (page 18, Table 4-6).

Response: This change has been made.

20. Comment: The Charles River Pollution Control District (CRPCD) treats wastewater from four towns, not eight as listed in this report. The four towns are Medway, Franklin, Bellingham and Millis (page 19, Charles River Segment MA72-05).

Response: This change has been made .

21. Comment: The Southwood Community Hospital Wastewater Treatment Facility is now closed (page 20, Stop River Segment MA72-10).

Response: The Southwood Community Hospital Wastewater Treatment Facility has been removed as NPDES discharger on 12/29/03. It has been removed from Stop River Segment MA72-10) summary in the report.

22. Comment: For CRWA's Lower Charles Flagging Program, the site ids corresponding to the descriptions for the four monitoring sites are NBS- North Beacon Street, LARZ – Larz Anderson Bridge, BU- Boston University Bridge, and LONG – Longfellow Bridge. While two flagging sites correspond to CRWA's monthly monitoring sites, the site ids are different for the two monitoring programs (page 27, Charles River Segment MA 72-08).

Response: The correct site ids have been included in Table 4-20: MA72-08 Charles River Fecal Coliform Data Summary.

23. Comment: The implementation plan (previously section 7.0, now section 8.0) should include the following: a timeline for when tasks are completed, description of work being conducted by other communities besides Boston, and MWRA's CSO plan should be presented in the context of the Charles River, not the full service are of MWRA which includes other watersheds.

Response: The timeframe for implementing corrective measures depends highly on the extent and source of the problem within each community, as such, it would be impossible to identify individual timelines within the TMDL. With that said, however, many timelines are established through the implementation of existing programs. For instance, the Phase II stormwater program required all communities to submit an application and plan in 2003. That plan must address the six minimum control measures and establish regulatory mechanisms to implement those measures by 2008. Status reports are developed annually to report their progress on achieving that goal.

MassDEP recognizes that the addition of timelines in the TMDLs would appear to strengthen the documents, however, the complexity of each source coupled with the many types of sources, which vary by municipality, simply does not lend itself to the TMDL framework and therefore must be achieved through other programmatic measures including but not limited to regulatory enforcement actions.

<u>Comments of Andrea C. Rex, Ph.D, MWRA</u>

24. Comment: MWRA is particularly concerned because it and its member communities have CSO discharges to the Charles River, which cannot meet the CSO TMDL requirements without a water quality standard change or a water quality variance. MWRA's long-term CSO control plan was predicated on receiving a water quality variance until 2020. Also, the discharges must be permitted through 2020. Footnote 4 should add "or a water quality standards variance for the discharge" at the end of the sentence.

Response: According to federal regulations the TMDL must identify what needs to be done to meet water quality standards. Those Standards as well as the permitting regulations provide provisions and procedures for variances and standard revisions where appropriate and applicable. Development of this TMDL does not remove those procedures from consideration.

25. Comment: The description of the monitoring plan (section 8, now section 9) is slim. It mentions MassDEP's five-year water quality monitoring, but there is no reference to a monitoring plan in the reference section, and no monitoring plan or Quality Assurance Project Plan for the Charles River Watershed is available on MassDEP's web site. There doesn't appear to be a MassDEP overall plan (apart from CRWA and MWRA) for monitoring water quality in the Charles River watershed in order to either detect the relative importance of sources or to measure the effectiveness of TMDL implementation. This is crucial, as the TMDL emphasizes the difficulties of knowing the sources of pathogen contamination. EPA's protocol for developing pathogen TMDLs emphasizes that the more uncertainty exists about the source of a pollutant, the more monitoring should be done.

Response: The specific details of MassDEP's monitoring plan need to be worked out separately from the TMDL. MassDEP conducts ambient monitoring of all watersheds on a five-year cycle. At that time the specific monitoring goals and details and the development of QAPP's will take place. MassDEP recognizes that additional source tracking and identification also needs to be conducted to identify and eliminate currently unknown sources. Doing so will require the resources of many including the State, MWRA, and local groups such as CRWA and the Cities and Towns. Recognizing these needs MassDEP has also developed and piloted a bacteria source-tracking program and we are presently in the process of hiring regional monitoring coordinators who will be able to conduct this kind of work and help train local groups to do the same.

26. Comment: An updated version of Figure 1, CSO Location map, will be provided by MWRA.

Response: Thank you. The CSO map has been provided in Appendix A. Appendix A also provides links to other MWRA CSO data and information.

27. Comment: Table 7-2 Please change:

- 1992-2000 Phase 2 "Upgrade CSO treatment facilities" to "system optimization plans"
- 1996-2008 to "1996 – 2015"
- Screening/disinfection/dechlorination for Fort Point Channel (not Reserved Channel)"

Response: These suggested changes have been made.