

DRAFT *Technical Memorandum*
Northeast Region Bacteria Source Tracking
2008 Results

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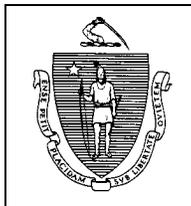


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Appendices

- Appendix A:** MassDEP Wall Experiment Station Human Marker and *Enterococcus* spp. Results
- Appendix B:** 2008 Precipitation Data
- Appendix C:** Site ID Key
- Appendix D:** Landuse Analysis
- Appendix E:** Measures L, Y, and W

EXECUTIVE SUMMARY

The year 2008 marks the second year since the Bacteria Source Tracking (BST) program has been established at MassDEP's Northeast Regional Office (NERO). The goal of the program is to improve the water quality of pathogen impaired water bodies by locating sources of bacteria pollution and recommending appropriate remediation actions. In 2007 a laboratory was built in the NERO office space, facilitating in-house bacteria concentration quantification and use of several supplementary analytical techniques.

Over 300 samples were collected between April and November 2008 and analyzed for *E. coli* (freshwater conditions) or *Enterococcus* spp. concentrations (generally brackish/saline conditions, but sometimes *Enterococcus* spp. was analyzed in freshwater situations to ease logistical concerns). Screening methods, such as ammonia and chlorine test strips, optical brightener pads, and detergents kits, were used at a smaller number of sites to further identify human or non-human sources of bacteria contamination. The MassDEP Wall Experiment Station also analyzed 25 samples for a suite of "human marker" analytes. Samples were collected in twenty-five NERO municipalities in 9 different watersheds, ranging from small stream segments to specific storm drain outfall pipes. Based on the sampling data collected, a number of "hot spots" were identified, which warranted further MassDEP actions.

Of particular note among hot spots identified in 2008:

- A sample containing an *E. coli* concentration of 24,196 Most Probable Number (MPN) per 100 milliliters (mL) was collected from a stormwater pipe discharging near Constitution Beach in Boston.
- Samples containing *E. coli* concentrations as high as more than 241,000 MPN/100mL were collected from two stormwater pipes discharging to Ell Pond in Melrose.
- Samples containing *Enterococcus* spp. concentrations up to more than 11,000 MPN/100mL were collected from a stormwater pipe that is a former Combined Sewer Overflow (CSO) outfall and discharges near Tenean Beach in Boston.
- Samples containing *E. coli* concentrations up to nearly 13,000 MPN/100mL were collected from a stormwater pipe discharging to Leverett Pond (part of the Muddy River system) in Boston.
- Instream samples containing *Enterococcus* spp. concentrations of up to approximately 1,600 MPN/100mL were collected from Kimball Brook in Ipswich.
- Samples containing *Enterococcus* spp. concentrations in excess of 14,000 MPN/100mL were collected from a stormwater pipe discharging to the Powwow River in Amesbury.
- Samples containing *E. coli* concentrations up to more than 15,000 MPN/100mL were collected from a stormwater pipe which is owned by Lawrence General Hospital and discharges to the Spickett River.

- A sample containing an *Enterococcus* spp. concentration greater than 3,300 MPN/100mL was collected from a stormwater pipe discharging to the North River in Salem.

MassDEP utilized a range of response and enforcement actions, based on the severity of the violations, the identification of specific (pipe) sources, and the sensitivity of the water resource affected. Actions include two Notices of Noncompliance (“NON”), two “Section 303” requests for information, and emails to a municipality requesting updates on Illicit Discharge Detection and Elimination work. Each NON and Section 303 request included requirements for the municipality to provide maps of the storm drain and sewer systems, and a detailed plan to identify and eliminate any illegal wastewater connections to the storm drain system. Based on past experience, it is anticipated that it will take some time before municipal efforts to locate wastewater sources in the storm drain system are completed. NERO BST staff will continue to track progress of such efforts and conduct follow-up sampling when appropriate.

DISCLAIMER

References to trade names, commercial products, manufacturers, or distributors in this report constitute neither endorsement nor recommendations by MassDEP for use.

ACKNOWLEDGEMENTS

Data and information used during the 2008 field season of NERO's Bacteria Source Tracking program were provided in part by the following agencies and organizations:

Local

- Boston Water and Sewer Commission
- Roger Frymire, Cambridge citizen

State

- Massachusetts Department of Environmental Protection (MassDEP):
 - Division of Watershed Management (DWM)
 - Bureau of Resource Protection
 - Wall Experiment Station
- Massachusetts Department of Public Health (MDPH)
- Massachusetts Office of Coastal Zone Management

Federal

- United States Environmental Protection Agency (EPA)

Regional

- Charles River Watershed Association (CRWA)
- Ipswich River Watershed Association (IRWA)
- Merrimack River Watershed Council (MRWC)
- Mystic River Watershed Association (MyRWA)
- Neponset River Watershed Association (NepRWA)
- Salem Sound Coastwatch (SSCW)
- Shawsheen River Watershed Association (SRWA)
- University of Massachusetts - Boston

The field investigation, sampling, and analyses for the 2008 BST program were carried out by Jenny Birnbaum and Katie Zink, with support provided by staff from the NERO Wastewater Management section and Division of Watershed Management.

1.0 INTRODUCTION

A large number of Massachusetts waters appear on the State's 303(d) list of impaired water bodies due to violations of the water quality standards for bacteria (pathogens). Previous monitoring plans developed by the Division of Watershed Management (DWM) to evaluate surface water quality conditions in Massachusetts addressed a number of parameters, and were not designed to identify specific locations of sources of bacterial contamination or to implement remediation actions. To begin to rectify this situation, a Bacteria Source Tracking (BST) program has been initiated in the MassDEP northeast region ("NERO"), hereafter known as the "NERO BST program".

This year (2008) marks the second year of the NERO BST program. The overall goal of this program is to improve the water quality of rivers, streams, and tidal areas in the northeast region that are impaired due to bacterial contamination. Steps toward achieving this goal were made by locating sources of bacteria contamination within targeted sub-watersheds and recommending appropriate action to initiate remediation. A secondary goal of this program was to focus on sensitive use areas, such as public swimming beaches.

The main objectives of the NERO BST program in 2008 were as follows:

1. Identify watersheds in the northeast region with documented water quality impairment due to elevated bacteria;
2. Prioritize watersheds on which to perform source tracking (with an emphasis on EPA measure L, Y or W segments- see Appendix E for more information);
3. Conduct screening level sampling for *E. coli* (freshwater) and Enterococci (brackish/saline water) in "targeted" watersheds, during dry weather conditions;
4. Review data from screening level (core) sites and the information collected during extensive watershed characterization. Refine sampling plan and implement iterative source tracking sampling using various techniques such as Colilert® (*E. coli*), Enterolert™ (*Enterococcus* spp.), optical brighteners, detergents, human marker analysis, and further field observation;
5. Identify sources of bacteria to MassDEP jurisdictional level;
6. Notify appropriate authorities of the suspected source(s);
7. Recommend appropriate action (e.g. further source tracking work, immediate clean up, municipal or MassDEP enforcement) to initiate remediation and coordinate with local authorities as needed.

One "targeted" sub-watershed from each basin in the northeast region was initially selected to undergo screening level sampling. These basins were: Boston Harbor (Mystic, Neponset, Weymouth & Weir), Charles, Shawsheen, SuAsCo, North Coastal, Merrimack, Ipswich, and Parker (see Figure 1). Additional sub-watersheds in most basins were sampled. This report summarizes results of sampling conducted April through November 2008.

Figure 1. 2008 Targeted Bacteria Source Tracking Basins



2.0 METHODS

Bacteria source tracking requires a well-defined set of protocols to direct activities, due to the high variability of bacteria concentrations in rivers and streams and the potential for the misinterpretation of results due to multiple bacteria sources. The recommended bacteria source tracking protocols used for the NERO BST program in 2008 are encompassed into a sampling process design which includes: 1) Identification, characterization and prioritization of contaminated watersheds, 2) screening level sampling and 3) source tracking monitoring. This design is fully described in *Bacteria Source Tracking in the Northeast Region, Sampling Analysis Plan 2008* (MassDEP 2008). The foundations of this design are based on the DWM Bacteria Source Tracking “Toolbox” and lessons learned during the 2004 Bacteria Source Tracking Pilot Study (MassDEP 2005a and MassDEP 2004).

The fundamental methodology used to track bacteria sources involved the initial collection of water samples from selected river/stream sites and other sources (such as stormwater outfall pipes) using procedures described in *CN 1.21 - Sampling Collection Techniques for DWM Surface Water Quality Monitoring* (MassDEP 2005b) or *CN 1.5 – Stormwater Monitoring* (MassDEP 2005c).

These water samples were then analyzed in the NERO BST lab for total coliform and *Escherichia coli* (*E. coli*), or *Enterococcus* spp. using procedures described in *CN 198.0 - Analytical Quantification of Escherichia coli and Enterococci Bacteria in Ambient Surface Waters Using an Enzyme Substrate Test (Standard Methods 9223B)* (MassDEP 2006 as modified by NERO staff). These enzyme substrate tests, known as Colilert® and Enterolert™, can produce results in 18 to 24 hours. The rapid generation of results allowed for a quick focus or redirection of tracking activities.

Other components of the “Toolbox” were used to surmise whether a specific bacteria source is human or non-human. For example, optical brightener pads were deployed in special cages using procedures described in *CN 58.0 – DWM Sampling Protocol for Optical Brightener Testing* (MassDEP 2005d). Optical brightener pads were used at select sites to determine if laundry detergents (an indicator of human waste) were present in the water. Some water samples were also analyzed for ammonia, detergents, and/or chlorine using various screening methods. In addition, the William X. Wall Experiment Station (WES) in Lawrence conducted Human Marker analyses (i.e., DNA by polymerase chain reaction techniques, caffeine, and fluorescent whitening agents) on a limited number of samples. Data on 2008 Human Marker results may be found in Appendix A.

Additional information regarding field and laboratory methods, method and reporting detection limits, data quality objectives, and data validation can be found in *Quality Assurance Program Plan, Surface Water Monitoring & Assessment, 2005-2009* (MassDEP 2005a).

3.0 Site Descriptions, Results, and Significant Findings

In order to make this report as user friendly as possible, sites have been grouped into sub-watersheds or relevant areas and organized by sub-basin. In all tables, multiple sites in a water body are generally arranged downstream (DS) to upstream (US). Sub-watershed descriptions, including a map depicting site locations, are followed by results, significant findings, and recommended follow-up actions for each sub-watershed or relevant area. Data on antecedent rainfall may be found in Appendix B. The precipitation conditions for five days prior to sampling were determined by reviewing the National Oceanographic and Atmospheric Administration's (NOAA) data from their website (NOAA 2008). In rare instances, National Weather Station precipitation data was retrieved from the Plymouth State University website (PSU 2008). Sampling dates were considered wet weather if they did not meet dry weather conditions (dates that follow a minimum of 3 days with less than 0.1 inches of rain) and are shaded in tables in the body of the report and in Appendix B. Detailed site descriptions, including geographical coordinates, may be found in Appendix C.

3.1 BOSTON HARBOR - MYSTIC

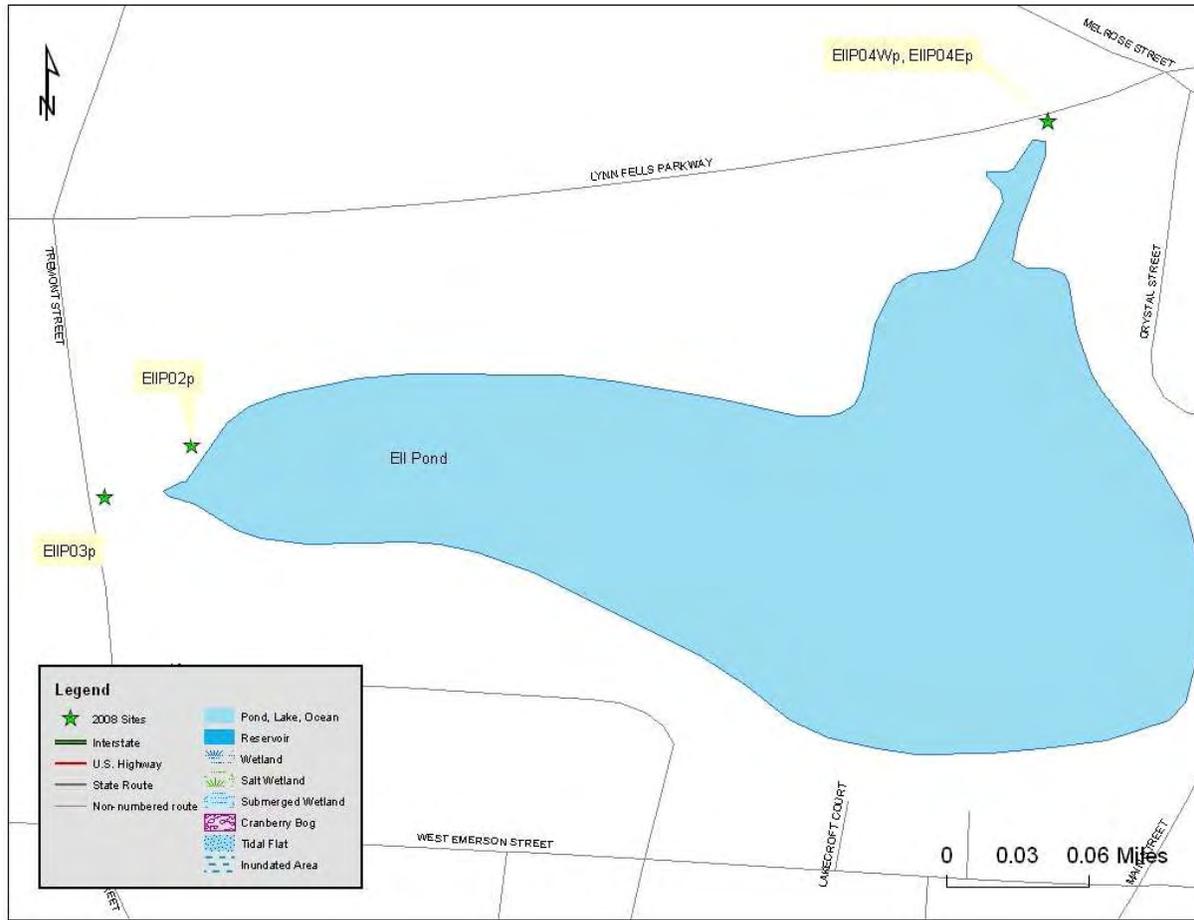
Ell Pond (Melrose)

Sampling locations were chosen based on historical data from the Mystic River Watershed Association.

Sub-watershed Description

- Ell Pond is located in Melrose. It receives some baseflow from historical streams which combine with stormwater and discharge through outfalls on the North and West sides. The outflow from the pond forms Spot and Ell Pond Brook, which flows underground for a time and becomes the Malden River, a major tributary of the Mystic River.
- The sub-watershed is urban, with mixed residential and commercial use.
- Ell Pond is listed as impaired for pathogens on the 2006 303(d) list.
- Melrose is a NPDES Phase II community, with 100% of the population connected to the sewer system.

Figure 2. 2008 Bacteria Source Tracking Sites in the Ell Pond Sub-watershed



Results

Table 1. *E. coli* (EC) Concentrations (MPN/100mL) in the Ell Pond Sub-watershed

Site ID	Type	Water Body	Town	6/03/2008 (EC)	7/16/2008 (EC)
EIIP02p	pipe	Ell Pond	Melrose	>241,960	1,529
EIIP03p	pipe	Ell Pond	Melrose	1,153	>24,196
EIIP04Wp	pipe	Ell Pond	Melrose	158	201
EIIP04Ep	pipe	Ell Pond	Melrose	110	199

☐ = wet weather conditions

Significant Findings

- Sampling in the Ell Pond sub-watershed revealed significantly elevated bacteria concentrations at two stormwater outfalls (EIIP02p and EIIP03p).
- Optical brightener screening indicated EIIP02p and EIIP03p are sources of washwater to the pond, and screening of ammonia with test strips suggested the ammonia concentration

at EllP02p was 1 ppm on one occasion, providing further evidence of a potential human bacteria source.

- **Actions to be taken:** 1) Conduct site inspection of key junction stormdrain manholes with representatives from the City of Melrose 2) Review and comment on plans submitted by the City to investigate elevated bacteria levels and meet with City staff as appropriate.

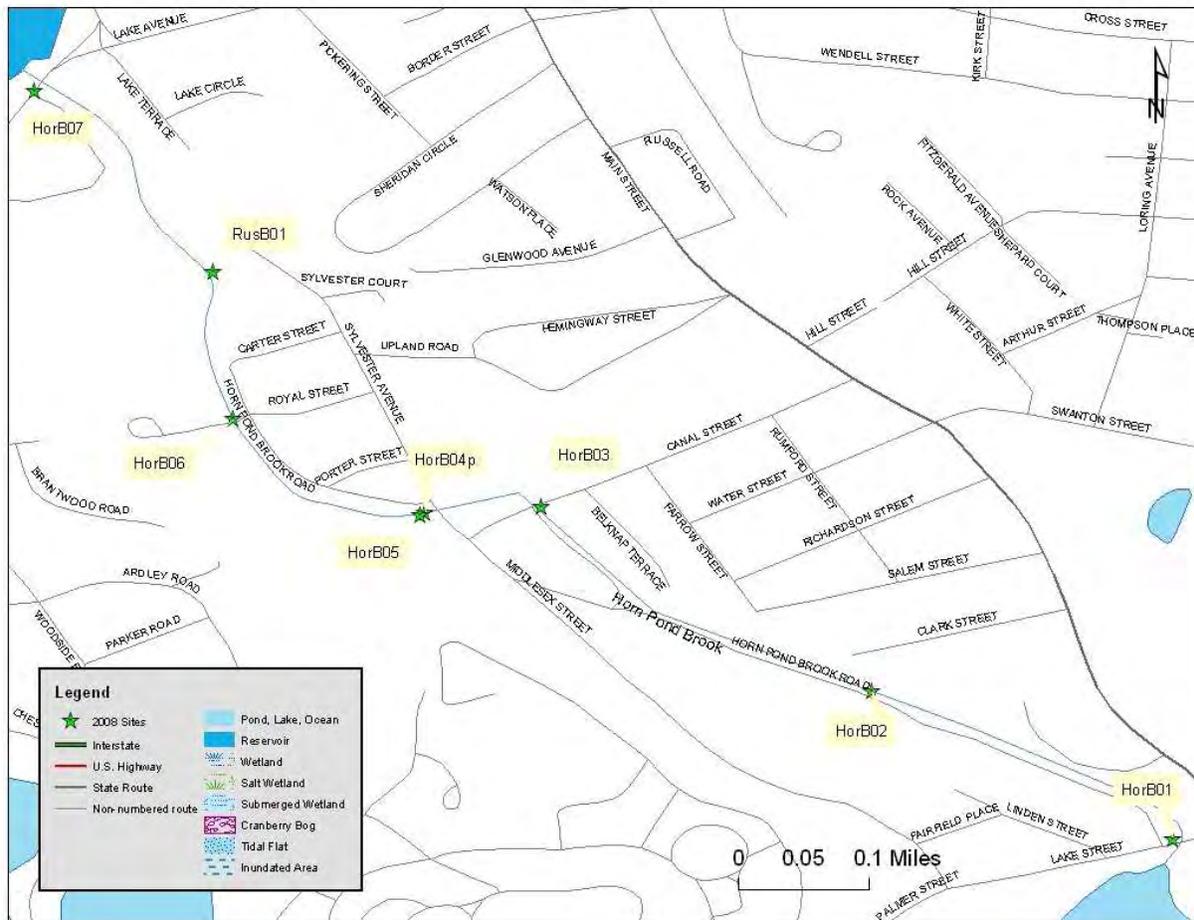
Horn Pond Brook (Winchester/Woburn)

Some sampling locations were chosen based on historical data from the Mystic River Watershed Association (MyRWA). A stream walk was coordinated with MyRWA staff, during which several of the sampling locations were chosen.

Sub-watershed Description

- Horn Pond Brook originates on the South side of Horn Pond in Woburn, and flows through Winchester into Wedge Pond, before joining the Aberjona River just downstream.
- The Horn Pond Brook sub-watershed is 10.0 square miles in area.
- Landuse in the Horn Pond Brook sub-watershed is characterized as follows: Residential 47%, Forest 25%, Commercial 13%, Water Resources 8%, Open Space 5%, Other 2%.
- The sub-watershed is mainly residential with some open space (cemetery), and the Town's DPW yard abuts the brook.
- Winchester and Woburn are NPDES Phase II communities. The Town of Winchester is 90% sewerred and 10% septic, while the City of Woburn is 100% sewerred.

Figure 3. 2008 Bacteria Source Tracking Sites in the Horn Pond Brook Sub-watershed



Results

Table 2. *E. coli* (EC) and *Enterococcus* spp. Concentrations (MPN/100mL) in the Horn Pond Brook Sub-watershed

Site ID	Type	Water Body	Town	6/03/2008 (EC)	7/16/2008 (EC)	8/18/2008 (ENT)
HorB01	stream	Horn Pond Brook	Winchester	556	1,860	52.1
HorB02	stream	Horn Pond Brook	Winchester	754	3,873	31
HorB03	stream	Horn Pond Brook	Winchester	266	3,448	63
HorB04p	pipe	Horn Pond Brook	Winchester	20	ns	ns
HorB05	stream	Horn Pond Brook	Winchester	185	4,106	31
HorB06	stream	Horn Pond Brook	Winchester	52	657	<10

Site ID	Type	Water Body	Town	6/03/2008 (EC)	7/16/2008 (EC)	8/18/2008 (ENT)
RusB01	stream	Russell Brook	Winchester	20	441	213
HorB07	stream	Horn Pond Brook	Woburn	52	52	2
ns = not sampled						

 = wet weather conditions

Significant Findings

- HorB04p was an outfall with a slight amount of dry weather flow that was identified during the stream walk. There was no flow on two of the sampling dates, so it could not be sampled.
- Bacteria concentration was significantly elevated at several instream sites (HorB02, HorB03, HorB05) in the Horn Pond Brook sub-watershed on a dry weather date, but was not elevated on a marginally wet weather date (June 3) or on a third date.
- Human Marker sampling (Appendix A) conducted at three of the sites indicated there was no evidence of a human bacteria source at HorB03 and HorB05, and that there was inconclusive evidence at the mouth of Russell Brook (RusB01), a tributary to Horn Pond Brook.
- **Actions to be taken: 1)** Communicate results to MyRWA and request results of any follow-up sampling conducted by MyRWA.

Mystic River and Alewife Brook pipes (Somerville/Arlington), Junction Brook (Belmont) and Constitution Beach pipe (Boston)

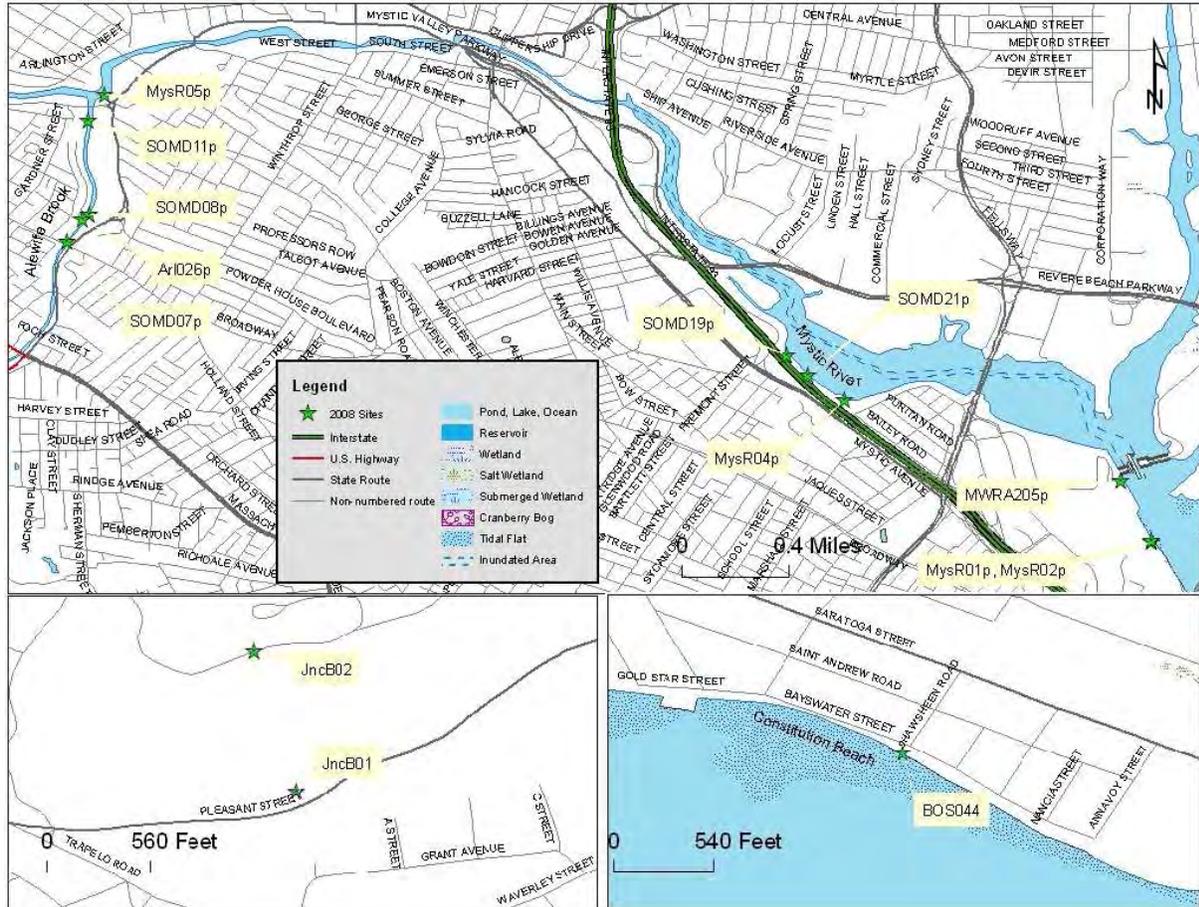
Most of these sites were originally sampled in 2007 and were chosen for follow-up sampling. In 2007, the Mystic River and Alewife Brook sites were chosen based on historical data from the Mystic River Watershed Association (MyRWA). The Junction Brook sites were sampled in 2008 due to data from MyRWA. The Constitution Beach site was sampled during an educational demonstration to students from the Missionworks Harbor and Neighborhood of Affordable Housing high school crews of East Boston.

Sub-watershed Description

- Alewife Brook is a tributary of the Mystic River. Junction Brook forms part of the headwaters of Wellington Brook (which flows through a series of ponds and into the Little River, which becomes Alewife Brook). The Constitution Beach area flows directly into Boston Harbor.
- The Alewife Brook sub-watershed is 8.9 square miles in area and the Mystic River watershed (which includes Alewife Brook) upstream of MysR01p is 63 square miles.
- The study areas are mainly very urban, with mixed high density residential and commercial use. The Junction Brook sites are located in an undeveloped parcel downstream of the McLean property. The Mystic River is dammed upstream of MWRA205p.

- The Alewife Brook and Mystic River watersheds, and the Boston Harbor are listed as impaired for pathogens on the 2006 303(d) list.
- The City of Boston is a NPDES Phase I community, while Somerville, Arlington, and Belmont are NPDES Phase II communities. All four communities are 100% sewered.

Figure 4. 2008 Bacteria Source Tracking Sites in the Mystic River, Alewife Brook, and Junction Brook Sub-watersheds, and at a Site Near Constitution Beach



Results

Table 3. *E. coli* (EC) and *Enterococcus* spp. (ENT) Concentrations (MPN/100mL) in the Mystic River, Alewife Brook, Junction Brook, and a Pipe Near Constitution Beach

Site ID	Type	Water Body	Town	7/01/2008 (EC)	7/29/2008 (EC)	7/31/2008 (EC)	9/24/2008 (ENT)
JncB01	stream	Junction Brook	Belmont	327	ns	399	ns
JncB02	stream	Junction Brook	Belmont	ns	ns	132	ns
BOS044p	pipe	Boston Harbor	Boston	ns	24,196	ns	ns
MysR01p	pipe	Mystic River	Somerville	ns	ns	ns	10
MysR02p	pipe	Mystic River	Somerville	ns	ns	ns	<10

Site ID	Type	Water Body	Town	7/01/2008 (EC)	7/29/2008 (EC)	7/31/2008 (EC)	9/24/2008 (ENT)
MWRA205p	pipe	Mystic River	Somerville	ns	ns	ns	10
MysR04p	pipe	Mystic River	Somerville	ns	ns	ns	213
SOMD21p	pipe	Mystic River	Somerville	ns	ns	ns	56.3
SOMD19p	pipe	Mystic River	Somerville	ns	ns	ns	116.2
MysR05p	pipe	Mystic River	Somerville	ns	ns	ns	3.1
SOMD11p	pipe	Alewife Brook	Somerville	ns	ns	ns	7.5
SOMD08p	pipe	Alewife Brook	Somerville	ns	ns	ns	41
Arl026p	pipe	Alewife Brook	Arlington	ns	ns	ns	201.4
SOMD07p	pipe	Alewife Brook	Somerville	ns	ns	ns	11

ns = not sampled

 = wet weather conditions

Significant Findings

- None of the samples collected from sites on Junction Brook, the Mystic River, or Alewife Brook yielded significantly elevated bacteria concentrations.
- MysR05p was sampled as a follow-up site from 2007, at which time, toilet paper and a chlorine odor were noted. A sample collected on January 7, 2008 and analyzed for residual chlorine (by MassDEP’s Wall Experiment Station) had a chlorine concentration of 1.8 mg/L. The MWRA was contacted and staff identified a leak in a drinking water main in the area of the stormwater outfall. The leak was repaired. During follow-up sampling in September, 2008, a low bacteria concentration was measured, but an elevated detergents concentration of >3 ppm was measured with a screening kit.
- A sample collected from the stormwater outfall (BOS044p) discharging to Boston Harbor near Constitution Beach contained a significantly elevated bacteria concentration. Additionally, screening of ammonia with test strips suggested the ammonia concentration at BOS044p was 1-3 ppm and screening of detergents with a field kit suggested the detergents concentration was 1-1.5 ppm, providing further evidence of a potential human bacteria source.
- **Actions to be taken:** 1) Work with NERO wastewater staff to review and comment on plans submitted by the City of Somerville to investigate illicit discharges to the MysR05p outfall and meet with City staff as appropriate 2) Review and comment on plans submitted by Boston Water and Sewer Commission (BWSC) to investigate elevated bacteria concentrations in the BOS044p drainage and meet with BWSC staff as appropriate.

3.2 BOSTON HARBOR - NEPONSET

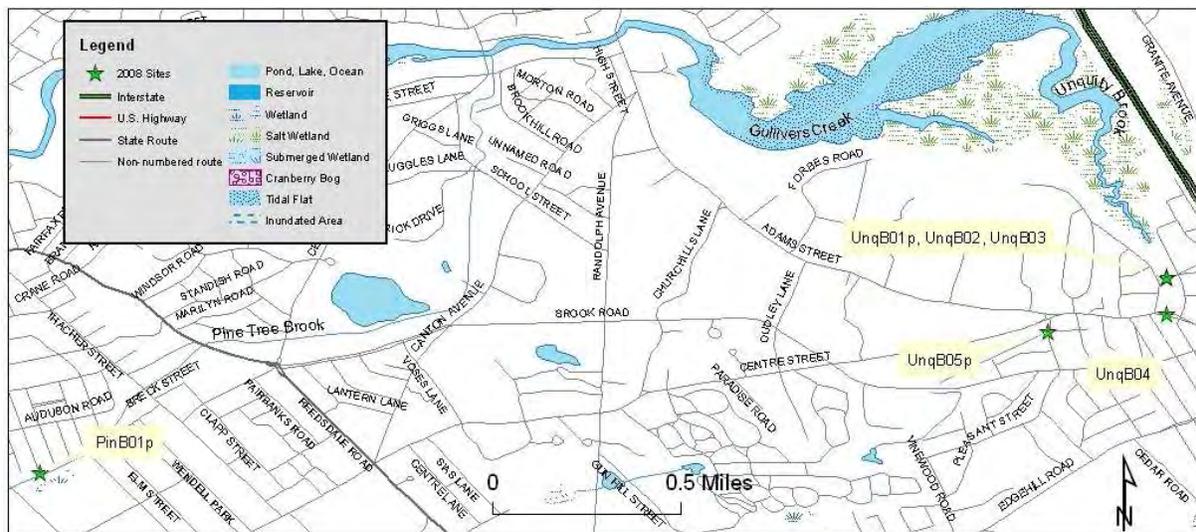
Unquity Brook and Pine Tree Brook (Milton)

These sites were originally sampled in 2007 and were chosen for follow-up sampling. Some sampling locations were chosen based on recommendations from the Neponset River Watershed Association.

Sub-watershed Description

- Pine Tree Brook is a tributary of the Neponset River, while Unquity Brook becomes Gullivers Creek, another tributary of the Neponset River.
- The Pine Tree Brook sub-watershed is 7.6 square miles in area and the Unquity Brook sub-watershed is 1.4 square miles.
- Landuse in the Pine Tree Brook sub-watershed is characterized as follows: Forest 46%, Residential 42%, Other 7%, Open Space 4%, Wetland 1%
- Landuse in the Unquity Brook sub-watershed is characterized as follows: Residential 68%, Open Space 16%, Forest 13%, Commercial 2%, Other 1%
- The section of the sub-watersheds near the study sites is generally residential. Unquity Brook is culverted underground at multiple locations.
- Pine Tree Brook and Unquity Brook are listed as impaired for pathogens on the 2006 303(d) list.
- The Town of Milton is a NPDES Phase II community, with 92% of the population on the sewer system and 8% on septic systems.

Figure 5. 2008 Bacteria Source Tracking Sites in the Unquity Brook and Pine Tree Brook Sub-watersheds



Results

Table 4. *Enterococcus* spp. (ENT) Concentrations (MPN/100mL) in the Unquity Brook and Pine Tree Brook Sub-watersheds

Site ID	Type	Water Body	Town	8/27/2008 (ENT)
PinB01p	pipe	Pine Tree Brook	Milton	54.4 ^j
UnqB01p	pipe	Unquity Brook	Milton	8.4 ^j
UnqB02	stream	Unquity Brook	Milton	97 ^j
UnqB03	stream	Unquity Brook	Milton	172.2 ^j
UnqB04	stream	Unquity Brook	Milton	172.3
UnqB05p	pipe	Unquity Brook	Milton	27.2

ns = not sampled, ^j = estimated value due to incubator temperature outside the acceptable range

Significant Findings

- None of the samples collected in Unquity Brook or Pine Tree Brook had elevated bacteria concentrations.
- **Actions to be taken: 1)** Communicate results to the Neponset River Watershed Association (NepRWA) and request results of any follow-up sampling conducted by NepRWA.

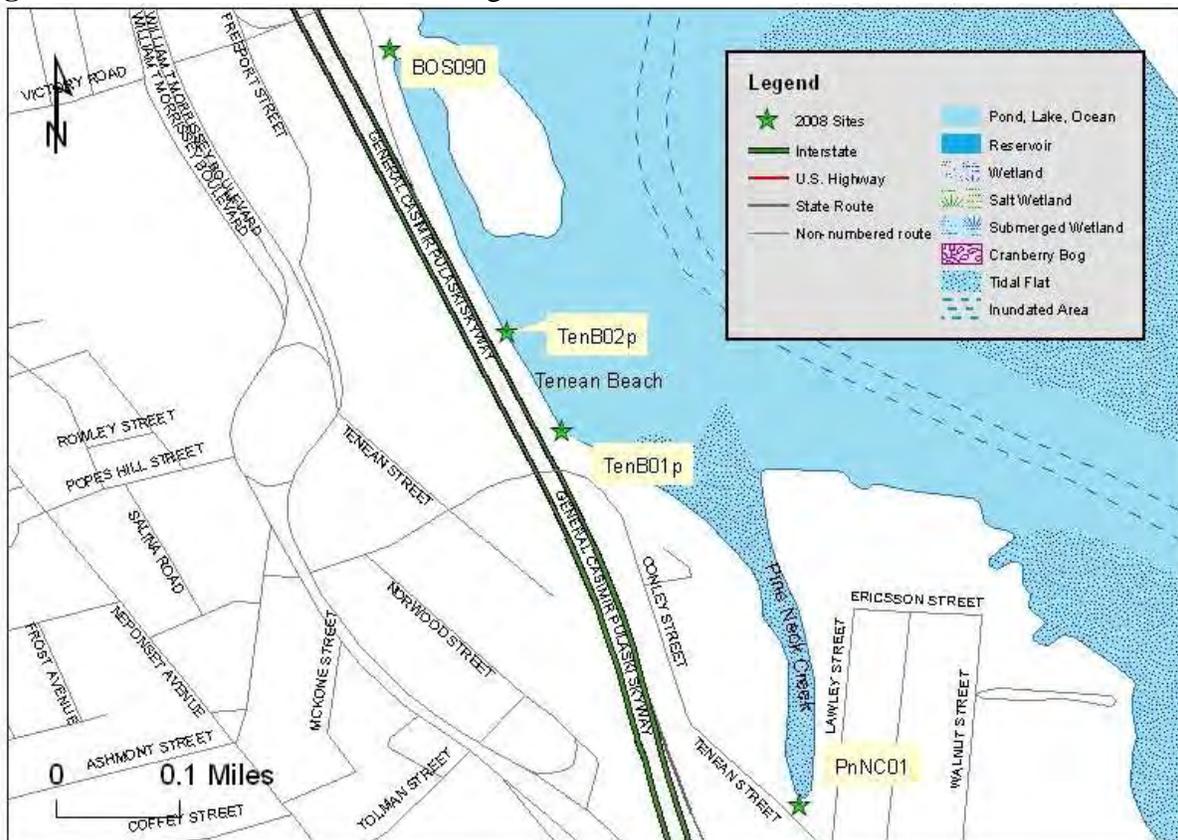
Tenean Beach (Boston)

Sampling locations were chosen based on data in the *Pine Neck Creek Water Quality Assessment Improvement Project* (BWSC 2006).

Sub-watershed Description

- Tenean Beach is located near the mouth of the Neponset River
- This section of the watershed is urban, with mixed residential and commercial use.
- Pine Neck Creek is not listed as a segment in the 2006 303(d) list, but this section of the Neponset River is listed as impaired for pathogens.
- Boston is a NPDES Phase I community and is 100% sewered.

Figure 6. 2008 Bacteria Source Tracking Sites Near Tenean Beach



Results

Table 5. *Enterococcus* spp. (ENT) Concentrations (MPN/100mL) at Tenean Beach Sites

Site ID	Type	Water Body	Town	7/22/2008 (ENT)	8/27/2008 (ENT)	10/20/2008 (ENT)
BOS090p	pipe	Neponset River	Boston	11,199 ^d	591	6,498.5
TenB01p	pipe	Neponset River	Boston	231 ^d	63	345.5
TenB02p	pipe	Neponset River	Boston	ns	839	416.5
PnNC01	stream	Pine Neck Creek	Boston	1,658 ^d	62	ns

ns = not sampled, ^d = precision of field or laboratory duplicates did not meet data quality objectives

 = wet weather conditions

Significant Findings

- Samples collected from a stormwater outfall (BOS090p) that was formerly a Combined Sewer Overflow contained elevated *Enterococcus* spp. concentrations.
- Human Marker sampling (Appendix A) conducted at BOS090p in November indicated there was strong evidence of a human bacteria source, and the *Enterococcus* spp. concentration was more than 3,300 cfu/100mL at the time.
- Although the bacteria concentration in a sample collected at the mouth of Pine Neck Creek in July was elevated, the water velocity was very low at the time.
- **Actions to be taken: 1)** Review and comment on plans submitted by Boston Water and Sewer Commission (BWSC) to investigate elevated bacteria concentrations in the BOS090p drainage and meet with BWSC staff as appropriate.

3.3 BOSTON HARBOR – WEYMOUTH & WEIR

Wollaston Beach (Quincy)

Sampling locations were chosen based on data in the Massachusetts Department of Public Health's *Draft Sanitary Survey of Wollaston Beach* (MADPH 2007).

Sub-watershed Description

- A number of stormwater outfalls belonging to the City of Quincy discharge directly to Wollaston Beach.
- This part of the watershed is generally residential with a small amount of open space near the southeast end of the beach.
- Quincy Bay is listed as impaired for pathogens on the 2006 303(d) list.
- The City of Quincy is a NPDES Phase II community, with 100% of the population connected to the sewer system.

Figure 7. 2008 Bacteria Source Tracking Sites at Wollaston Beach



Results

Table 6. *Enterococcus* spp. (ENT) Concentrations (MPN/100mL) at Wollaston Beach Sites

Site ID	Type	Water Body	Town	6/26/2008 (ENT)	8/21/2008 (ENT)
WolB01p	pipe	Wollaston Beach	Quincy	20	31 ^J
WolB04p	pipe	Wollaston Beach	Quincy	281	<10 ^J
WolB05p	pipe	Wollaston Beach	Quincy	109	<10 ^J
WolB10p	pipe	Wollaston Beach	Quincy	63	31 ^J
WolB20p	pipe	Wollaston Beach	Quincy	3,654	199 ^J
WolB21p	pipe	Wollaston Beach	Quincy	20	52 ^J

^J = estimated value due to incubator temperature outside the acceptable range

= wet weather conditions

Significant Findings

- A sample collected from the Sachem Street outfall (WolB20p) had a significantly elevated bacteria concentration in wet weather, but not in dry weather.
- **Actions to be taken:** 1) Follow-up sampling will be conducted during warmer dry weather in 2009 if time permits.

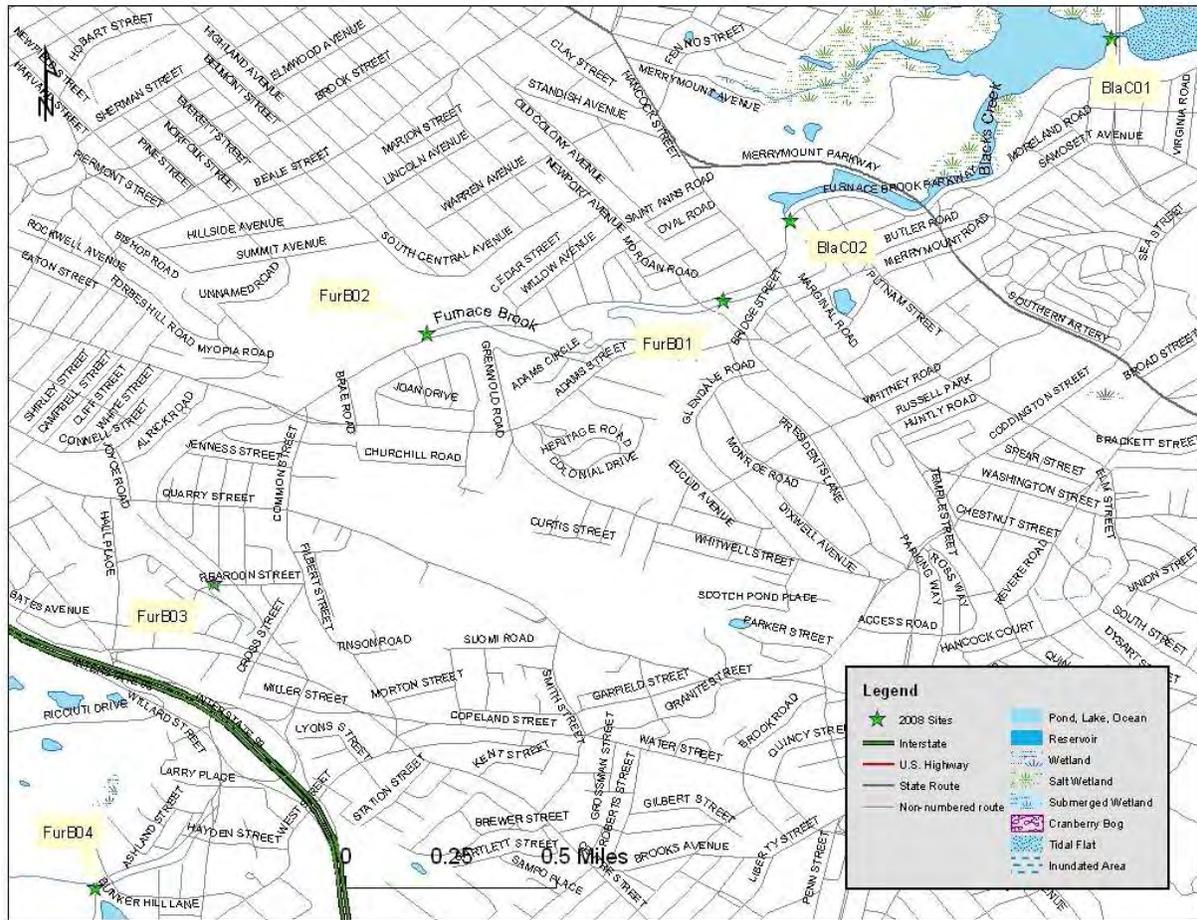
Blacks Creek and Furnace Brook (Quincy)

These sites were chosen because Blacks Creek flows into Quincy Bay (a pathogen impaired segment) relatively close to Wollaston Beach. Some sampling locations were chosen based on data provided by a University of Massachusetts – Boston researcher (Yasuda 2008).

Sub-watershed Description

- Furnace Brook originates in the Blue Hills Reservation and becomes the tidally influenced Blacks Creek downstream of study site BlaC02.
- The combined Furnace Brook and Blacks Creek sub-watershed is 4.6 square miles in area.
- Landuse in the combined Furnace Brook and Blacks Creek sub-watershed is characterized as follows: Residential 41%, Forest 28%, Commercial 12%, Open Space 11%, Water Resources 9%, Other 0.4%.
- Most of the sub-watershed near the study sites is generally residential with some open space and a small amount of commercial businesses. Furnace Brook is culverted underground upstream of Quarry Street and daylights near the Bernazzani Elementary School.
- The City of Quincy is a NPDES Phase II community, with 100% of the population connected to the sewer system.

Figure 8. 2008 Bacteria Source Tracking Sites in the Blacks Creek and Furnace Brook Sub-watersheds



Results

Table 7. *Enterococcus* spp. (ENT) Concentrations (MPN/100mL) in the Blacks Creek and Furnace Brook Sub-watersheds

Site ID	Type	Water Body	Town	6/26/2008 (ENT)	8/21/2008 (ENT)	10/20/2008 (ENT)
BlaC01	stream	Blacks Creek	Quincy	10	10 ^j	325.5
BlaC02	stream	Blacks Creek	Quincy	908	52 ^j	248.1
FurB01	stream	Furnace Brook	Quincy	336	97 ^j	77.1
FurB02	stream	Furnace Brook	Quincy	98	97 ^j	29.2
FurB03	stream	Furnace Brook	Quincy	591	121 ^j	119.8
FurB04	stream	Furnace Brook	Quincy	31	<10 ^j	4.1

^j = estimated value due to incubator temperature outside the acceptable range

= wet weather conditions

Significant Findings

- None of the samples collected in Furnace Brook or Blacks Creek had significantly elevated bacteria concentrations.
- **Actions to be taken:** 1) No actions are planned at this time.

3.4 CHARLES

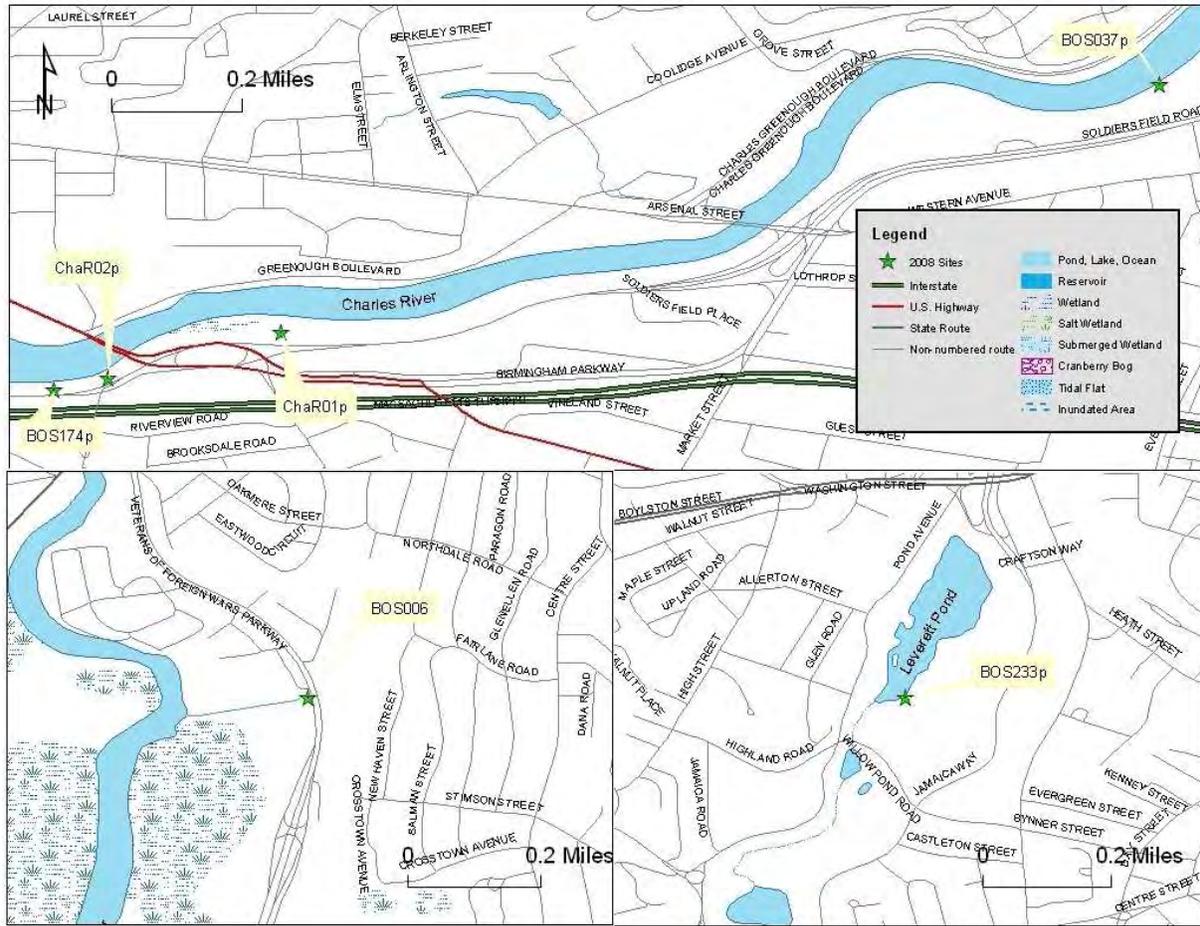
Charles River (Boston)

Sites were chosen based on historical data collected by a Charles River Watershed Association volunteer.

Sub-watershed Description

- Stormdrain outfalls discharging to the Charles River and several tributaries were sampled.
- The parts of the Charles River watershed where sampling occurred are generally very urban, with mixed residential and commercial use. The Leverett Pond site (BOS233p) is located in a residential area in the Emerald Necklace parklands.
- Both the Charles River segments and the Muddy River segment (which contains Leverett Pond) are listed as impaired for pathogens in the 2006 Integrated List of Waters.
- Boston is a NPDES Phase I community and is 100% sewered.

Figure 9. 2008 Bacteria Source Tracking Sites in the Charles River Watershed



Results

Table 8. *E. coli* (EC) and *Enterococcus* spp. (ENT) Concentrations (MPN/100mL) in the Charles River Watershed

Site ID	Type	Water Body	Town	4/22/2008 (EC)	5/14/2008 (EC)	7/22/2008 (ENT)	10/20/2008 (ENT)
BOS233p	pipe	Leverett Pond	Boston	6,586 ^{dj*}	12,997	959 ^d	ns
BOS037p	pipe	Charles River	Boston	183 ^{dj}	292	86 ^d	ns
ChaR01p	pipe	Charles River	Boston	<10 ^{dj}	<10	ns	ns
ChaR02p	pipe	Charles River	Boston	<10 ^{dj}	5,475	199 ^d	ns
BOS174p	pipe	Charles River	Boston	30 ^{dj}	<10	110 ^d	5
BOS006	tributary	unnamed brook	Boston	275 ^{dj}	908	1,421 ^d	ns

ns = not sampled, ^d = precision of field or laboratory duplicates did not meet data quality objectives, ^j = estimated value; large well not counted, ^{j*} = estimated value; dilution not accurately prepared

= wet weather conditions

Significant Findings

- A sample collected from a stormwater outfall draining to Leverett Pond (BOS233p) contained a significantly elevated bacteria concentration.
- A sample collected from a stormwater outfall discharging to the Charles River (ChaR02p) was significantly elevated on one date, but was below the surface water quality standard on two other occasions. The pipe was dry on a fourth visit.
- **Actions to be taken:** 1) Review and comment on plans submitted by Boston Water and Sewer Commission (BWSC) to investigate elevated bacteria concentrations in the BOS233p drainage and meet with BWSC staff as appropriate.

3.5 IPSWICH

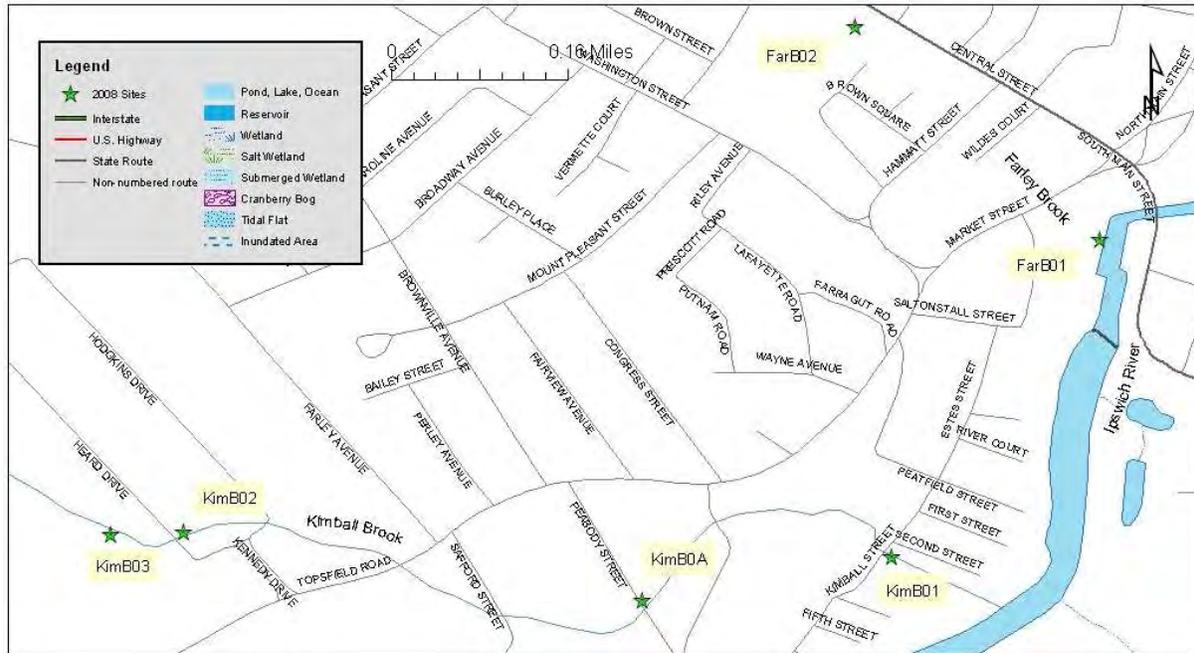
Howlett Brook (Topsfield), Kimball Brook and Farley Brook (Ipswich)

Farley Brook and Kimball Brook sites were sampled in 2007 and were chosen for follow-up sampling. Farley Brook was originally chosen as a study segment through consultation with the Ipswich River Watershed Association. Howlett Brook sampling locations were chosen to sample during reconnaissance in 2008.

Sub-watershed Description

- Howlett Brook, Farley Brook and Kimball Brook are tributaries of the Ipswich River. Pine Brook and Mile Brook join to form Howlett Brook. Farley Brook and Kimball Brook originate in rural residential areas and have sections that are culverted underground.
- Farley Brook is a very small sub-watershed, while the Kimball Brook sub-watershed is 1.0 square mile in area and the Howlett Brook sub-watershed is 10 square miles.
- Landuse in the Kimball Brook sub-watershed is characterized as follows: Residential 47%, Forest 23%, Commercial 11%, Open Space 8%, Other 7%, Wetland 4%
- Landuse in the Howlett Brook sub-watershed is characterized as follows: Forest 58%, Water Resources 21%, Residential 15%, Open Space 4%, Commercial 2%, Other 0.4%.
- The Farley Brook sites and downstream Kimball Brook sites are located near the Ipswich town center, which contains dense commercial and residential use. There is a horse farm upstream of KimB03.
- The Howlett Brook sub-watershed near the study sites is rural residential.
- Farley Brook is not listed as a segment in the 2006 Integrated List of Waters, while Kimball Brook and Howlett Brook are listed as impaired for pathogens on the 2006 303(d) list.
- Ipswich and Topsfield are NPDES Phase II communities. The Town of Ipswich is 50% sewerred and 50% septic, while 100% of the Town of Topsfield is on septic systems.

Figure 10. 2008 Bacteria Source Tracking Sites in the Howlett Brook, Kimball Brook, and Farley Brook Sub-watersheds



Results

Table 9. *Enterococcus* spp. (ENT) Concentrations (MPN/100mL) at Howlett Brook, Kimball Brook, and Farley Brook Sites

Site ID	Type	Water Body	Town	6/11/2008 (ENT)	6/19/2008 (ENT)	9/3/2008 (ENT)	9/18/2008 (ENT)
HowB01	stream	Howlett Brook	Topsfield	31	10	ns	ns
HowB02	stream	Howlett Brook	Topsfield	52	109	ns	ns
HowB03	stream	Howlett Brook	Topsfield	20	ns	ns	ns
MleB03	stream	Miles Brook	Topsfield	107	98	ns	ns
HowB05	stream	Howlett Brook	Topsfield	30	63	ns	ns
KimB01	stream	Kimball Brook	Ipswich	1,022	905	ns	648.8
KimB0A	stream	Kimball Brook	Ipswich	1,281	991	ns	235.9
KimB02	stream	Kimball Brook	Ipswich	1,624	230	ns	107.6
KimB03	stream	Kimball Brook	Ipswich	ns	481	ns	ns
FarB01	stream	Farley Brook	Ipswich	ns	ns	10	155
FarB02	stream	Farley Brook	Ipswich	ns	ns	246	579.4

ns = not sampled

= wet weather conditions

Significant Findings

- Most samples collected in Kimball Brook were significantly elevated. *Enterococcus* spp. concentrations were highest during the first sampling event in June, which was a dry weather date. However, there was not really a clear pattern of bacteria contamination.
- Human Marker sampling (Appendix A) conducted at KimB01 and KimB02 in September indicated there was no evidence of a human bacteria source.

- **Actions taken:** 1) Review and comment on plans submitted by the Town of Ipswich to investigate elevated bacteria concentrations in the Kimball Brook sub-watershed and meet with Town staff as appropriate.

3.6 MERRIMACK

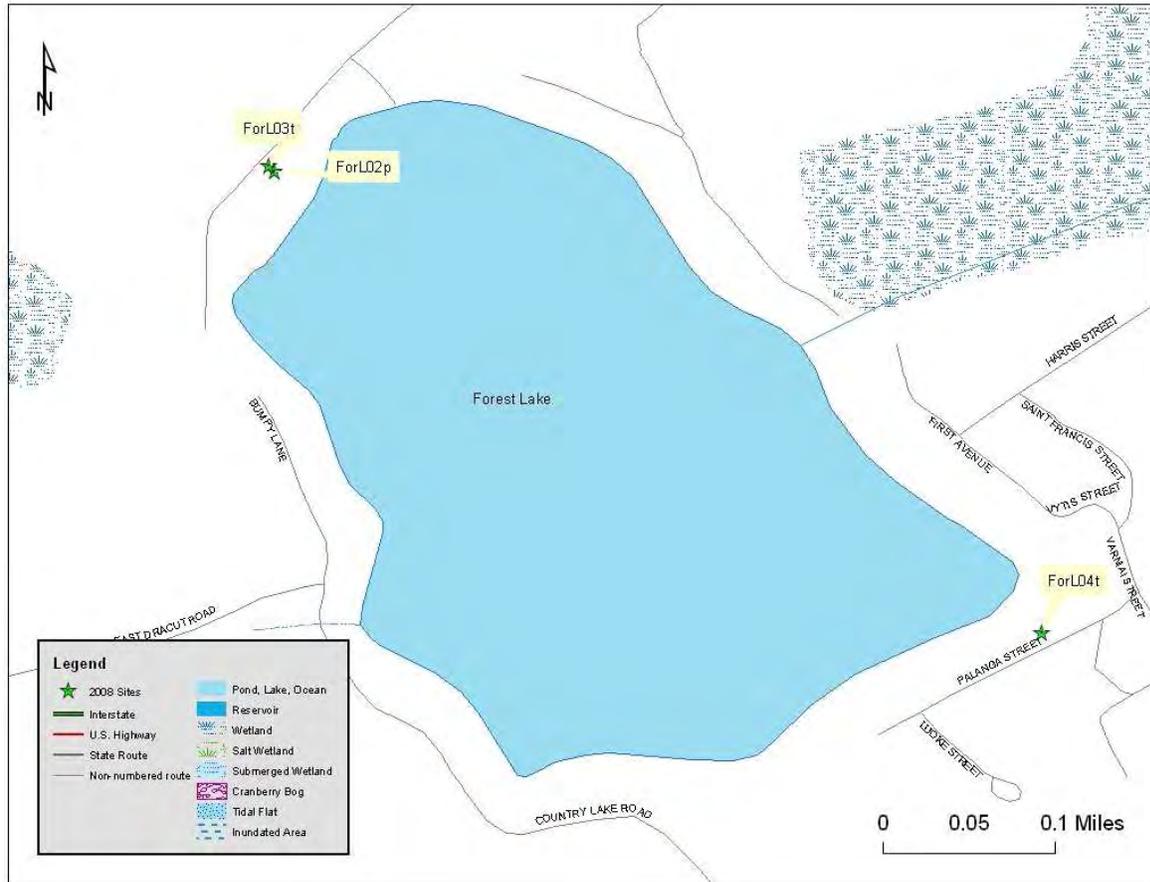
Forest Lake (Methuen)

Sites tributary to Forest Lake were chosen to sample due to a complaint filed with NERO. There were multiple beach closures during the 2008 recreational season because of elevated bacteria concentrations.

Sub-watershed Description

- Forest Lake is fed by a small unnamed stream and the outlet flows into Harris Brook. There is a storm drain on the southern side of the lake that may contain flow from a historical stream that fed the lake.
- The land use around Forest Lake is mixed residential use and conservation area. Most of the land use around the northern and western sections of Forest Lake (where the beach is located) is town forest.
- Methuen is a NPDES Phase II community, with 91% sewerred and 9% on septic systems.

Figure 11. 2008 Bacteria Source Tracking Sites Tributary to Forest Lake



Results

Table 10. *E. coli* (EC) Concentrations (MPN/100mL) in the Forest Lake Sub-watershed

Site ID	Type	Water Body	Town	7/30/2008 (EC)	8/14/2008 (EC)	10/8/2008 (EC)
ForL02p	pipe	Forest Lake	Methuen	20	<10	<10
ForL03t	tributary	Forest Lake	Methuen	461.1	52	2
ForL04t	tributary	Forest Lake	Methuen	ns	97 ^J	579.4

ns = not sampled, ^J = estimated value: one large well not filled

= wet weather conditions

Significant Findings

- Bacteria concentrations were not significantly high for marginally wet weather conditions.
- On the July 30, 2008 sampling date large numbers of geese and geese droppings were observed at the sampling locations on the North side of Forest Lake. The Town beach in this area was closed for much of the summer due to high bacteria counts.
- **Actions to be taken:** 1) No actions are planned at this time.

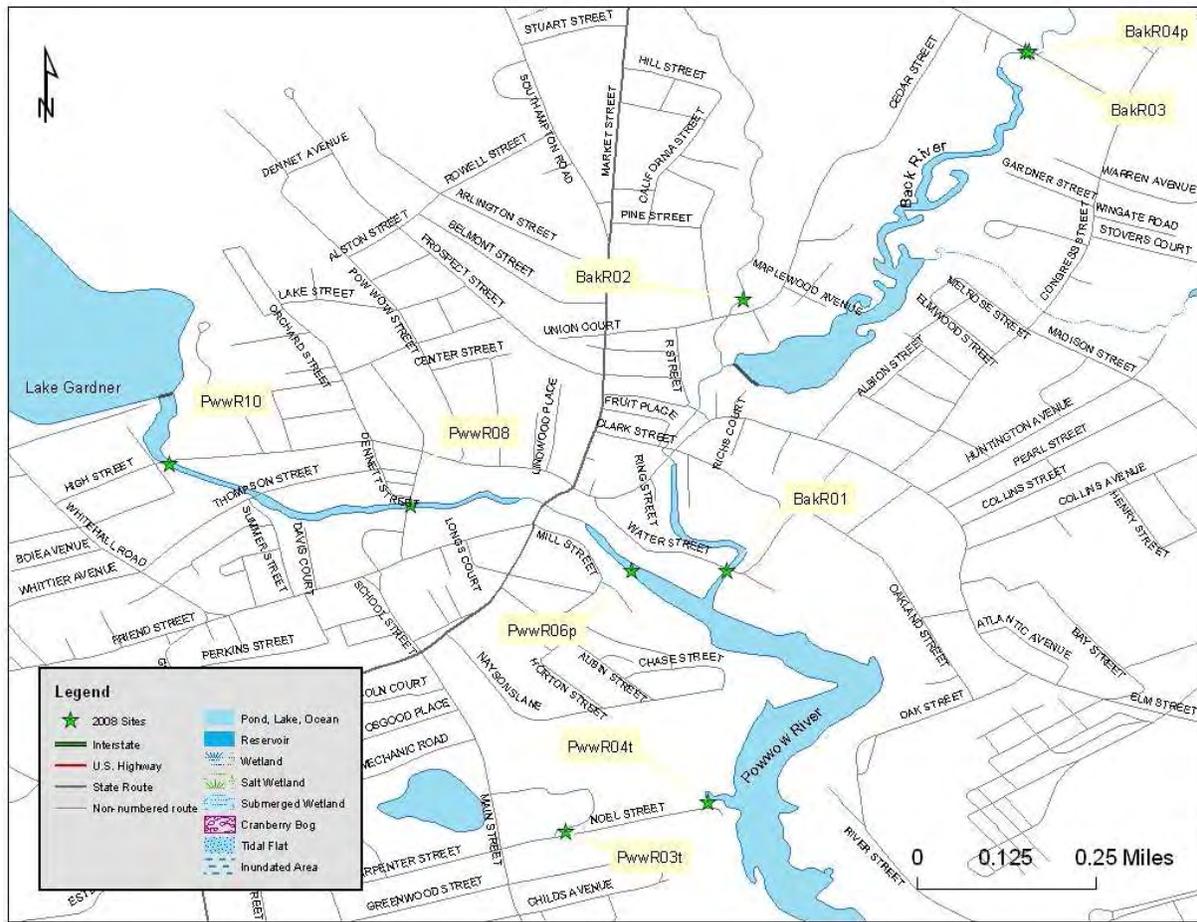
Powwow River (Amesbury)

Sampling locations were chosen based on DWM assessment reports, and through reconnaissance.

Sub-watershed Description

- The sources of the Powwow River include Lake Gardner and the Back River. The River flows through downtown Amesbury before the Back River joins it approximately one-half mile upstream of its confluence with the Merrimack River.
- The Powwow River sub-watershed is approximately 58 square miles in area upstream of PwwR04t.
- Landuse in the Massachusetts part of the Powwow River sub-watershed is characterized as follows: Forest 35%, Residential 22%, Water Resources 20%, Open Space 18%, Commercial 3%, Other 1%.
- Most of the sub-watershed near the study sites is dense mixed residential and commercial use.
- The Powwow River is listed as impaired for pathogens on the 2006 303(d) list.
- Amesbury is a NPDES Phase II community and is 100% sewerred.

Figure 12. 2008 Bacteria Source Tracking Sites in the Powwow River Sub-watershed



Results

Table 11. *Enterococcus* spp. (ENT) Concentrations (MPN/100mL) in the Powwow River Sub-watershed

Site ID	Type	Water Body	Town	4/24/2008 (ENT)	7/8/2008 (ENT)	8/26/2008 (ENT)	10/15/2008 (ENT)
PwwR04t	pipe	Unnamed tributary	Amesbury	20 ^d	20	ns	ns
PwwR03t	tributary	Unnamed tributary	Amesbury	<10 ^d	171	ns	ns
PwwR06p	pipe	Powwow River	Amesbury	216 ^d	14,136	122 ^{dj}	7,270 ^d
BakR01	stream	Back River	Amesbury	10 ^d	1,046	63 ^{dj}	7.2 ^d
BakR02	stream	Back River	Amesbury	ns	ns	85 ^{dj}	19.9 ^d
BakR03	stream	Back River	Amesbury	ns	ns	52 ^{dj}	73.3 ^d
BakR04p	pipe	Back River	Amesbury	ns	ns	ns	31.5 ^d
PwwR08	stream	Powwow River	Amesbury	<10 ^d	315	ns	ns
PwwR10	stream	Powwow River	Amesbury	<10 ^d	75	ns	ns

ns = not sampled, ^d = precision of field or laboratory duplicates did not meet data quality objectives, ^j = estimated value due to incubator temperature outside the acceptable range

Significant Findings

- Sampling in the Powwow River sub-watershed revealed significantly elevated bacteria concentrations at one stormwater outfall (PwwR06p).
- **Actions to be taken: 1)** Review and comment on plans submitted by the Town of Amesbury to investigate elevated bacteria concentrations in the PwwR06p drainage and meet with Town staff as appropriate.

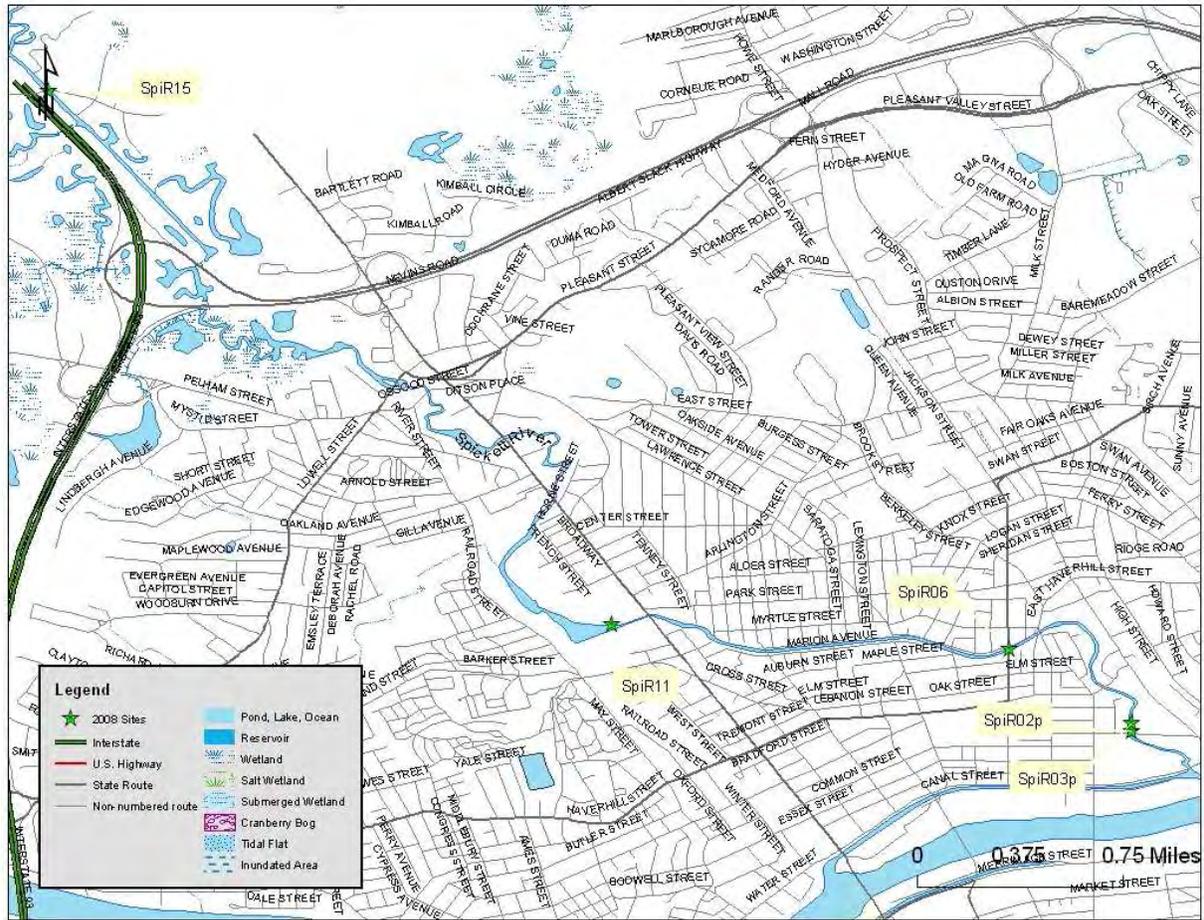
Spickett River (Lawrence)

The Spickett River was originally chosen as a study segment through consultation with the Merrimack River Watershed Council. Sampling locations were chosen during reconnaissance in 2008.

Sub-watershed Description

- The Spickett River originates in New Hampshire and is impounded at Stevens Pond. It flows into the Merrimack River in Lawrence, MA.
- The Spickett River sub-watershed is approximately 77 square miles in area upstream of SpiR02p.
- Landuse in the Massachusetts part of the Spickett River sub-watershed is characterized as follows: Residential 38%, Forest 24%, Water Resources 15%, Commercial 13%, Open Space 8%, Other 1%.
- The Spickett River sub-watershed near the study sites is mainly commercial and mixed residential use, with some industrial use near SpiR11.
- The Spickett River is listed as impaired for pathogens on the 2006 303(d) list.
- Lawrence is a NPDES Phase II community, with 100% sewerage.

Figure 13. 2008 Bacteria Source Tracking Sites in the Spickett River Sub-watershed



Results

Table 12. *Enterococcus* spp. (ENT) and *E. coli* (EC) Concentrations (MPN/100mL) in the Spickett River Sub-watershed

Site ID	Type	Water Body	Town	5/12/2008 (EC)	7/8/2008 (ENT)	7/30/2008 (EC)	11/5/2008 (EC)	11/12/2008 (EC)	11/20/2008 (EC)
SpiR02p	pipe	Spickett River	Lawrence	<10 ^d	96	20	ns	ns	ns
SpiR03p	pipe	Spickett River	Lawrence	364 ^d	1,565	11,199	>2,419.6 ^m	14,136 ^m	15,531 ^{dm}
SpiR06	stream	Spickett River	Lawrence	75 ^d	97	ns	ns	ns	ns
SpiR11	stream	Spickett River	Lawrence	41 ^d	110	ns	ns	ns	ns
SpiR15	stream	Spickett River	Lawrence	30 ^d	52	ns	ns	ns	ns

ns = not sampled, ^d = precision of field or laboratory duplicates did not meet data quality objectives, ^m = method not followed: QC organism expired 10/08

 = wet weather conditions

Significant Findings

- Sampling in the Spickett River sub-watershed revealed significantly elevated bacteria concentrations at one stormwater outfall (SpiR03p) owned by Lawrence General Hospital (LGH).
- LGH located and repaired a missing sewer cap where it crossed a drain line. Follow-up samples collected at SpiR03p did not show a decrease in bacteria concentration. BST staff then met with LGH staff and conducted a site walk. A leaking dumpster over a storm drain could be contributing bacteria to SpiR03p.
- **Actions to be taken:** 1) Conduct simultaneous sampling of key stormdrain manholes with LGH staff 2) Review and comment on plans submitted by LGH to investigate elevated bacteria levels and meet with LGH staff as appropriate.

3.6 NORTH COASTAL

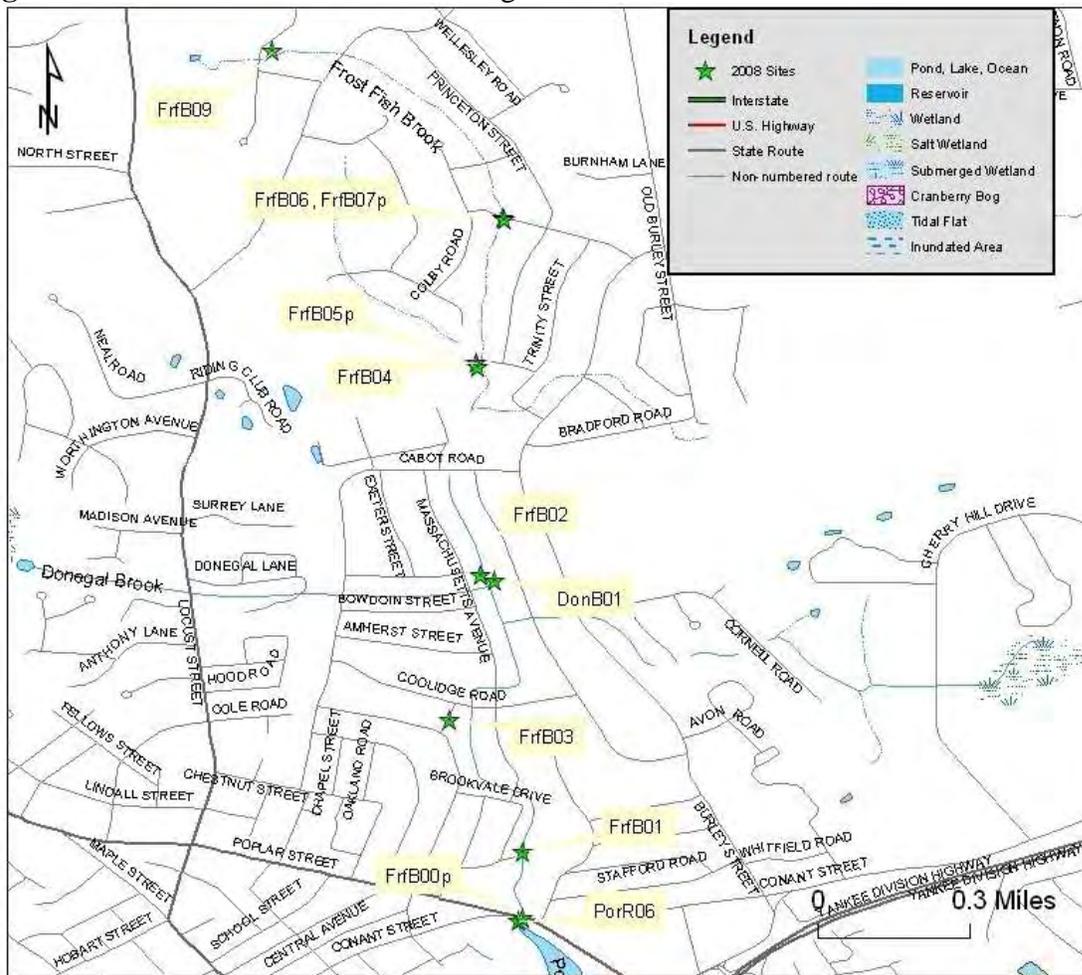
Frost Fish Brook (Danvers)

The Frost Fish Brook sites were chosen in coordination with staff from Salem Sound Coastwatch (SSCW).

Sub-watershed Description

- Frost Fish Brook flows south to the Porter River in Danvers. It is joined by Donegal Brook approximately three-quarters of a mile upstream of the confluence with the Porter River.
- The Frost Fish Brook sub-watershed is 3.0 square miles in area upstream of PorR06.
- Landuse in the Frost Fish Brook sub-watershed is characterized as follows: Residential 52%, Forest 20%, Commercial 16%, Open Space 6%, Water Resources 5%, Other 0.11%.
- The Frost Fish Brook sub-watershed is generally residential in the area around the sampling locations. There are three schools located in the drainage basin.
- Frost Fish Brook is listed as impaired for pathogens on the 2006 303(d) list.
- The Town of Danvers is a NPDES Phase II community, with 99% sewerred and 1% on septic systems.

Figure 14. 2008 Bacteria Source Tracking Sites in the Frost Fish Brook Sub-watershed



Results

Table 13. *Enterococcus* spp. (ENT) Concentrations (MPN/100mL) in the Frost Fish Brook Sub-watershed

Site ID	Type	Water Body	Town	7/7/2008 (ENT)	8/5/2008 (ENT)	8/28/2008 (ENT)
PorR06	stream	Porter River	Danvers	379	504	ns
FrfB00p	pipe	Frost Fish Brook	Danvers	ns	487	ns
FrfB01	stream	Frost Fish Brook	Danvers	613	417	517.2
DonB01	stream	Donegal Brook	Danvers	754	420	410.6
FrfB02	stream	Frost Fish Brook	Danvers	960	520	344.8
FrfB03t	stream	Frost Fish Brook	Danvers	717	325.5	1,274
FrfB04	stream	Frost Fish Brook	Danvers	1,019	686.7	360.9
FrfB05p	pipe	Frost Fish Brook tributary	Danvers	<10	<10	1.0
FrfB06	stream	Frost Fish Brook	Danvers	520	932	248.9
FrfB07p	pipe	Frost Fish Brook tributary	Danvers	189	187	54.6
FrfB09	stream	Frost Fish Brook	Danvers	6,131	410	171

ns = not sampled

= wet weather conditions

Significant Findings

- Bacteria concentrations were elevated in samples collected at several sites in the Frost Fish Brook sub-watershed; however, there was no clear pattern of bacteria contamination.
- Human Marker samples (Appendix A) collected from three Frost Fish Brook sites in September indicated there was weak (FrFB02, FrFB04) or inconclusive (FrFB09) evidence of a human bacteria source. *Enterococcus* spp. concentrations were 640, 760, and 580 cfu/100mL, respectively (FrFB02, FrFB04, FrFB09) at that time.
- **Actions to be taken: 1)** Follow-up sampling will be conducted at Frost Fish Brook in 2009.

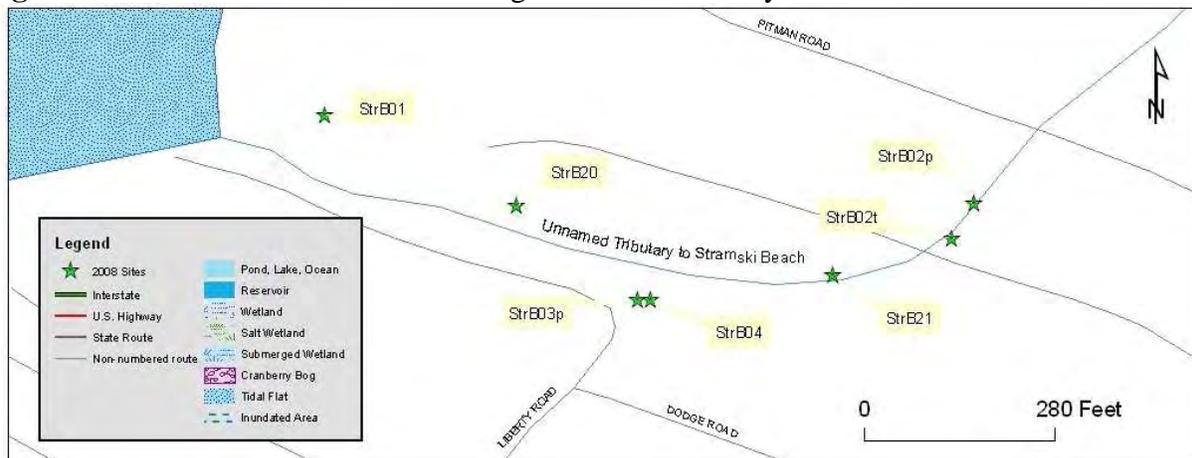
Stramski Beach (Marblehead)

These sites were originally sampled in 2007 and were chosen for follow-up sampling in conjunction with weekly sampling conducted by the Town of Marblehead DPW, as required by a MassDEP issued Notice of Noncompliance. Stramski Beach was originally chosen for BST investigation because of historical beach closures listed on the Massachusetts Department of Public Health website.

Sub-watershed Description

- Stramski Beach is a marine beach on the Salem Harbor side of Marblehead. An unnamed stream flows onto the beach.
- The contributing area of the stream flowing to Stramski Beach is approximately 0.2 square miles.
- Landuse in the Stramski Beach sub-watershed is characterized as follows: Residential 64%, Open Space 23%, Forest 13%
- The sub-watershed is mainly residential.
- The unnamed stream is not listed as a segment on the 2006 Integrated List of Waters.
- The Town of Marblehead is a NPDES Phase II community and is 100% sewered.

Figure 15. 2008 Bacteria Source Tracking Sites in a Tributary to Stramski Beach

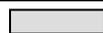


Results

Table 14. *Enterococcus* spp. (ENT) Concentrations (MPN/100mL) in a Tributary to Stramski Beach

Site ID	Type	Water Body	Town	8/18/2008 (ENT)
StrB01	stream	unnamed tributary	Marblehead	830
StrB20	stream	unnamed tributary	Marblehead	1,291
StrB03p	pipe	unnamed tributary	Marblehead	10
StrB04	stream	unnamed tributary	Marblehead	1,529
StrB21	stream	unnamed tributary	Marblehead	1,467
StrB02t	stream	unnamed tributary	Marblehead	733
StrB02p*	pipe	unnamed tributary	Marblehead	10

* = upstream source of StrB02t

 = wet weather conditions

Significant Findings

- Samples containing elevated bacteria concentrations were collected at multiple sites in an unnamed stream flowing out to Stramski Beach.
- Human Marker sampling (Appendix A) conducted at StrB20 in September and November yielded inconclusive evidence for a human bacteria source on both dates. Human marker samples collected at StrB04 in November indicated weak evidence of human bacteria sources.
- **Actions to be taken: 1)** Strategize with the Town of Marblehead on further means of investigating elevated bacteria concentrations.

Miscellaneous Sites (Salem/Swampscott/Lynn)

These sites were chosen based on data from Salem Sound Coastwatch (SSCW 2008). The outfall discharging at Derby Wharf in Salem, and the two discharging in Nahant Bay (Lynn) were chosen to sample as follow-up sites from 2007.

Sub-watershed Description

- Most of these sites are stormwater outfalls that drain to Salem Harbor, the North River, or Nahant Bay. NahB01p is a CSO that discharges to Nahant Bay (but should not discharge combined sewerage in dry weather). DerW01p is a follow-up site, where work had been conducted pertaining to a Notice of Noncompliance issued by BST staff in 2007. The North River originates in a residential area and flows roughly east toward Beverly Harbor. The river is tidal at site NorR03.
- The Derby Wharf outfall (DerW01p) and North River sampling locations are located in high density mixed residential/commercial areas. The North River has industrial areas in the upstream section.
- The City of Salem, the City of Lynn, and the Town of Swampscott are all NPDES Phase II communities, and are 100% sewerred.

Figure 16. 2008 Bacteria Source Tracking Sites in Salem Harbor, Nahant Bay, and the North River



Results

Table 15. *Enterococcus* spp. (ENT) Concentrations (MPN/100mL) in Salem Harbor

Site ID	Type	Water Body	Town	6/11/2008 (ENT)	7/7/2008 (ENT)	8/5/2008 (ENT)	9/18/2008 (ENT)
PhI01p	pipe	Nahant Bay	Swampscott	ns	624	181	ns
DerW01p	pipe	Salem Harbor	Salem	ns	ns	ns	960
NorR03	stream	North River	Salem	ns	ns	ns	249
Wil01p	pipe	Salem Harbor	Salem	ns	85	ns	ns
NahB01p	pipe	Nahant Bay	Lynn	146	ns	ns	ns
NahB02p	pipe	Nahant Bay	Lynn	20	ns	ns	ns

ns = not sampled

= wet weather conditions

Significant Findings

- The City of Salem installed a duckbill tide-gate on the mouth of DerW01p in January, 2008 to prevent harbor water from entering the outfall.
- Salem Sound Coastwatch reported that samples collected during summer, 2008 at DerW01p, as well as a stormwater outfall (NorR01p) discharging to the North River, had significantly elevated bacteria concentrations (SSCW 2008). MassDEP sampling supported those results.
- Human Marker samples (Appendix A) collected at DerW01p and NorR01p in November indicated there was strong evidence of a human bacteria source. The *Enterococcus* spp. concentrations were 660 and >3,300 cfu/100mL, respectively, at the time.
- **Actions to be taken:** 1) Review and comment on plans submitted by the City of Salem to further investigate elevated bacteria concentrations in the DerW01p drainage and initiate work in the NorR01p drainage. NERO BST staff may sample with City staff as appropriate.

3.7 PARKER

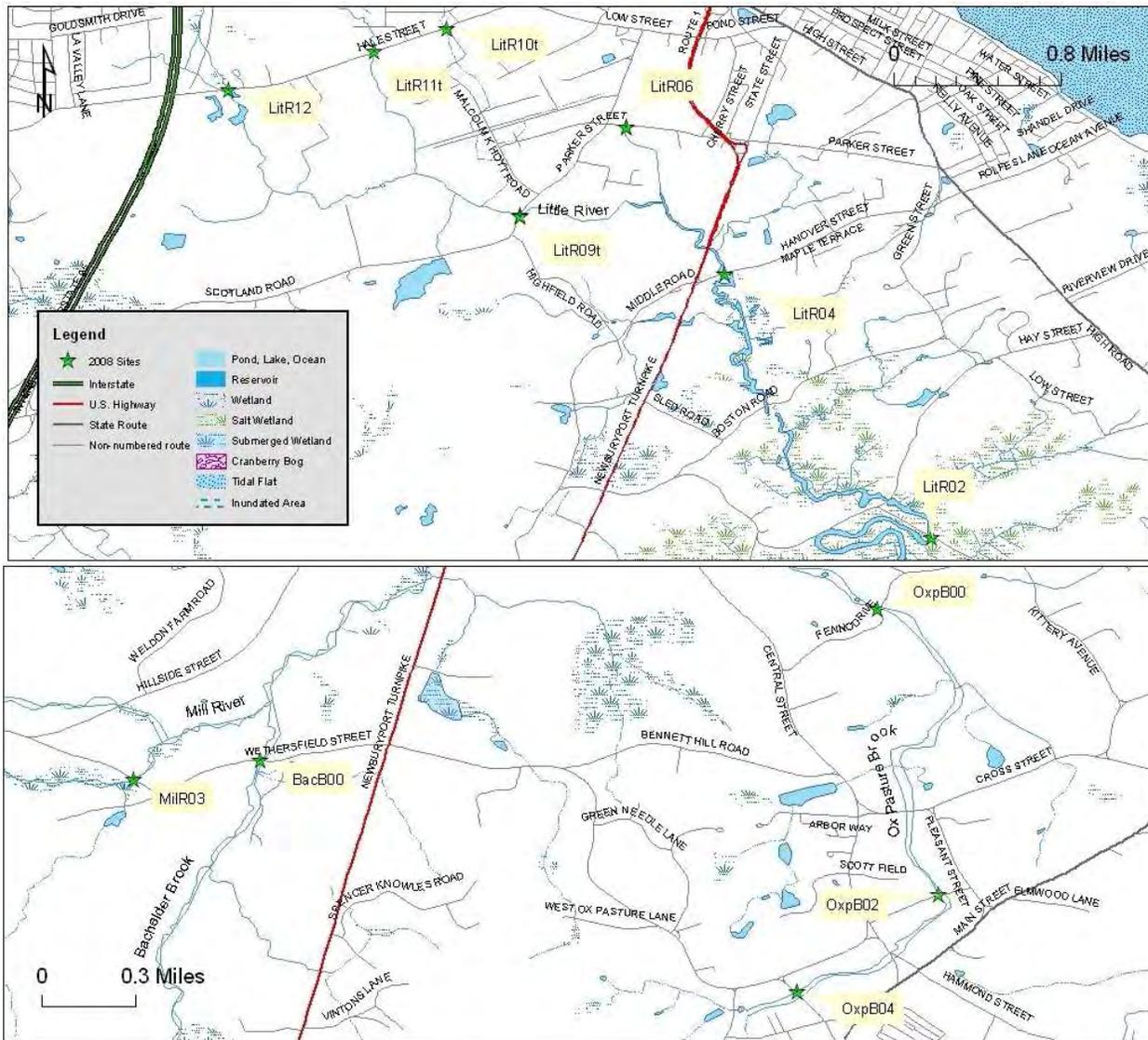
Little River, Mill River, and Tributaries (Rowley/Newbury/Newburyport)

Little River sites were chosen to sample due to recommendations from the Massachusetts Office of Coastal Zone Management. Some of the tributary sites were chosen to sample as follow-up sites from 2007.

Sub-watershed Description

- The Little River originates in Newburyport and flows southeast into the Parker River.
- Ox Pasture Brook and Bachelder Brook are tributaries of the Mill River, which flows into the Parker River.
- The Little River sub-watershed upstream of LitR02 is 8.5 square miles, while the Mill River sub-watershed (including Ox Pasture Brook and Bachelder Brook tributaries) upstream of the point where Ox Pasture Brook joins the River is 14.9 square miles.
- Landuse in the Little River sub-watershed is characterized as follows: Forest 33%, Water Resources 19%, Open Space 17%, Residential 17%, Commercial 14%, Other 0.04%.
- Landuse in the Mill River sub-watershed is characterized as follows: Forest 58%, Water Resources 17%, Residential 14%, Open Space 6%, Commercial 5%, Other 0.8%.
- The Little River sub-watershed near the study sites is mostly residential with some open space and commercial land uses.
- There is some low density residential use in the Mill River sub-watershed near the study sites, but there is mainly open space and undeveloped land.
- Little River and Mill River are listed as impaired for pathogens in the 2006 Integrated List of Waters.
- The Towns of Rowley and Newbury are NPDES Phase II communities, with 100% of the town on septic systems. The City of Newburyport is a NPDES Phase II community, with 75% sewer and 25% on septic systems.

Figure 17. 2008 Bacteria Source Tracking Sites in the Little River and Mill River Sub-watersheds



Results

Table 16. *Enterococcus* spp. (ENT) Concentrations (MPN/100mL) in the Little River and Mill River Sub-watersheds

Site ID	Type	Water Body	Town	7/9/2008 (ENT)	9/3/2008 (ENT)
OxpB00	stream	Ox Pasture Brook	Rowley	148 ^d	488.4
OxpB02	stream	Ox Pasture Brook	Rowley	414 ^d	344.8
OxpB04	stream	Ox Pasture Brook	Rowley	455 ^d	222.4
BacB00	stream	Bachelor Brook	Rowley	41 ^d	123.6
MIIR03	stream	Mill River	Rowley	52 ^d	88.2
LitR02	stream	Little River	Newbury	30 ^d	52
LitR04	stream	Little River	Newbury	185 ^d	1,299.7
LitR06	stream	Little River	Newburyport	121 ^d	31
LitR08	stream	Little River	Newbury	120 ^d	96

Site ID	Type	Water Body	Town	7/9/2008 (ENT)	9/3/2008 (ENT)
LitR09t	tributary	unnamed tributary	Newbury	644 ^d	ns
LitR10t	tributary	unnamed tributary	Newburyport	10 ^d	ns
LitR11t	tributary	unnamed tributary	Newburyport	613 ^d	107.6
ns = not sampled, ^d = precision of field or laboratory duplicates did not meet data quality objectives					

Significant Findings

- Samples collected from most sampling locations contained slightly elevated bacteria concentrations, but there was no clear pattern and no point sources were observed.
- Human Marker sampling (Appendix A) conducted at LitR04 and LitR11t in September indicated inconclusive and no evidence, respectively, of a human bacteria source.
- **Actions to be taken:** 1) Follow-up sampling will be conducted in the Little River in 2009.

3.8 SHAWSHEEN

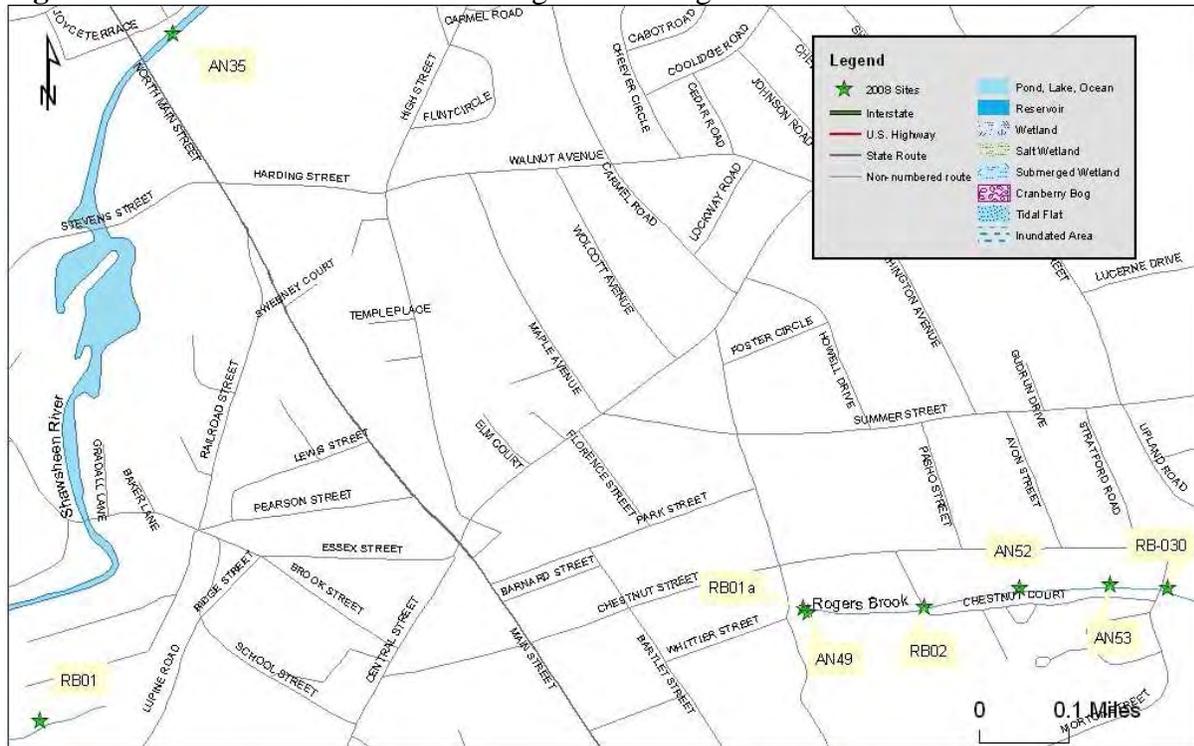
Rogers Brook & Shawsheen River pipe (Andover)

The stormdrain outfall discharging directly to the Shawsheen River was chosen to sample as a follow-up site from 2007.

Sub-watershed Description

- Rogers Brook originates in open land upstream of Morton Street. It is culverted below ground at Whittier Street, and then reemerges just East of 5 Dundee Park, before joining the Shawsheen River after several hundred feet.
- The Rogers Brook sub-watershed upstream of RB01 is approximately 1.3 square miles in area.
- Landuse in the Rogers Brook sub-watershed is characterized as follows: Residential 44%, Forest 27%, Commercial 16%, Open Space 10%, Water Resources 4%.
- The Rogers Brook sub-watershed contains mainly mixed residential and commercial uses, with more open space in the upstream part. There is a commercial area immediately upstream of the Shawsheen River outfall, but the larger surrounding area is mainly mixed residential and open space.
- Both Rogers Brook and the Shawsheen River are listed as impaired for pathogens in the 2006 Integrated List of Waters.
- The Town of Andover is a NPDES Phase II community, with 70% sewered and 30% septic.

Figure 18. 2008 Bacteria Source Tracking Sites in Rogers Brook and the Shawsheen River



Results

Table 17. *E. coli* (EC) Concentrations (MPN/100mL) at Sites in Rogers Brook and the Shawsheen River

Site ID	Type	Water Body	Town	7/17/2008 (EC)	7/30/2008 (EC)	8/14/2008 (EC)	10/8/2008 (EC)
AN35	pipe	Shawsheen River	Andover	31	ns	209	365.4
RB01	stream	Rogers Brook	Andover	24,196	581	1,664	480
RB01a	stream	Rogers Brook	Andover	8,164	697	345	2,098
AN49	pipe	Rogers Brook	Andover	ns	10	20	686.7
RB02	stream	Rogers Brook	Andover	670	309	260.3	2,419.6
AN52	pipe	Rogers Brook	Andover	754	565	521	579.4
AN53	pipe	Rogers Brook	Andover	ns	108	495	ns
RB-030	stream	Rogers Brook	Andover	228	97	63	222.4

ns = not sampled

= wet weather conditions

Significant Findings

- Samples containing significantly elevated bacteria concentrations were collected at several different instream Rogers Brook locations on three different dates, although a clear pattern of contamination was not evident.

- Human Marker sampling (Appendix A) conducted at RB01 and RB01a in September indicated there was strong evidence of a human bacteria source, and the *Enterococcus* spp. concentrations were more than >1,300 and 920 cfu/100mL, respectively, at the time.
- **Actions to be taken:** 1) Follow-up sampling, potentially including placement of optical brightener pads in stormwater outfalls, will be conducted during warmer dry weather in 2009.

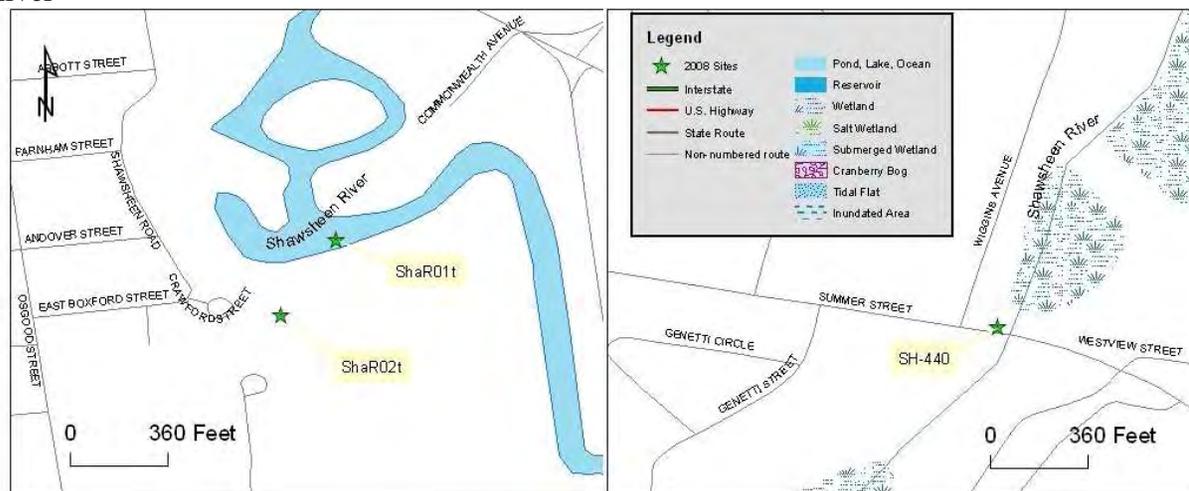
Shawsheen River Tributary & Upper Shawsheen River (Lawrence/Bedford)

These sites were chosen to sample as follow-up sites from 2007. The unnamed tributary to the Shawsheen River in Lawrence was originally chosen for investigation because of a tip from the Shawsheen River Watershed Association.

Sub-watershed Description

- Two of the sites are located on an unnamed tributary to the Shawsheen River in Lawrence, while a third is located on the river itself much further upstream.
- The Shawsheen River upstream of SH-440 is 6.6 square miles
- Landuse in the Shawsheen River sub-watershed is characterized as follows: Residential 36%, Forest 21%, Commercial 21%, Open Space 15%, Other 4%, Wetland 3%
- The unnamed tributary is located in an area of dense residential use and the daylighted section is immediately downstream of a school. There is a woodland buffer of several hundred feet around the daylighted section of the stream.
- The Shawsheen River site is located in an area of mixed undeveloped land, and low density commercial and residential use. It is also downstream of Hanscom Air Force Base.
- The unnamed tributary is not listed as a segment in the 2006 Integrated List of Waters, but all segments of the Shawsheen River are listed as impaired for pathogens.
- The City of Lawrence and the Town of Bedford are NPDES Phase II communities. Lawrence is 100% sewerred, while Bedford is 88% sewerred and 12% septic.

Figure 19. 2008 Bacteria Source Tracking Sites in the Upper Shawsheen River Sub-watershed and a Tributary of the Shawsheen River



Results

Table 18. *E. coli* (EC) Concentrations (MPN/100mL) at Sites in the Upper Shawsheen River Sub-watershed and a Tributary of the Shawsheen River

Site ID	Type	Water Body	Town	5/12/2008 (EC)	7/17/2008 (EC)	7/30/2008 (EC)	11/5/2008 (EC)	11/12/2008 (EC)	11/20/2008 (EC)
ShaR01t	tributary	unnamed brook	Lawrence	2,359 ^d	7,270	733	461.1 ^m	290.9 ^m	35.9 ^{dm}
ShaR02t	tributary	unnamed brook	Lawrence	2,909 ^d	19,863	7,270	6,131 ^m	1,112 ^m	55 ^{dm}
SH-440	stream	Shawsheen River	Bedford	ns	185	ns	ns	ns	ns

ns = not sampled, ^d = precision of field or laboratory duplicates did not meet data quality objectives, ^m = method not followed: QC organism expired 10/08

☐ = wet weather conditions

Significant Findings

- After the City of Lawrence located and repaired a break in a sewer line where it crossed a drain line, samples collected at ShaR02t showed decreased bacteria concentrations over time
- **Actions to be taken:** 1) Follow-up sampling will be conducted during warmer dry weather in 2009.

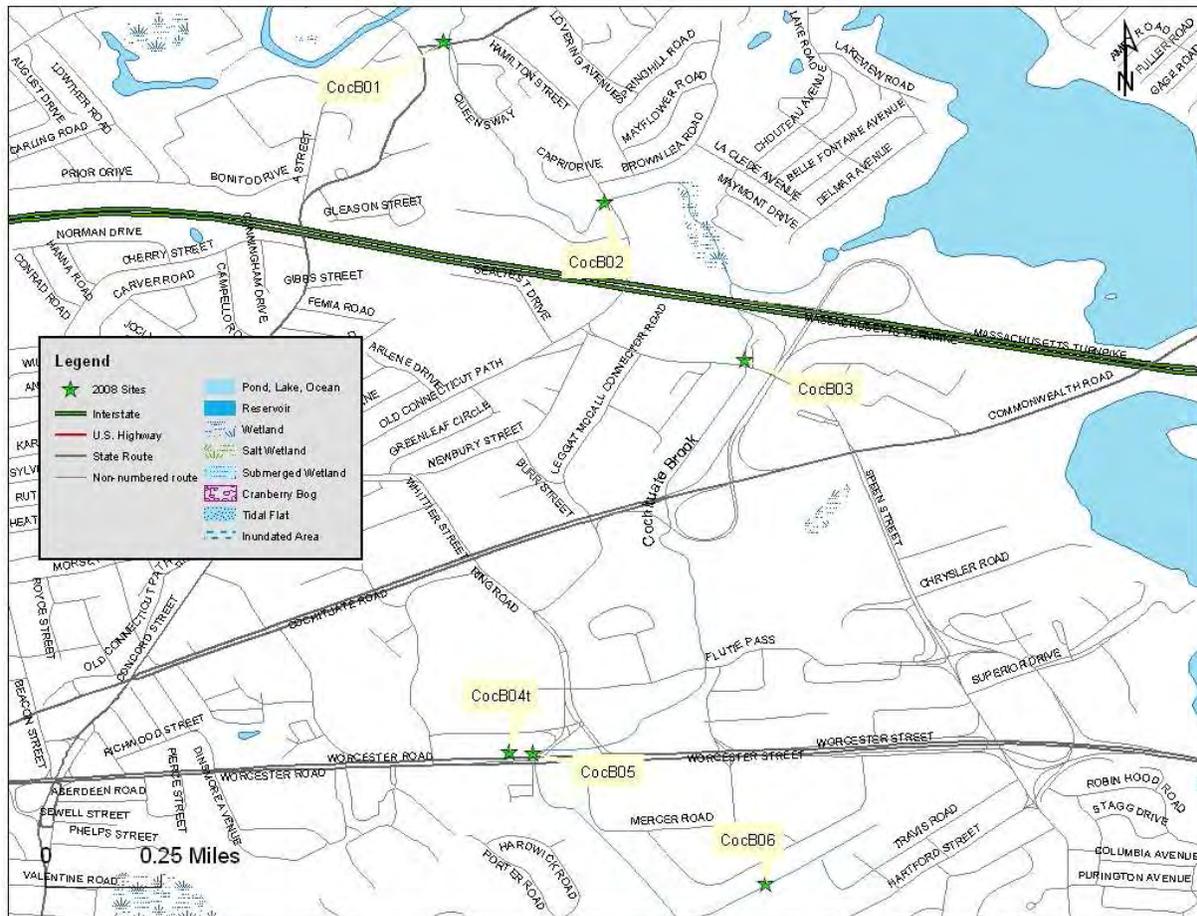
3.8 SuAsCo

Cochituate Brook (Framingham)

Sub-watershed Description

- Cochituate Brook is a tributary of the Sudbury River.
- The Cochituate Brook sub-watershed is approximately 20.2 square miles in area upstream of CocB01.
- Landuse in the Cochituate Brook sub-watershed is characterized as follows: Residential 33%, Forest 29%, Commercial 17%, Water Resources 16%, Open Space 4%, Other 1%.
- The location of the sampling sites varies from commercial to residential, to commercial again for the most downstream site.
- Cochituate Brook is not listed as impaired for pathogens on the 2006 303(d) list; however, it is under a pathogen TMDL.
- The Town of Framingham is a NPDES Phase II community, with 95% sewered and 5% on septic systems.

Figure 20. 2008 Bacteria Source Tracking Sites in the Cochituate Brook Sub-watershed



Results

Table 19. *E. coli* (EC) Concentrations (MPN/100mL) in the Cochituate Brook Sub-watershed

Site ID	Type	Water Body	Town	7/01/2008 (EC)	7/31/2008 (EC)	10/9/2008 (EC)
CocB01	stream	Cochituate Brook	Framingham	183	275.5	49.6
CocB02	stream	Cochituate Brook	Framingham	98	360.9	39.3
CocB03	stream	Cochituate Brook	Framingham	145	1,850	79.4
CocB04t	tributary	unnamed brook	Framingham	275	161	980.4
CocB05	stream	Cochituate Brook	Framingham	146	1,178	83.6
CocB06	stream	Cochituate Brook	Natick	1,106	464	111.5

Significant Findings

- Although a few samples collected from Cochituate Brook contained elevated bacteria concentrations, there was no pattern.
- Water flow was often stagnant or nearly so at CocB06, which may have contributed to an elevated bacteria concentration on July 1.
- **Actions to be taken: 1)** No actions are planned at this time.

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APPENDIX A MassDEP Wall Experiment Station Human Marker and *Enterococcus* spp. Results

Results from September 25, 2008

The Wall Experiment Station (WES) performed Human Marker (HM) analysis on thirteen samples, one duplicate, and one blank collected by NERO staff on September 25, 2008. Analyses performed included *Enterococcus* spp. concentration, *Enterococcus* spp. DNA analysis by polymerase chain reaction (PCR), Bacteroidetes DNA analysis by PCR, fluorescent whitening agent concentration, and caffeine concentration. WES uses an internal algorithm that takes into account the weight of evidence of human sources of bacteria, which can then be ranked as “none,” “inconclusive,” “weak,” or “strong.”

Although many of the samples indicated no evidence of human sources of bacteria, or returned inconclusive results, four samples were ranked as weak or strong, indicating a likely presence of human sources of bacteria. Among these, samples from two sites on **Frost Fish Brook** in Danvers ranked as weak. At both sites, human markers in Bacteroidetes and Enterococci DNA were present. A sample collected at a third site further upstream returned a result of inconclusive, indicating that there may be a source of bacteria between this third site and the two downstream sites. With further evidence, samples from two sites on **Rogers Brook** in Andover were ranked as strong. These samples again were positive for human markers in Bacteroidetes and Enterococci DNA. However, the samples also tested positive for a fluorescent whitening agent and for caffeine. The combined weight of evidence indicates a strong likelihood of a human source of bacteria in Rogers Brook.

Table 1. September 25, 2008 Precipitation Data Summary

Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Survey Day
	Boston	Boston	Boston	Boston	Boston	Boston
25 September	0	0.31	0	0	0	0
NOAA/NWS precipitation station = Boston Precipitation data reported in inches.						

Note: Conditions at the Boston Logan gage were generally representative of those throughout the Northeast Region.

Table 2. *Enterococcus* spp. Concentration (cfu/100mL) and Human Marker (HM) Analysis for September 25, 2008

Site ID	Type	Basin	Water Body	Town	<i>Enterococcus</i> spp.	HM Analysis	Site Description
HorB03 / 949-51	stream	Boston Harbor - Mystic	Horn Pond Brook	Winchester	310	None	Horn Pond Brook: DS of Canal St, Lat/Long 42.46061N, 71.14602W

HorB05 / 952-54	stream	Boston Harbor - Mystic	Horn Pond Brook	Winchester	320	None	Horn Pond Brook: ~10ft US of HorB04p (12" black cpp ~10ft US of Sylvester Ave), Lat/Long 42.46052N, 71.14736
RusB01 / 957-59	stream	Boston Harbor - Mystic	Russell Brook	Winchester	530	Inconclusive	Russell Brook: where it daylights at confluence with Horn Pond Brook, near N end of Sylvester Ave, Lat/Long 42.46323N, 71.14967W
KimB01 / 937-39	stream	Ipswich	Kimball Brook	Ipswich	540	None	Kimball Brook: DS of Kimball St, Lat/Long 42.67478N, 70.84062W
KimB02 / 940-42	stream	Ipswich	Kimball Brook	Ipswich	110	None	Kimball Brook: DS of Heard Dr, Lat/Long 42.67516N, 70.84977W
FrFB02 / 925-27	stream	North Coastal	Frost Fish Brook	Danvers	640	Weak	Frost Fish Brook: Mass Ave after Bowdoin St. US of Donegal Brook, Lat/Long 42.57777N, 71.92862W
FrFB04 / 928-30	stream	North Coastal	Frost Fish Brook	Danvers	760	Weak	Frost Fish Brook: End of Princeton St, follow path to the brook, Lat/Long 42.58406N, 70.92915W
FrFB09 / 931-33	stream	North Coastal	Frost Fish Brook	Danvers	580	Inconclusive	Frost Fish Brook: Wildwood Rd Crossing, DS side, Lat/Long 42.58820N, 70.92835W
FrFB09 / 934-36	stream/ duplicate	North Coastal	Frost Fish Brook	Danvers	390	Inconclusive	Frost Fish Brook: Wildwood Rd Crossing, DS side, Lat/Long 42.58820N, 70.92835W
StrB20 / 960-62	stream	North Coastal	Stramski Beach stream	Marblehead	610	Inconclusive	Stramski Beach stream: ~190 feet DS of Liberty outlet, US side of wooden foot bridge, Lat/Long 42.51392N, 70.86473W
LitR04 / 943-45	stream	Parker	Little River	Newbury	78	Inconclusive	Little River: Hanover Street Bridge, US side, Lat/Long 42.79024N, 70.87651W
LitR11t / 946-48	tributary	Parker	Little River	Newburyport	190	None	Little River: Hale Street, crossing #2, aka TC#6, at pump station, Lat/Long 42.80566N, 70.90085W
RB01 / 963-65	stream	Shawsheen	Rogers Brook	Andover	>1300	Strong	Rogers Brook: even w/ shed behind #5 Dundee Park (Yang's Fitness Center), Lat/Long 42.65399N, 71.14759W
RB01a / 966-68	stream	Shawsheen	Rogers Brook	Andover	920	Strong	Rogers Brook: US of Whittier St, Lat/Long, 42.65582N, 71.13525W
969-71	blank	na	na	na	<2	None	na
DS = downstream, US = upstream							

Results from November 4, 2008

The Wall Experiment Station (WES) performed Human Marker (HM) analysis on eight samples, one duplicate, and one blank collected by NERO staff on November 4, 2008. Analyses performed included *Enterococcus* spp. concentration, *Enterococcus* spp. DNA analysis by polymerase chain reaction (PCR), Bacteroidetes DNA analysis by PCR, fluorescent whitening agent (FWA) concentration, and caffeine concentration. WES uses an internal algorithm that takes into account the weight of evidence of human sources of bacteria, which can then be ranked as “none,” “inconclusive,” “weak,” or “strong.”

Although some of the samples indicated no evidence of human sources of bacteria, or returned inconclusive results (such as those at **Good Harbor Beach** in Gloucester), five samples were ranked as strong or weak, indicating a likely presence of human sources of bacteria. Among these, a sample (StrB04) collected upstream of the Liberty/Dodge outlet in a stream draining to **Stramski Beach** in Marblehead ranked as weak based on human markers present in Bacteroidetes DNA and presence of caffeine. However, a sample collected further downstream (StrB20) was only ranked inconclusive, indicating there may be a human source around StrB04, which is diluted or dissipates further downstream. Samples collected from stormwater outfalls discharging from **Derby Wharf** (DerW01p) and into the **North River** (NorR01p) in Salem both ranked as strong. These samples contained multiple FWAs, caffeine, as well as human markers present in Bacteroidetes DNA, indicating a likely human source of bacteria. Samples from two sites in Boston were also ranked as strong. A sample from a former CSO (BOS090p) discharging relatively near **Tenean Beach** contained multiple FWAs, caffeine, as well as human markers present in both Bacteroidetes and Enterococci DNA, indicating a strong likelihood of a human source of bacteria. A sample collected where **Canterbury Brook** daylighted contained very high concentrations of chemical analytes, as well as the Bacteroidetes human marker. However, no Enterococci DNA was available to test for human markers, indicating that other contaminants (possibly industrial) may have killed off Enterococci organisms.

Table 3. November 4, 2008 Precipitation Data Summary

Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Survey Day
	Boston	Boston	Boston	Boston	Boston	Boston
4 November	0	0	0	0	0	0
NOAA/NWS precipitation station = Boston Precipitation data reported in inches.						

Note: Conditions at the Boston Logan gage were generally representative of those throughout the Northeast Region.

Table 4. *Enterococcus* spp. Concentration (cfu/100mL) and Human Marker (HM) Analysis for November 4, 2008

Site ID	Type	Basin	Water Body	Town	<i>Enterococcus</i> spp.	HM Analysis	Site Description
BOS090p / 1011-13	pipe	Boston Harbor - Neponset	Neponset River	Boston	>3,300	Strong	Tenean Beach: Boston former CSO #090 located N of Tenean Beach next to Victory Rd Park, Lat/Long 42.29820N, 71.04658W
BOS577 / 1016-18	stream	Charles	Canterbury Brook	Boston	<2	Strong	Canterbury Brook: Boston stormdrain daylighting brook DS of Harvard St, Lat/Long 42.288331N, 71.092789W
BOS577 / 1019-21	stream/duplicate	Charles	Canterbury Brook	Boston	<2	Strong	Canterbury Brook: Boston stormdrain daylighting brook DS of Harvard St, Lat/Long 42.288331N, 71.092789W
GooH01 1022-24	beach	North Coastal	Good Harbor	Gloucester	<2	None	Good Harbor: Foot of Witham St, follow wall to Marine Sample, Lat/Long 42.620815N, 70.627906W
GooH02 1025-27	stream	North Coastal	Unnamed tributary to Good Harbor	Gloucester	44	Inconclusive	Unnamed trib: ~100' US of footbridge on Nautilus Rd, Lat/Long 42.61838N, 70.63571W
NorR01p 1028-30	pipe	North Coastal	North River	Salem	>3,300	Strong	North River: Commercial Street across from Spartan Oil Company aka SSCW #537, Lat/Long 42.524470N, 70.900660W
DerW01p / 1031-33	pipe	North Coastal	Salem Harbor	Salem	660	Strong	Derby Wharf: 18" rcp on NW side, same as SSC 630, Lat/Long 42.521091N, 70.887103W
1034-36	blank	na	na	na	<2	None	na
StrB04 / 1040-42	stream	North Coastal	Stramski Beach stream	Marblehead	190	Weak	Stramski Beach stream: ~6 ft US of Liberty outlet, Lat/Long 42.513537N, 70.864194W
StrB20 / 1037-39	stream	North Coastal	Stramski Beach stream	Marblehead	170	Inconclusive	Stramski Beach stream: ~190 feet DS of Liberty/Dodge outlet, US side of wooden foot bridge, Lat/Long 42.51392N, 70.86473W
DS = downstream, US = upstream							

APPENDIX B 2008 Precipitation Data

= wet weather conditions

Boston Harbor - Mystic Basin 2008 Precipitation Data Summary

Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Survey Day
	Boston	Boston	Boston	Boston	Boston	Boston
	Bedford	Bedford	Bedford	Bedford	Bedford	Bedford
03 June	0	0	0.02	0	0	0
	0	0	0.30	0	0	0
01 July	T	0.66	T	T	T	0.17 ^a
	T	0.27	0.01	0.11	T	0.34 ^a
16 July	0	0	0	0.07	0	0
	0	0	0	T	0.01	0
29 July	2.16	0	0	0.19	0	0
	na	na	na	na	na	na
31 July	0	0.19	0	0	0	0.04
	0.01	0.64	0	0	0.01	0.15 ^M
18 August	0	0.09	0.35	T	0	0
	0.01	0.01	0.63	0.35	0.01	0.01
24 September	0	0	0.31	0	0	0
	0	0.01	0.16	0.01	0	0.24 ^M

T = trace amounts, ^a = rainfall on day of sampling occurred after sampling, ^M = majority of rainfall on day of sampling occurred after sampling (<0.1 inches before sampling)
 Precipitation data reported in inches.

Boston Harbor - Neponset River Basin 2008 Precipitation Data Summary

Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Survey Day
	Boston	Boston	Boston	Boston	Boston	Boston
22 July	0	0.13	0	1.15	0.14	0.25 ^a
27 August	0	0	0	0	0	0
20 October	0	T	0	0	0	0

T = trace amounts, ^a = rainfall on day of sampling occurred after sampling
 Precipitation data reported in inches.

Boston Harbor - Weymouth & Weir Basin 2008 Precipitation Data Summary

Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Survey Day
	Boston	Boston	Boston	Boston	Boston	Boston
26 June	0	T	0.46	0.78	0	T
21 August	T	0	0	0.01	0	0
20 October	0	T	0	0	0	0
T = trace amounts Precipitation data reported in inches.						

Charles River Basin 2008 Precipitation Data Summary

Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Survey Day
	Boston	Boston	Boston	Boston	Boston	Boston
22 April	0	0	0	0	0	0
14 May	0.21	T	0	0	0	0
22 July	0	0.13	0	1.15	0.14	0.25 ^a
20 October	0	T	0	0	0	0
T = trace amounts, ^a = rainfall on day of sampling occurred after sampling Precipitation data reported in inches.						

Ipswich River Basin 2008 Precipitation Data Summary

Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Survey Day
	Beverly	Beverly	Beverly	Beverly	Beverly	Beverly
11 June	0.2	0	0	0	T	T
19 June	T	0.36	0.18	T	0	0
03 September	0	T	0	0	0	0.04
05 September	0	0	0	0.04	0	0
18 September	0	0.06	0	0	0	0
T = trace amounts Precipitation data reported in inches.						

Merrimack River Basin 2008 Precipitation Data Summary

Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Survey Day
	Lawrence	Lawrence	Lawrence	Lawrence	Lawrence	Lawrence
24 April	0	0	0	0	T	0
12 May	0	0.1	0.12	0	0	0
08 July	0.61	0.4	0.01	0	0.01	0

Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Survey Day
	Lawrence	Lawrence	Lawrence	Lawrence	Lawrence	Lawrence
30 July	0	0.01	1.13	0	0	0
14 August	0.01	0.36	0.38	0.48	0.01	0.37 ^a
26 August	0	0	0	0	0.01	T
08 October	T	0	T	0	0 ^P	0
15 October	0	0	0.01	0	0	0.01
05 November	0	0	0	0	T	0.01
12 November	0.04	0.03	T	T	0	0
20 November	0.31	0.2	0	0	0	0

T = trace amounts, ^a = rainfall on day of sampling occurred after sampling, ^P = data retrieved from Plymouth State University website
Precipitation data reported in inches.

North Coastal Basin 2008 Precipitation Data Summary

Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Survey Day
	Beverly	Beverly	Beverly	Beverly	Beverly	Beverly
11 June	0.2	0	0	0	T	T
07 July	0.29	0.41	0.13	T	0	0
05 August	0.05	0	0.01	0.73	0	0
18 August	0	T	0.22	0.07	0	0
28 August	0	0	0	T	0	0
18 September	0	0.06	0	0	0	0

T = trace amounts
Precipitation data reported in inches.

Parker River Basin 2008 Precipitation Data Summary

Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Survey Day
	Lawrence	Lawrence	Lawrence	Lawrence	Lawrence	Lawrence
09 July	0.40	0.01	0	0.01	0	0.20 ^a
03 September	T	0.02	0	0	0	0

T = trace amounts, ^a = rainfall on day of sampling occurred after sampling
Precipitation data reported in inches.

Shawsheen River Basin 2008 Precipitation Data Summary

Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Survey Day
	Bedford	Bedford	Bedford	Bedford	Bedford	Bedford
	Lawrence	Lawrence	Lawrence	Lawrence	Lawrence	Lawrence
12 May	na	na	na	na	na	na
	0	0.10	0.12	0	0	0
17 July	0	0	T	0.01	0	0
	0	0	T	0	0	T
30 July	na	na	na	na	na	na
	0	0.01	1.13	0	0	0
14 August	na	na	na	na	na	na
	0.01	0.36	0.38	0.48	0.01	0.37 ^a
8 October	na	na	na	na	na	na
	T	0	T	0	MFR	0
5 November	na	na	na	na	na	na
	0	0	0	0	T	0.01 ^a
12 November	na	na	na	na	na	na
	0.03	0.04	T	T	0	0
20 November	na	na	na	na	na	na
	0.31	0.20	0	0	0	0

MFR = missing from record, T= trace amounts, ^a = rainfall on day of sampling occurred after sampling
 Precipitation data reported in inches.

SuAsCo Basin 2008 Precipitation Data Summary

Survey Dates	5 Days Prior	4 Days Prior	3 Days Prior	2 Days Prior	1 Day Prior	Survey Day
	Bedford	Bedford	Bedford	Bedford	Bedford	Bedford
	Boston	Boston	Boston	Boston	Boston	Boston
	Norwood	Norwood	Norwood	Norwood	Norwood	Norwood
01 July	T	0.27	0.01	0.11	T	0.34 ^a
	T	0.66	T	T	T	0.17 ^a
	0.02	0.03	0.02	0.02	0.01	0.02
31 July	0.01	0.64	0	0	0.01	0.15 ^M
	0	0.19	0	0	0	0.04
	0.01	0.72	0	0	0	0.07
9 October	0	0	0.01	MFR	0	0.04
	0	T	0	0	0	0.01
	0	0	0	MFR	0	0.01

MFR = missing from record, T= trace amounts, ^a = rainfall on day of sampling occurred after sampling, ^M = majority of rainfall on day of sampling occurred after sampling (<0.1 inches before sampling)
 Precipitation data reported in inches.

APPENDIX C Site ID Key

Note: DS = downstream, US = upstream

Basin	Town	ID	Type	Water Body	Description	Lat N	Long W
Boston-Mystic	Winchester	HorB01	stream	Horn Pond Brook	Horn Pond Brook: US of Lake St	42.45690	-71.13898
Boston-Mystic	Winchester	HorB02	stream	Horn Pond Brook	Horn Pond Brook: @ end of Clark St	42.45855	-71.14233
Boston-Mystic	Winchester	HorB03	stream	Horn Pond Brook	Horn Pond Brook: DS of Canal St	42.46061	-71.14602
Boston-Mystic	Winchester	HorB04p	pipe	Horn Pond Brook	Horn Pond Brook: 12" black cpp ~10ft US of Sylvester (left bank)	42.46055	-71.14731
Boston-Mystic	Winchester	HorB05	stream	Horn Pond Brook	Horn Pond Brook: ~10ft US of HorB04p (12" black cpp ~10ft US of Sylvester Ave)	42.46052	-71.14736
Boston-Mystic	Winchester	HorB06	stream	Horn Pond Brook	Horn Pond Brook: US of Lynch Elementary bridge (across from Royal St)	42.46159	-71.14944
Boston-Mystic	Winchester	RusB01	stream	Russell Brook	Russell Brook: where it daylights at confluence with Horn Pond Brook, near N end of Sylvester Ave	42.46323	-71.14967
Boston-Mystic	Woburn	HorB07	stream	Horn Pond Brook	Horn Pond Brook: DS of Lake Ave	42.46525	-71.15166
Boston-Mystic	Melrose	EIIP02p	pipe	EII Pond	EII Pond: 42" concrete pipe ~100ft N of red bridge (near DPW building on Tremont St)	42.46145	-71.06886
Boston-Mystic	Melrose	EIIP03p	pipe	EII Pond	EII Pond: ~5ft rectangular concrete pipe across from DPW building on Tremont St	42.46114	-71.06939
Boston-Mystic	Melrose	EIIP04Wp	pipe	EII Pond	EII Pond: 42" concrete pipe on N side of pond, W of double culvert, same as MyRWA MELx02	42.46342	-71.06366
Boston-Mystic	Melrose	EIIP04Ep	pipe	EII Pond	EII Pond: 42" concrete pipe on N side of pond, E of double culvert, same as MyRWA MELx02E	42.46342	-71.06366
Boston-Mystic	Belmont	JncB01	stream	Junction Brook	Junction Brook: ~75ft US of Pleasant St where path intersects brook	42.38947	-71.18888
Boston-Mystic	Belmont	JncB02	stream	Junction Brook	Junction Brook: @ top of hill US of Pleasant St	42.39154	71.18953
Boston-Mystic	Boston	BOS044	pipe	Boston Harbor	Constitution Beach vicinity: off Baywater St, slightly NW of Shawsheen Rd	42.38331	-71.00159

Basin	Town	ID	Type	Water Body	Description	Lat N	Long W
Boston-Mystic	Somerville	MysR01p	pipe	Mystic River	Mystic River: 24" metal pipe w/ flapgate on right bank between commuter rail bridge and Rt. 99 (US of Charlestown bus depot), immediately DS of MysR02p	42.39071	-71.07437
Boston-Mystic	Somerville	MysR02p	pipe	Mystic River	Mystic River: pipe welling up from square opening in ground on right bank between commuter rail bridge and Rt. 99 (US of Charlestown bus depot), immediately US of MysR01p	42.39074	-71.07441
Boston-Mystic	Somerville	MWRA205p	pipe	Mystic River	Mystic River: CSO #205 DS of Amelia Earhart Dam, right bank	42.39402	-71.07608
Boston-Mystic	Somerville	MysR04p	pipe	Mystic River	Mystic River: 36" concrete pipe ~200ft US of Blessing of the Bay Boathouse, right bank	42.39847	-71.09117
Boston-Mystic	Somerville	SOMD21p	pipe	Mystic River	Mystic River: 48" concrete pipe several hundred feet US of MysR04p & even w/ Rt 93 exit sign, right bank	42.39981	-71.09320
Boston-Mystic	Somerville	SOMD19p	pipe	Mystic River	Mystic River: 48" concrete pipe ~200 feet DS of N-bound entrance ramp bridge over I-93 (US of SOMD21p), former CSO SOM006, right bank	42.40095	-71.09433
Boston-Mystic	Somerville	MysR05p	pipe	Mystic River	Mystic River: 24" wide wooden outfall off Rt. 16, opposite MWRA drinking water building, right bank, joint Somerville/Medford pipe, same as MyRWA MDCMYT	42.41518	-71.13161
Boston-Mystic	Somerville	SOMD11p	pipe	Alewife Brook	Alewife Brook: 12" iron pipe @ DS corner of Dilboy Field parking lot, right bank, used to be CSO #4	42.41381	-71.13256
Boston-Mystic	Somerville	SOMD08p	pipe	Alewife Brook	Alewife Brook: 24" concrete pipe even w/ Powderhouse Blvd intersection, former CSO #002	42.40866	-71.13248
Boston-Mystic	Arlington	Arl026p	pipe	Alewife Brook	Alewife Brook: 12" concrete pipe @ US end of Sunnyside Ave alley, access thru gate in fence, right bank	42.40842	-71.13289
Boston-Mystic	Somerville	SOMD07p	pipe	Alewife Brook	Alewife Brook: 24" clay pipe ~25ft DS of Broadway, right bank	42.40717	-71.13370
Boston-Neponset	Boston	BOS090	pipe	Neponset River	Tenean Beach: Boston CSO #090 located N of Tenean Beach next to Victory Rd Park	42.29820	-71.04658
Boston-Neponset	Boston	TenB01p	pipe	Neponset River	Tenean Beach: 36" concrete outfall w/ vertical bars on opening, N of beach	42.29372	-71.04456
Boston-Neponset	Boston	TenB02p	pipe	Neponset River	Tenean Beach: 48" outfall halfway between TenB01p & opening of BOS090 channel N of beach	42.29488	-71.04522

Basin	Town	ID	Type	Water Body	Description	Lat N	Long W
Boston-Neponset	Boston	PnNC01	stream	Pine Neck Creek	Pine Neck Creek: point of daylighting S of Tenean Beach near Tenean St & Lawley St	42.28933	-71.04179
Boston-Neponset	Milton	PinB01p	pipe	Pine Tree Brook	Pine Tree Brook: pipe at end of Harold St ~200ft DS of pedestrian bridge	42.25417	-71.09028
Boston-Neponset	Milton	UnqB01p	pipe	Unquity Brook	Unquity Brook: rectangular CSO pipe DS of Squantum St (E of 2 circular pipes)	42.26167	-71.04694
Boston-Neponset	Milton	UnqB02	stream	Unquity Brook	Unquity Brook: E culvert DS of Squantum St (middle of 3 culverts/pipes)	42.26167	-71.04694
Boston-Neponset	Milton	UnqB03	stream	Unquity Brook	Unquity Brook: W culvert DS of Squantum St (W of 3 culverts/pipes)	42.26167	-71.04694
Boston-Neponset	Milton	UnqB04	stream	Unquity Brook	Unquity Brook: US of Adams St	42.26028	71.04694
Boston-Neponset	Milton	UnqB05p	pipe	Unquity Brook	Unquity Brook: pipe under Pleasant St	42.259608	-71.051515
Boston-Weymouth & Weir	Quincy	WolB01p	pipe	Wollaston Beach	Wollaston Beach: 18" concrete "CVS" pipe on Quincy Shore Dr near East Squantum St	42.28742	-71.02237
Boston-Weymouth & Weir	Quincy	WolB04p	pipe	Wollaston Beach	Wollaston Beach: 18" clay pipe at Quincy Shore Dr & Webster St	42.28300	-71.01846
Boston-Weymouth & Weir	Quincy	WolB05p	pipe	Wollaston Beach	Wollaston Beach: 4ft rectangular concrete pipe at Quincy Shore Dr & Milton St	42.28138	-71.01725
Boston-Weymouth & Weir	Quincy	WolB10p	pipe	Wollaston Beach	Wollaston Beach: 18"(?) concrete pipe at Quincy Shore Dr & Carle St	42.28021	-71.01534
Boston-Weymouth & Weir	Quincy	WolB20p	pipe	Wollaston Beach	Wollaston Beach: 5.5ft rectangular concrete pipe at Quincy Shore Dr & Sachem St	42.27736	-71.00894
Boston-Weymouth & Weir	Quincy	WolB21p	pipe	Wollaston Beach	Wollaston Beach: 36" concrete pipe at Quincy Shore Drive SE of Sachem St outfall WolB20p	42.27731	-71.00761

Basin	Town	ID	Type	Water Body	Description	Lat N	Long W
Boston-Weymouth & Weir	Quincy	BlaC01	stream	Blacks Creek	Blacks Creek: US of Quincy Shore Dr	42.26645	-70.99710
Boston-Weymouth & Weir	Quincy	BlaC02	stream	Blacks Creek	Blacks Creek: US of Furnace Brook Parkway near Hudson St, same as UMB BCa	42.26019	-71.00816
Boston-Weymouth & Weir	Quincy	FurB01	stream	Furnace Brook	Furnace Brook: DS of MBTA bridge across from 433 Furnace Brook Parkway	42.25744	-71.01045
Boston-Weymouth & Weir	Quincy	FurB02	stream	Furnace Brook	Furnace Brook: where it daylights next to Bernazzani Elem, same as UMB FBd	42.25629	-71.02066
Boston-Weymouth & Weir	Quincy	FurB03	stream	Furnace Brook	Furnace Brook: DS of Fr. McMahon Way (across from Reardon St) by St. Mary's/Joseph's Cemetery	42.24768	-71.02799
Boston-Weymouth & Weir	Quincy	FurB04	stream	Furnace Brook	Furnace Brook: US of Wampatuck Rd	42.23718	-71.03209
Charles	Boston	BOS233p	pipe	Leverett Pond	Leverett Pond: 24" concrete pipe on SE side of Leverett Pond, even w/ homeplate of northern baseball diamond	42.32688	-71.11488
Charles	Boston	BOS037p	pipe	Charles River	Charles River: Herter Park outfall near kiddie playground (S side)	42.36486	-71.13833
Charles	Boston	ChaR01p	pipe	Charles River	Charles River: 24" concrete pipe (S side) DS of BOS031 stormdrain in small tributary channel to the Charles River, across from IHOP on Soldiers Field Rd	42.35933	-71.15788
Charles	Boston	ChaR02p	pipe	Charles River	Charles River: 18" concrete pipe (S side) ~125ft US of N. Beacon/Nonantum rotary on Soldiers Field Rd	42.35833	-71.16173
Charles	Boston	BOS174p	pipe	Charles River	Charles River: 24" clay pipe (S side) ~250ft US of N. Beacon/Nonantum rotary on Soldiers Field Rd	42.35806	-71.16292
Charles	Boston	BOS006	tributary	unnamed brook	Charles River: ~40ft DS of Boston stormdrain #006 at daylighting point of tributary, @ Rt 1 (near East St)	42.26551	-71.16833

Basin	Town	ID	Type	Water Body	Description	Lat N	Long W
Ipswich	Topsfield	HowB01	stream	Howlett Brook	Howlett Brook: Ipswich Road crossing, 2 culverts under bridge	42.65505	-70.91701
Ipswich	Topsfield	HowB02	stream	Howlett Brook	Howlett Brook: East St bridge, very rural	42.66074	-70.91984
Ipswich	Topsfield	HowB03	stream	Howlett Brook	Howlett Brook: North St bridge, horse barn US river right, sample DS	42.66046	-70.93289
Ipswich	Topsfield	MleB03	stream	Miles Brook	Miles Brook: North St crossing	42.65239	-70.94039
Ipswich	Topsfield	HowB05	stream	Howlett Brook	Howlett Brook: Haverhill Road bridge, after Coventry Lane	42.65468	-70.95293
Ipswich	Ipswich	KimB01	stream	Kimball Brook	Kimball Brook: Kimball St bridge, DS	42.67475	-70.84053
Ipswich	Ipswich	KimB0A	stream	Kimball Brook	Kimball Brook: Peabody St crossing, DS side next to factory, park in sand lot	42.67418	-70.84382
Ipswich	Ipswich	KimB02	stream	Kimball Brook	Kimball Brook: Heard Drive crossing, across from # 6	42.67507	-70.84984
Ipswich	Ipswich	KimB03	stream	Kimball Brook	Kimball Brook: Heard Drive behind #8	42.67504	-70.85081
Ipswich	Ipswich	FarB01	stream	Farley Brook	Ipswich River: Farley Brook conduit to Ipswich River ~200-250ft US of Choate bridge	42.67893	-70.83780
Ipswich	Ipswich	FarB02	stream	Farley Brook	Farley Brook: near "Back to Normal Chiropractic" at 78 Central St	42.68173	-70.84102
Merrimack	Methuen	ForL01p	pipe	Forest Lake trib	Forest Lake: pipe on East Side of beach on 7/30 we sampled in a stagnant pool in front of the pipe as there was no flow at time of sampling	42.72986	-71.24915
Merrimack	Methuen	ForL02p	pipe	Forest Lake tributary	Forest Lake: pipe DS of access road on right (West) side of unknown tributary	42.73034	-71.24932
Merrimack	Methuen	ForL03t	unknown tributary	Forest Lake tributary	Forest Lake: unknown stream Northeast of pavilion, DS of access road	42.73039N	-71.24937
Merrimack	Methuen	ForL04t	unknown tributary	Forest Lake tributary	Forest Lake: Palanga St stormwater outfall, South side of boat ramp	42.72646	-71.24287
Merrimack	Lawrence	SpiR02p	pipe	Spickett River	Spickett River: flared concrete pipe, on river left, ~5 feet US of General St bridge	42.70931	-71.15133
Merrimack	Lawrence	SpiR03p	pipe	Spickett River	Spickett River: 24" metal pipe, river left, ~200 feet US of General St bridge	42.70973	-71.15136
Merrimack	Lawrence	SpiR06	stream	Spickett River	Spickett River: Jackson St bridge, DS, basket sampler needed	42.71367	-71.15778

Basin	Town	ID	Type	Water Body	Description	Lat N	Long W
Merrimack	Lawrence	SpiR11	stream	Spickett River	Spickett River: Spickett River off of Broadway St/ Route 28. Access though Mill parking lot at 550 Broadway, site is river left of dam next to the spillway.	42.71492	-71.17872
Merrimack	Lawrence	SpiR15	stream	Spickett River	Spickett River: Hampshire Road bridge, DS side, rural with good riparian buffer	42.74307	-71.20837
Merrimack	Amesbury	PwwR04t	pipe	Unnamed tributary	Powwow River: Noel St, pipe near end of St in drainage ditch	42.85159	-70.92732
Merrimack	Amesbury	PwwR03t	tributary	Unnamed tributary	Powwow River: Noel St drainage ditch to left of Noel St, below entrance to plaza	42.85100	-70.93020
Merrimack	Amesbury	PwwR06p	pipe	Powwow River	Powwow River: Mill St, across from 35 Mill St. at upstream end of dirt lot	42.85628	-70.92886
Merrimack	Amesbury	BakR01	stream	Back River	Back River: Water St bridge, DS side, ~200' us of confluence with Powwow	42.85629	-70.92694
Merrimack	Amesbury	BakR02	stream	Back River	Back River: Cedar St, across from #35 Cedar St.	42.86180	-70.92659
Merrimack	Amesbury	BakR03	stream	Back River	Back River: Clinton St crossing, DS side of bridge	42.86680	-70.92088
Merrimack	Amesbury	BakR04p	pipe	Back River	Back River: 20' DS of Clinton St bridge on river left	42.86680	-70.92082
Merrimack	Amesbury	PwwR08	stream	Powwow River	Powwow River: Pond St bridge, DS, instream sample, but there is a pipe under the bridge- no access	42.85763	-70.93334
Merrimack	Amesbury	PwwR10	stream	Powwow River	Powwow River: DS of High St bridge, ~250' DS of Lake Gardner	42.85845	-70.93823
N. Coastal	Gloucester	GooH01	Marine	Good Harbor	Good Harbor: Foot of Witham St, marine sample ~20' from beach at low tide	42.620815	-70.62791
N. Coastal	Gloucester	GooH02	stream	Unnamed tributary	Good Harbor: ~100' US of footbridge on Nautilus Rd	42.61838	-70.63571
N. Coastal	Swampscott	Phl01p	pipe	Unnamed tributary	Phillips Beach: access at the end of Ocean Ave, Swampscott	42.47226	-70.88491
N. Coastal	Marblehead	StrB01	stream	Unnamed tributary	Stramski Beach stream: end of Stramski Way DS of last culvert before beach	42.514287	-70.865509
N. Coastal	Marblehead	StrB20	stream	Unnamed tributary	Stramski Beach stream: ~190 feet DS of Liberty/Dodge outlet, US side of wooden foot bridge	42.51392	-70.86473
N. Coastal	Marblehead	StrB03p	pipe	Unnamed tributary	Stramski Beach stream: pipe draining Dodge Rd, access behind 23 Dodge Rd, same as SSC 722A	42.513541	-70.864235

Basin	Town	ID	Type	Water Body	Description	Lat N	Long W
N. Coastal	Marblehead	StrB04	stream	Unnamed tributary	Stramski Beach stream: ~6ft US of StrB03p (pipe behind 23 Dodge Rd)	42.513537	-70.864194
N. Coastal	Marblehead	StrB21	stream	Unnamed tributary	Stramski Beach stream: US of culvert that crosses stream (between StrB04 & StrB02t)	42.51364	-70.86345
N. Coastal	Marblehead	StrB02t	tributary	Unnamed tributary	Stramski Beach stream: ~20ft US of Stramski Way culvert & ~50ft DS of pipe draining Pitman Rd, similar to SSC 722B	42.51379	-70.862966
N. Coastal	Marblehead	StrB02p	pipe	Unnamed tributary	Stramski Beach stream: pipe draining Pitman Rd accessed US of Stramski Way culvert (N side), same as SSC 722B	42.513932	-70.862876
N. Coastal	Salem	DerW01p	pipe	Salem Harbor	Derby Wharf: 18" rcp on NW side, same as SSC 630	42.521091	-70.887103
N. Coastal	Salem	NorR01	pipe	North River	North River: Across from #14 Commercial St. Spartan Oil Company aka SSCW #537, river left	42.524470	-70.900660
N. Coastal	Salem	NorR03	stream	North River	North River: Commercial St foot bridge, DS side	42.52312	-70.90384
N. Coastal	Salem	Wil01p	pipe	Unnamed tributary	Pipe at end of Willow Ave, Salem	42.51008	-70.88795
N. Coastal	Danvers	PorR06	stream	Porter River	Porter River: after confluence with Frost Fish Brook, below bridge at Route 62 (Conant St) and Holt Richmond School	42.56806	-70.92791
N. Coastal	Danvers	FrfB00p	pipe	Frost Fish Brook	Frost Fish Brook: pipe under Conant St bridge, river right	42.56814	-70.92781
N. Coastal	Danvers	FrfB01	stream	Frost Fish Brook	Frost Fish Brook: between #6&9 Hemlock St. ~15' from end of fence	42.57003	-70.92779
N. Coastal	Danvers	DonB01	stream	Donegal Brook	Donegal Brook: Mass Ave after Bowdoin St. Park by Electric Pole # 18, follow left side of fence to the brook, the brook daylights in culvert, river right	42.57784	-70.92863
N. Coastal	Danvers	FrfB02	stream	Frost Fish Brook	Frost Fish Brook: Mass Ave after Bowdoin St. Park by Electric Pole # 18, follow left side of fence to the brook ~10' us of Donegal Brook	42.57777	-71.92862
N. Coastal	Danvers	FrfB03	stream	Frost Fish Brook	Frost Fish Brook: Short Rd, ~10' from crossing, access along DS side	42.57384	-70.92990
N. Coastal	Danvers	FrfB04	stream	Frost Fish Brook	Frost Fish Brook: End of Princeton St, follow path to the brook, ~4' US of crossing	42.58406	-70.92915
N. Coastal	Danvers	FrfB05p	pipe	Frost Fish Brook tributary	Frost Fish Brook: End of Princeton St, Outfall is river right	42.58395	-70.92909
N. Coastal	Danvers	FrfB06	stream	Frost Fish Brook	Frost Fish Brook: Dartmouth St crossing, DS side of bridge	42.58821	-70.92836

Basin	Town	ID	Type	Water Body	Description	Lat N	Long W
N. Coastal	Danvers	FrfB07p	pipe	Frost Fish Brook tributary	Frost Fish Brook: culvert at Dartmouth St crossing, DS, river left	42.58820	-70.92834
N. Coastal	Danvers	FrfB09	stream	Frost Fish Brook	Frost Fish Brook: Wildwood Rd Crossing, DS at mouth of culvert	42.58820	-70.92835
Parker	Rowley	OxpB00	stream	Ox Pasture Brook	Ox Pasture Brook: Fenno Drive bridge, bridge closed, very rural, beaver dam backs up flow	42.73308	-70.88012
Parker	Rowley	OxpB02	stream	Ox Pasture Brook	Ox Pasture Brook: School St bridge, stormwater remediation at this site	42.71986	-70.87725
Parker	Rowley	OxpB04	stream	Ox Pasture Brook	Ox Pasture Brook: Independent St crossing	42.71536	-70.88382
Parker	Rowley	BacB00	stream	Bachelor Brook	Bachelor Brook: Wethersfield Road bridge, marshy/ flood plain	42.72611	-70.90871
Parker	Rowley	MilR03	stream	Mill River	Mill River: Wethersfield Road bridge, bridge closed, wetland US	42.72521	-70.91455
Parker	Newbury	LitR02	stream	Little River	Little River: Newman Road, Flows through salt marsh	42.77193	-70.86207
Parker	Newbury	LitR04	stream	Little River	Little River: Hanover St bridge	42.79024	-70.87651
Parker	Newburyport	LitR06	stream	Little River	Little River: Parker St bridge, daylights ~250ft from intersection	42.80042	-70.88331
Parker	Newburyport	LitR07p	pipe	Little River	Little River: Parker St bridge, ~10 us of flowing pipe	42.80042	-70.88331
Parker	Newbury	LitR08	stream	Little River	Little River: Parker (Scotland) Road, 2 large CMP's under bridge. aka TC#5	42.79432	-70.89071
Parker	Newbury	LitR09t	tributary	Unnamed tributary	Parker (Scotland) Road at small trib river right	42.79426	-70.89071
Parker	Newburyport	LitR10t	tributary	Unnamed tributary	Hale St, crossing #1, west of Squires Glen Rd	42.80725	-70.89579
Parker	Newburyport	LitR11t	tributary	Unnamed tributary	Hale St, crossing #2, aka TC#6, across from pump station.	42.80566	-70.90085
Parker	Newburyport	LitR12	tributary	Unnamed tributary	Hale St, crossing #3, aka TC#7 at pull off before 95 underpass	42.80302	-70.91098
Shawsheen	Lawrence	ShaR01t	tributary	unnamed brook	Shawsheen River: tributary E of S Lawrence E Elem. School, ~50ft US of confluence w/ Shawsheen R.	42.69629	-71.14550

Basin	Town	ID	Type	Water Body	Description	Lat N	Long W
Shawsheen	Lawrence	ShaR02t	tributary	unnamed brook	Shawsheen River: conduit at upper end of tributary E of S Lawrence E Elem. School	42.69553	-71.14606
Shawsheen	Andover	AN35	pipe	Rogers Brook	Shawsheen River: 30" concrete pipe ~100ft DS of Rt 28 on SE side of river	42.66514	-71.14545
Shawsheen	Andover	RB01	stream	Rogers Brook	Rogers Brook: even w/ shed behind #5 Dundee Park (Yang's Fitness Center)	42.65399	-71.14759
Shawsheen	Andover	RB01a	stream	Rogers Brook	Rogers Brook: US of Whittier St	42.65582	-71.13525
Shawsheen	Andover	AN49	pipe	Rogers Brook	Rogers Brook: 18" concrete pipe ~50ft US of Whittier St	42.65575	-71.13517
Shawsheen	Andover	RB02	stream	Rogers Brook	Rogers Brook: DS of Chestnut Ct	42.65585	-71.13328
Shawsheen	Andover	AN52	pipe	Rogers Brook	Rogers Brook: 36" concrete pipe at end of Chestnut Ct near Andover Housing Authority	42.65614	-71.13175
Shawsheen	Andover	AN53	pipe	Rogers Brook	Rogers Brook: 36" concrete pipe ~150-200ft DS of Morton St	42.65621	-71.13028
Shawsheen	Andover	RB-030	stream	Rogers Brook	Rogers Brook: US of Morton St	42.65615	-71.12935
Shawsheen	Bedford	SH-440	stream	Shawsheen River	Shawsheen River: DS of Summer St	42.47380	-71.26394
SuAsCo	Framingham	CocB01	stream	Cochituate Brook	Cochituate Brook: DS of School St	42.32143	-71.39638
SuAsCo	Framingham	CocB02	stream	Cochituate Brook	Cochituate Brook: DS of Old Connecticut Path	42.31639	-71.39133
SuAsCo	Framingham	CocB03	stream	Cochituate Brook	Cochituate Brook: ~15 ft DS of Speen St (by #150 Speen St)	42.31143	-71.38693
SuAsCo	Framingham	CocB04t	tributary	unnamed brook	Cochituate Brook: northernmost of 4 culverts feeding tributary joining Cochituate Brook near Rt 9	42.29912	-71.39432
SuAsCo	Framingham	CocB05	stream	Cochituate Brook	Cochituate Brook: N (DS) of Rt 9	42.29907	-71.39358
SuAsCo	Natick	CocB06	stream	Cochituate Brook	Cochituate Brook: @ #15 Strathmore Rd (Next Generation Children's Center)	42.29499	-71.38630

APPENDIX D Landuse Analysis

MassGIS data layers were used to calculate area for new sub-watersheds that were sampled in 2008. Area was typically calculated for the portion of the sub-watershed that was upstream of the most downstream sampling location. Landuse in the sub-watersheds was derived from MassGIS digital imagery captured in spring 2005. The data set is divided into forty landuse categories. NERO BST staff grouped these landuses into a smaller number of groupings as follows:

Landuse Group	Landuse Categories
Commercial	Commercial, industrial, urban open, transportation, marina, urban public, nursery, junkyards
Forest	Forest, brushland/successional
Open Space	Crop land, pasture, open land, participation recreation, golf course, cemetery, orchard
Residential	Multi-family residential, high density residential, medium density residential, low density residential, very low density residential
Water Resources	Wetland, water-based recreation, saltwater wetland, water, cranberry bog, saltwater sandy beach, new ocean, forested wetland
Other	Mining, spectator recreation, waste disposal, powerline

APPENDIX E Measures L, Y, and W

As part of DWM's Performance Partnership Agreement with EPA, an emphasis has been placed on conducting BST work in segments that may lead to measure L, Y, or W restoration. Measure Y measures the number of impairments that are corrected for impaired water bodies. Measure L is an indicator of the number of segments / water bodies that are restored (i.e. water bodies with only one impairment). Measure W is a measure of the number of HUC-12 watersheds where 40% or more of the segments / water bodies show significant watershed wide improvement (there may originally be more than one impairment).

EPA measures L, Y, and W were incorporated into the NERO Bacteria Source Tracking (BST) program in 2008. Most sub-basins in the 2008 Sampling Analysis Plan (SAP) were assigned to one of the measures. In a number of instances, NERO regional monitoring coordinators tracked bacteria pollution to municipal stormdrain outfalls. NERO took an aggressive enforcement approach to such cases, issuing section 303 information requests or Notices of Noncompliance (NONs), depending on the severity of the pollution and resource impacted. These actions typically required the municipality to submit copies of sanitary sewer and stormdrain maps to MassDEP, and create and implement an Illicit Discharge Detection and Elimination (IDDE) plan which is approved by MassDEP. IDDE work that is typically performed by the municipality may include further monitoring in stormdrain manholes upstream of the contaminated outfall, dye testing, and CCTV inspection work, among others. NERO regional monitoring coordinators track progress of IDDE work and conduct follow-up sampling after a bacteria source has been identified and eliminated.

The examples described below illustrate instances where significant progress has been made on IDDE work, potentially leading to future improvements in water quality. It is important to note, however, that 2008 enforcement actions were recently issued, and municipalities have just begun IDDE investigations.

2008 Actions:

- **Constitution Beach vicinity** (Boston, Boston Harbor – Mystic Basin)- An *E. coli* concentration of 24,196 Most Probable Number (MPN) per 100 milliliters (mL) was measured at a stormwater pipe discharging to this **measure Y** segment. The Boston Water and Sewer Commission was notified and provided MassDEP an update on IDDE work being performed in this area. NERO regional monitoring coordinators will continue to track further progress.
- **Derby Wharf** (Salem, North Coastal Basin)- *Enterococcus* spp. concentrations up to more than 10,000 MPN/100mL were measured in 2007 at a stormwater pipe discharging near Derby Wharf in this **measure Y** segment. The City of Salem was issued a NON and initiated IDDE work that included installation of a duck-bill tide gate over the mouth of the outfall to prevent contaminated surface water from flowing back into the drain at high tide. Follow-up human marker sampling (lab analyses performed by the MassDEP Wall Experiment Station) in 2008 revealed "strong" evidence of a human wastewater source in this drainage area, as well as for a stormwater pipe discharging to the North River. The

City has been notified and will conduct further IDDE work in both systems. NERO regional monitoring coordinators will continue to track progress and conduct follow-up sampling as appropriate.

- **Ell Pond** (Melrose, Boston Harbor – Mystic Basin)- *E. coli* concentrations of more than 241,000 MPN/100mL were measured at stormwater pipes discharging to this **measure Y** segment. The Town of Melrose has been issued a NON. NERO regional monitoring coordinators will track progress of IDDE work.
- **Kimball Brook** (Ipswich, Ipswich Basin) - *Enterococcus* spp. concentrations of up to 1,624 MPN/100mL were measured instream in this **measure W** segment. The Town of Ipswich has been issued a 303 information request. NERO regional monitoring coordinators will track progress of IDDE work.
- **Leverett Pond** (Boston, Charles Basin)- *E. coli* concentrations up to nearly 13,000 MPN/100mL were measured at a stormwater pipe discharging in this **measure Y** segment. The Boston Water and Sewer Commission was notified and provided MassDEP an update on IDDE work being performed in this area. NERO regional monitoring coordinators will continue to track further progress.
- **Powwow River** (Amesbury, Merrimack Basin) – *Enterococcus* spp. concentrations were found in excess of 14,000 MPN/ 100mL at a stormwater pipe discharging in this **measure Y** segment. The Town of Amesbury was issued a NON. NERO regional monitoring coordinators will track progress of IDDE work.
- **Shawsheen River tributary** (Lawrence, Shawsheen Basin)- *E. coli* concentrations up to more than 1,900 MPN/100mL were collected in 2007 from a small tributary where it daylighted before joining this **measure Y** segment. A strong sewage odor was apparent and what appeared to be sewage fungus was observed in the benthos of the stream. The City of Lawrence was issued a NON, initiated IDDE work, and recently repaired a break in a sewer line where it crossed a drain line. Follow-up sampling conducted by NERO regional monitoring coordinators in Fall 2008 showed a marked decrease in bacteria concentration. Further sampling will be conducted during warm weather conditions in 2009.
- **Spickett River** (Lawrence, Merrimack Basin) – *E. coli* concentrations of over 15,000 MPN/100mL were measured at a stormwater pipe discharging in this **measure Y** segment. Lawrence General Hospital (LGH) was notified of this discharge via a 303 information request. LGH initiated IDDE work and believed it had remediated a bacteria source. However, follow-up sampling showed that there was still a problem in this line. NERO staff conducted a site inspection with LGH officials. A dumpster leaking above a catch basin was identified as a possible bacteria source. LGH has been notified that it should protect the area around the dumpster from contributing polluted runoff to the stormdrain system. NERO regional monitoring coordinators will conduct follow-up sampling.

- **Tenean Beach vicinity** (Boston, Boston Harbor – Neponset Basin) – *Enterococcus* spp. concentrations up to more than 11,000 MPN/100mL were measured at a former Combined Sewer Overflow (CSO) outfall discharging in this **measure Y** segment. Additionally, human marker sampling (lab analyses performed by the MassDEP Wall Experiment Station) revealed “strong” evidence of a human wastewater source in this drainage area. The Boston Water and Sewer Commission has been notified and will provide MassDEP an update on IDDE work being performed in this area. NERO regional monitoring coordinators will track progress of IDDE work.