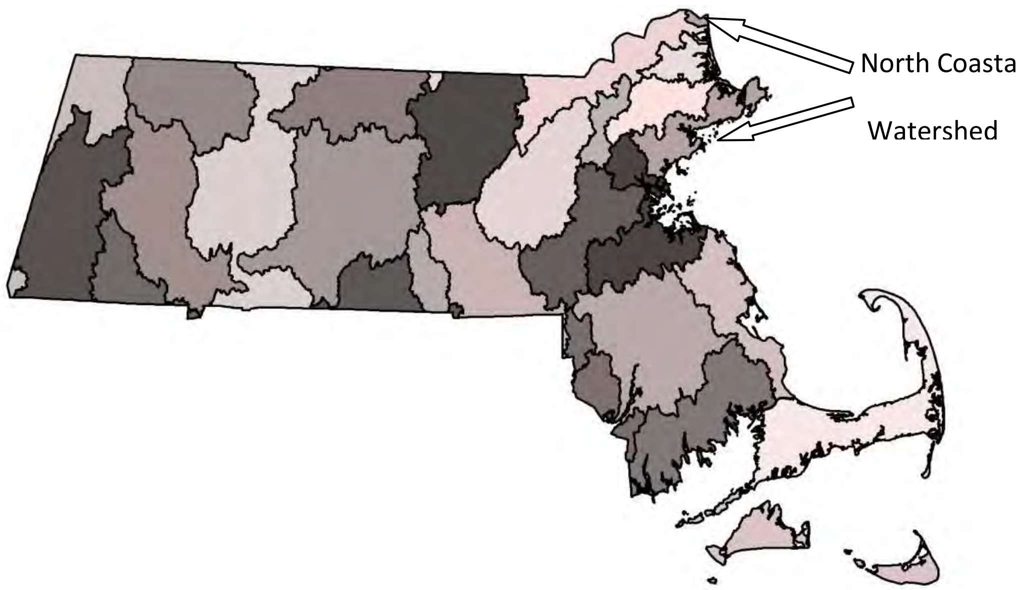
Final Pathogen TMDL for the North Coastal Watershed
March 2012

(Control Number CN: 155.0)



Prepared as a cooperative effort by:

Massachusetts DEP
1 Winter Street
Boston, Massachusetts 02108

USEPA New England Region 1
1 Congress Street, Suite 1100
Boston, Massachusetts 02114

ENSR International
2 Technology Park Drive
Westford, MA 01886

NOTICE OF AVAILABILITY

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

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

This report is also available from MassDEP at: www.mass.gov/dep/water/resources/tmdls.htm

A complete list of reports published by the Division of Watershed Management since 1963 is updated annually. This list, titled "Publications of the Massachusetts Division of Watershed Management (DWM) – Watershed Planning Program, 1963-(current year)", is available at: http://www.mass.gov/dep/water/priosres.htm

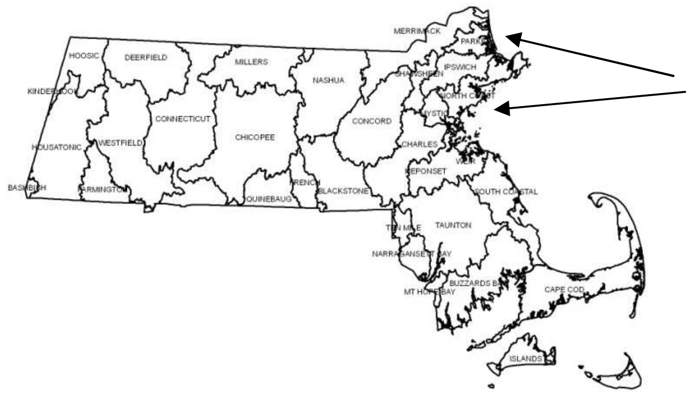
DISCLAIMER

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

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

Much of this document was prepared using text and general guidance from the previously approved Charles River Basin, Buzzards Bay and Cape Cod Bacteria Total Maximum Daily Load documents.

Total Maximum Daily Loads for Pathogens within the North Coastal Watershed



Location of the North Coastal Watershed

Key Features: Pathogen TMDL for the North Coastal Watershed
Location: EPA Region 1
Land Type: New England Coastal
303(d) Listings: Pathogens:

Alewife Brook (MA93-45)
Alewife Brook (MA93-46)
Annisquam River (MA93-12)
Bass River (MA93-08)
Beaverdam Brook (MA93-30)
Bennetts Pond Brook (MA93-48)
Beverly Harbor (MA93-20)
Cat Brook (MA93-29)
Causeway Brook (MA93-47)
Crane Brook (MA93-02)
Crane River (MA93-41)
Danvers River (MA93-09)
Essex River (MA93-11)
Essex Bay (MA93-16)
Frost Fish Brook (MA93-36)
Gloucester Harbor (MA93-18)
Goldthwait Brook (MA93-05)
Hawkes Brook (MA93-32)
Hawkes Brook (MA93-33)
Lynn Harbor (MA93-52)
Lynn Harbor (MA93-53)
Manchester Harbor (MA93-19)
Marblehead Harbor (MA93-22)
Mill River (MA93-28)
Mill River (MA93-31)
Nahant Bay (MA93-24)
North River (MA93-42)
Pines River (MA93-15)
Porter River (MA93-04)
Proctor Brook (MA93-39)

Proctor Brook (MA93-40)
Rockport Harbor (MA 93-57, formerly MA93-17 on 2008 Integrated List)
Salem Harbor (MA93-21, formerly MA93-21 on 2008 Integrated List)
Salem Sound (MA93-55, formerly MA93-25 on 2008 Integrated List)
Salem Sound (MA93-56, formerly MA93-25 on 2008 Integrated List)
Saugus River (MA93-34)
Saugus River (MA93-35)
Saugus River (MA93-43)
Saugus River (MA93-44)
Shute Brook (MA93-49)
Shute Brook (MA93-50)
Unnamed Tributary (MA93-51)
Waters River (MA93-01)

Data Sources:

- Coastal Zone Management (CZM) 2004. Gloucester Harbor Characterization: Environmental History, Human Influences, and Status of Marine Resources.
- Division of Marine Fisheries (DMF) 2002. The Marine Resources of Salem Sound, 1997.
- MassDEP 2000. North Coastal Watershed 1997/1998 Water Quality Assessment Report.
- Saugus River Watershed Council (SRWC) 2004. Saugus River Watershed 2003 Water Quality Report.
- Salem Sound Coast Watch (SSCW) 2004. Salem Sound Clean Beaches and Streams Program 2004 Report.

Data Mechanism:

Massachusetts Surface Water Quality Standards for Bacteria; The Federal BEACH Act; Massachusetts Department of Public Health Bathing Beaches; Massachusetts Division of Marine Fisheries shellfishing Sanitation and Management; Massachusetts Coastal Zone Management

Monitoring Plan:

Massachusetts Watershed Five-Year Cycle; Division of Marine Fisheries Shellfishing Data; Department of Public Health Beaches Data; Coastal Zone Management Data

Control Measures:

Watershed Management; Stormwater Management (e.g., illicit discharge removals, public education/behavior modification); Combined Sewer Overflow (CSO) & Sanitary Sewer Overflow (SSO) Abatement; Agricultural and other BMPs; No Discharge Areas; By-laws; Ordinances; Septic System Maintenance/Upgrades; waterfowl management.

Executive Summary

Purpose and Intended Audience

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

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

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

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

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

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

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

North Coastal Watershed

The North Coastal Watershed is geographically comprised of 4 major systems: the Essex Bay System; the Annisquam River System, the Salem Sound System; and the Saugus River System. The watershed has 6 major harbors: Rockport, Gloucester, Manchester, Beverly, Salem, and Lynn. Marinas, yacht clubs, and boatyards provide critical services to the boating public—maintaining, mooring, fueling, storing, and launching vessels of all kinds. The entire area is very densely populated, with various studies indicating particularly extensive impervious surfaces (up to 30% or greater) created by dense housing developments, commercial buildings, roads, and parking lots. Stormwater runoff from these areas has moderate to high bacterial loadings, which affects the integrity of swimming and shellfishing areas in the estuary and harbor areas. Numerous stormdrains discharge directly to the harbor areas, and the tributaries that connect with the harbors or estuary areas. Sampling has demonstrated high bacteria levels, particularly following wet weather events. Prime bacterial sources in the stormwater appear to be from failing sewer line infrastructure, failing septic systems, and animal (pet, bird) waste. Boat wastes also contribute to water quality issues in the harbor areas.

Besides numerous stormdrains going into the harbors, Combined Sewer Overflows (CSO's) have been a historical problem, particularly in Gloucester and Lynn Harbors, and in the Nahant Bay area. CSO's have also affected adjoining tributaries to these harbors: Mill and Annisquam Rivers going into Gloucester Harbor, and the Saugus River System going into the Lynn Harbor. Both Gloucester and Lynn are under joint Federal/State Judgments to eliminate all CSO's and to address contaminated stormwater.

Failing septic systems have been a problem throughout the watershed in non-sewered areas. In particular, there have been extensive problems in the Essex Bay system with impaired segments located in the towns of Essex, Ipswich, and Gloucester. A consent decree between the town of Essex and MassDEP regarding failed systems, and the city of Gloucester Federal/State Judgment on removing failed systems, has resulted in a success story. The completed sewer line construction expansion project removed many failed systems by tying these homes and businesses into the Gloucester WWTP facility.

In an effort to provide guidance for setting bacterial implementation priorities within the North Coastal Watershed, a summary table is provided. Table ES- 1 below provides a prioritized list of pathogen-impaired segments that will require additional bacterial source tracking work and stepwise implementation of structural and non-structural Best Management Practices (BMPs). Since limited source information and data are available in each impaired segment a simple scheme was used to prioritize segments based on fecal coliform concentrations. High priority was assigned to those segments where either dry or wet weather concentrations (end of pipe or ambient) were equal to or greater than 10,000 cfu/100 mL. Medium priority was assigned to segments where concentrations ranged from 1,000 to 9,999 cfu/100 mL. Low priority was assigned to segments where concentrations were observed less than 1,000 cfu/100 mL. MassDEP believes the higher concentrations are indicative of the potential presence or raw sewage and, therefore, they pose a greater risk to the public. It should be noted that in all cases, waters exceeding the water quality standards identified in Table ES- 1 are considered impaired.

Also, prioritization is adjusted upward based on proximity of waters, within the segment, to sensitive areas such as Outstanding Resource Waters (ORW's), or designated uses that require higher water quality standards than Class B, such as public water supply intakes, public swimming areas, or shellfish areas. Best professional judgment was used in determining this upward adjustment. Generally speaking, waters that were determined to be lower priority based on the numeric range identified above were elevated up one level of priority if that segment were adjacent to or immediately upstream of a sensitive use. An asterisk * in the priority column of the specific segment would indicate this situation.

MassDEP believes that segments ranked as high priority in Table ES-1 are indicative of the potential presence of raw sewage and, therefore, they pose a greater risk to the public. Elevated dry weather bacteria concentrations could be the result of illicit sewer connections or failing septic systems. As a result, the first priority should be given to bacteria source tracking activities in those segments where sampling activities show elevated levels of bacteria during dry weather. Identification and remediation of dry weather bacteria sources is usually more straightforward and successful than tracking and eliminating wet weather sources. If illicit bacteria sources are found and eliminated it should result in a dramatic reduction of bacteria concentration in the segment in both dry and wet-weather. Segments that remain impaired during wet weather should be evaluated for stormwater BMP implementation opportunities starting with less costly non-structural practices first (such as street sweeping, and/or managerial approaches are using local regulatory controls), followed by more expensive structural measures. Structural stormwater BMP implementation may require additional study to identify cost efficient and effective technology. In many cases the DMF sampling results that were used to develop Table ES-1 don't differentiate whether the sampling was conducted during wet or dry weather.

Table ES-1. Bacteria Impaired Segment Priorities- North Coastal Watershed (By Sub- Basin Systems).

Segment ID	Segment Name	Segment Type, Class	Size[1]	Segment Description	Priority "Dry"	Priority "Wet"
Essex Bay System						
MA93-45	Alewife Brook, B	River	1.4	Headwaters, outlet Chebacco Lake, Essex to Landing Road, Essex.	Medium	High
MA93-46	Alewife Brook, SA	Estuary	0.01	Landing Road, Essex to confluence with Essex River, Essex.	Medium* shellfishing	High* shellfishing
MA93-11	Essex River, SA	Estuary	0.5	Source east of Southern Avenue to mouth at Essex Bay, Essex.	Medium* (possible illicit discharges) ORW, shellfishing	High* (from Alewife Bk trib) ORW, shellfishing
MA93-16	Essex Bay, SA	Estuary	1.0	Essex/Ipswich/Gloucester	Insufficient Data, public swimming, shellfishing	Insufficient Data, public swimming, shellfishing
Annisquam River System						
MA93-28	Mill River, SA	Estuary	0.1	Outlet Mill Pond, Gloucester to confluence with Annisquam River, Gloucester.	Medium* shellfishing	Medium* Sewer pump stations shellfishing
MA93-12	Annisquam River, SA	Estuary	0.82	The waters from the Gloucester Harbor side of the Route 127 bridge, Gloucester to Ipswich Bay at an imaginary line drawn from Bald Rocks to Wigwam Point, Gloucester.	Insufficient Data shellfishing	Insufficient Data 2 Sewer pump stations shellfishing
MA-93-57 (formerly	Rockport Harbor, SB	Estuary	0.35	Waters landward of an imaginary line from Gully Point,	Insufficient Data	Insufficient Data

Segment ID	Segment Name	Segment Type, Class	Size[1]	Segment Description	Priority "Dry"	Priority "Wet"
MA93-17)				Rockport to Granite Pier, Rockport (including Back Harbor and a portion of Sandy Bay) (includes area formerly reported as segment MA93-17)		
MA93-18	Gloucester Harbor, SB	Estuary	2.3	The waters landward of an imaginary line drawn between Mussel Point and the tip of the Dog Bar Breakwater, Gloucester excluding the Annisquam River.	Medium* public swimming, 3 sewer pump stations, CSOs, shellfishing in adjoining waterbody	High* public swimming, 3 sewer pump stations, CSOs, shellfishing in adjoining waterbody
Salem Sound System						
MA93-47	Causeway Brook, B	River	1.1	Headwaters, outlet Dexter Pond, Manchester to confluence with Cat Brook, Manchester	Medium	High
MA93-29	Cat Brook, B	River	1.7	Headwaters north of Route 128 Manchester/Essex/Gloucester to confluence Manchester Harbor, Manchester.	Medium	High (one reading 10,000cfu)
MA93-19	Manchester Harbor, SB	Estuary	0.33	The waters landward of an imaginary line drawn between Gales Point and Chubb Point, Manchester excluding Cat Brook.	Medium (possible illicit discharges)	Medium
MA93-08	Bass River, SA	Estuary	0.12	Outlet of Lower Shoe Pond north of Route 62 to confluence with Danvers River, Beverley.	High* (possible illicit discharges)	High* (wet weather maximums)
MA93-36	Frost Fish Brook, B	River	1.0	Cabot Road, Danvers to Porter River confluence at Route 62.	Medium (possible illicit discharges)	Medium
MA93-04	Porter River, SA	Estuary	0.13	Confluence with Frost Fish Brook at Route 62 to confluence with Danvers River, Danvers.	High (possible illicit discharges)	Medium*
MA93-02	Crane Brook, B	River	1.8	Headwaters east of route 95, to inlet Mill Pond, Danvers.	Medium (possible illicit discharges)	Medium (wet weather highs, 2002 survey)
MA93-41	Crane River, SA	Estuary	0.07	Outlet pump house sluiceway at Purchase Street, Danvers to confluence Danvers River, Danvers.	Insufficient Data,	Insufficient Data,

Segment ID	Segment Name	Segment Type, Class	Size[1]	Segment Description	Priority "Dry"	Priority "Wet"
MA93-01	Waters River, SA	Estuary	0.09	Headwaters west of Route 128, Peabody/Danvers, to confluence with Danvers River, Danvers.	Medium*	Medium*
MA93-05	Goldthwait Brook, B	River	3.3	Outlet Cedar Pond, Peabody to confluence with Proctor Brook, Peabody.	Low	Medium
MA93-39	Proctor Brook, B	River	2.9	Outlet of small pond in wetland north of Downing Road, Peabody to Grove/Goodhue Street bridge, Salem (formerly part of 93-05).	Medium	Medium
MA93-42	North River, SA	Estuary	0.15	Downstream of Route 114 bridge (Proctor Brook becomes North River at this bridge), Salem to confluence with Danvers River, Salem (formerly part of MA93-06).	Insufficient Data,	Insufficient Data,
MA93-09	Danvers River, SA	Estuary	0.53	Confluence with Porter, Crane and Waters rivers, Danvers to mouth at Beverly Harbor, Beverly/Salem.	Medium*	Medium*
MA93-20	Beverly Harbor, SB	Estuary	1.02	From the mouth of the Danvers River, Salem/Beverly to an imaginary line from Juniper Point, Salem to Hospital Point, Beverly.	Medium* (possible illicit discharges) public swimming	Medium* public swimming,
MA93-40	Proctor Brook, SA	Estuary	0.01	Grove/ Goodhue Street bridge, Salem to Route 114 culvert, Salem (formerly part of MA93-06)	Medium	Medium
MA93-54 (formerly MA93-21)	Salem Harbor, SB	Estuary	4.91	Waters landward of an imaginary line from Naugus Head, Marblehead to the northwest point of Bakers Island, Salem to Hospital Point, Beverly to Juniper Point, Salem (excluding Forest River) (formerly segment MA93-21 Salem Harbor and a portion of segment MA93-25 Salem Sound [waterbody code 93907])	High* (possible illicit discharges) public swimming,	Medium* public swimming
MA93-22	Marblehead Harbor, SA	Estuary	0.56	The waters landward of an imaginary line drawn northwesterly from the northern tip of Marblehead Neck to Fort Sewall, Marblehead.	High* (possible illicit discharges)	Medium*
MA93-55 (formeryMA93	Salem Sound, SA	Estuary	3.46	Northern portion of Salem Sound, waters landward of and	Medium* public	Medium* public

Segment ID	Segment Name	Segment Type, Class	Size[1]	Segment Description	Priority "Dry"	Priority "Wet"
-25)				within imaginary lines from Chubb Point, Manchester to Gales Point , Manchester to the northwest point of Bakers Island, Salem to Hospital Point, Beverly (formerly reported as a portion of segment MA93-25)	swimming,	swimming,
MA93-56 (formerly MA93-25)	Salem Sound, SA	Estuary	2.55	Southern portion of Salem Sound, waters landward of and within imaginary lines from Fort Sewall, Marblehead to the Marblehead Lighthouse on Marblehead Neck, Marblehead to the northwest point of Bakers Island, Salem to Saugus Head, Marblehead (formerly reported as a portion of segment MA93-25)	Medium* public swimming,	Medium* public swimming,
MA93-24	Nahant Bay, SA	Estuary	5.1	The waters landward of an imaginary line drawn between Galloupes Point, Swampscott and East Point, Nahant.	Medium* public swimming, CSO	High* public swimming, CSO
Saugus River System						
MA93-34	Saugus River, B	River	3.1	Headwaters, outlet of Lake Quannapowitt, Wakefield (thru Reedy Meadow) to Lynn Water & Sewer Commission diversion canal, Wakefield/Lynnfield (canal diverts to Hawks Pond) (formerly part of segment MA93-13).	Medium	High
MA93-30	Beaverdam Brook, B	River	1.5	Headwaters west of Main Street, Lynnfield to confluence with Saugus River, Lynnfield.	Medium	Low
MA93-35	Saugus River, B	River	5.4	From the Lynn Water & Sewer Commission diversion canal, Wakefield/Lynnfield to Saugus Iron Works, Bridge Street, Saugus (formerly part of segment MA93-13).	Medium* public swimming	High* public swimming
MA93-31	Mill River, B	River	2.0	From headwaters in wetlands north of Salem Street in Wakefield to confluence with Saugus River, Wakefield.	Medium	Medium
MA93-32	Hawkes Brook, A	River	2.6	Headwaters at the Lynn/Lynnfield border to the outlet of Hawkes Pond in North Saugus.	High* (possible illicit discharges) ORW	Medium* ORW

Segment ID	Segment Name	Segment Type, Class	Size[1]	Segment Description	Priority "Dry"	Priority "Wet"
MA93-33	Hawkes Brook, B	River	1.1	Outlet of Hawkes Pond, North Saugus to confluence with Saugus River, Saugus.	Medium (possible illicit discharges)	Low
MA93-48	Bennetts Pond Brook, B	River	2.4	Headwaters east of Lynn Fells Parkway (in Bellevue Golf Course), Melrose to confluence with Saugus River, Saugus.	Medium	Medium
MA93-49	Shute Brook, SA	Estuary	0.01	Approximately 350 feet downstream from Central St., Saugus to the confluence with the Saugus River, Saugus.	Medium*	High*
MA93-50	Shute Brook, B	River	0.89	From the confluence with Fiske Brook, Saugus to approximately 350 feet downstream from Central St., Saugus.	Medium	High
MA93-43	Saugus River, SB	Estuary	0.04	Saugus Iron Works, Bridge Street , Saugus, to Lincoln Avenue/Boston Street, Saugus/Lynn (formerly part of segment (MA93-14).	Insufficient Data	Insufficient Data
MA93-44	Saugus River, SB	Estuary	0.36	Lincoln Avenue/Boston Street, Saugus/Lynn to mouth (east of Route 1A) at Lynn Harbor, Lynne/Revere (formerly part of 93-14).	Medium* ORW, CSOs	High* ORW, CSOs
MA93-51	Unnamed Tributary, SA	Estuary	0.02	Unnamed tributary locally known as "Town Line Brook" from Route 99, Malden to the confluence with the Pines River, Revere.	Medium*	High*
MA93-15	Pines River, SB	Estuary	0.58	Headwaters east of Route 1, Revere/Saugus to confluence with the Saugus River, Saugus/Revere.	High* (possible illicit discharges) ORW,	Medium* ORW
MA93-52	Lynn Harbor, SB	Estuary	1.6	The "inner" portion of Lynn Harbor; the waters landward of an imaginary line from Black Rock Point, Nahant to the eastern edge of Point of Pines, Revere excluding the Saugus River (formerly part of 93-23)..	High* (possible illicit discharges) CSOs	High* CSOs
MA93-53	Lynn Harbor, SB	Estuary	6.6	The "outer" portion of Lynn Harbor; the waters landward of an imaginary line drawn from Baileys Hill, Nahant to the eastern point of Winthrop Highlands, Winthrop to the seaward edge of the "inner" portion of Lynn Harbor (at an	High* (effects from the inner harbor) CSOs	High* (effects from the inner harbor) CSOs

Segment ID	Segment Name	Segment Type, Class	Size[1]	Segment Description	Priority "Dry"	Priority "Wet"
				imaginary line drawn from Black Rock Point, Nahant to the eastern edge of Point of Pines, Revere) (formerly part of segment 93-23).		

[1] Units = Miles for river segments and square miles for estuaries

TMDL OVERVIEW

The Massachusetts Department of Environmental Protection (MassDEP) is responsible for monitoring the waters of the Commonwealth, identifying those waters that are impaired, and developing a plan to bring them back into compliance with the Massachusetts Water Quality Standards (WQS). The Massachusetts Year 2008 Integrated List of Waters contains a list of impaired waters (Category 5 Waters) that require a TMDL (formerly known as the "303d list"), which identifies impaired segments of rivers and streams, coastal waters, and the reasons for the impairment.

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

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

Sources of indicator bacteria in the North Coastal are believed to be primarily from boat wastes; failing septic systems; pets, wildlife, and birds; and stormwater. Section 5 provides a general compilation of likely bacteria sources in the North Coastal watershed including failing septic systems, combined sewer overflows (CSO), sanitary sewer overflows (SSO), sewer pipes connected to storm drains, certain recreational activities, wildlife including birds along with domestic pets and animals and direct overland stormwater runoff. Note that bacteria from wildlife would be considered a natural condition unless some form of human inducement, such as feeding, is causing congregation of wild birds or animals. A discussion of pathogen related control measures and best management practices are provided in the companion document:

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

This TMDL applies to the 43 pathogen impaired segments of the North Coastal watershed that are currently listed on the CWA § 303(d) list of impaired waters. MassDEP recommends however, that the information contained in this TMDL guide management activities for all other waters throughout the watershed to help maintain and protect existing water quality. For these non-impaired waters, Massachusetts is proposing "pollution prevention TMDLs" consistent with CWA § 303(d)(3).

The analyses conducted for the pathogen impaired segments in this TMDL would apply to the non-impaired segments, since the sources and their characteristics are equivalent. The concentration waste load and/or load allocation for each source and designated use would be the same as specified in this TMDL. Therefore, the pollution prevention TMDLs would have identical waste load and load allocations based on the sources present and the designated use of the water body segment (see Table ES-2 and Table 7-1).

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

Since accurate estimates of existing sources are generally unavailable, it is difficult to estimate the pollutant reductions for specific sources. For the illicit sources, the goal is complete elimination (100% reduction). However, overall wet weather indicator bacteria load reductions can be estimated using typical stormwater bacteria concentrations. These data indicate that in general two to three orders of magnitude (i.e., greater than 90%) reductions in stormwater fecal coliform loading will be necessary, especially in developed areas.

TMDL goals for each type of bacteria source are provided in Table ES-2. Municipalities are the primary responsible parties for elimination of pathogen sources. TMDL implementation to achieve these goals should be an iterative process by first prioritizing areas based on available data while considering their impact to downgradient resources. This information should then be used to identify and remove specific sources including the removal of illicit connections (if applicable) contributing to wet and dry weather violations. Once illicit connections are removed then priority should be given to identifying and implementing best management practices (BMPs) to mitigate stormwater runoff. Certain towns in the watershed are classified as Urban Areas by the United States Census Bureau and are subject to the Stormwater Phase II Final Rule that requires the development and implementation of an illicit discharge detection and elimination plan.

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

Table ES-2. Sources and Expectations for Limiting Bacterial Contamination in the North Coastal Watershed.

Surface Water Classification	Pathogen Source	Waste Load Allocation Indicator Bacteria (cfu/100 mL)[1]	Load Allocation Indicator Bacteria (cfu/100 mL)[1]
A, B, SA, SB (prohibited)	Illicit discharges to storm drains	0	Not applicable
	Leaking sanitary sewer lines	0	Not Applicable
	Failing septic systems	Not Applicable	0
A (Includes filtered water supply) & **B**	Any regulated discharge- including stormwater runoff[4] subject to Phase I or II NPDES permits, NPDES wastewater treatment plant discharges [7,9], and combined sewer overflows[6].	Either; a) E. coli <=geometric mean[5] 126 colonies per 100 mL; single sample <=235 colonies per 100 mL; or b) Enterococci geometric mean[5] <= 33 colonies per 100 mL and single sample <= 61 colonies per 100 mL	Not Applicable
	Nonpoint source stormwater runoff[4]	Not Applicable	Either a) E. coli <=geometric mean[5] 126 colonies per 100 mL; single sample <=235 colonies per 100 mL; or Enterococci geometric mean[5]<= 33 colonies per 100 mL and single sample <= 61 colonies per 100 mL
SA (approved for shellfishing)	Any regulated discharge - including stormwater runoff[4] subject to Phase I or II NPDES permits, NPDES wastewater treatment plant discharges[7,9], and combined sewer overflows[6].	Fecal Coliform <= geometric mean, MPN, of 14 organisms per 100 mL nor shall 10% of the samples be >=28 organisms per 100 mL	Not Applicable
	Nonpoint Source Stormwater Runoff[4]	Not Applicable	Fecal Coliform <= geometric mean, MPN, of 14 organisms per 100 mL nor shall 10% of the samples be >=28 organisms per 100 mL

Surface Water Classification	Pathogen Source	Waste Load Allocation Indicator Bacteria (cfu/100 mL)[1]	Load Allocation Indicator Bacteria (cfu/100 mL)[1]
SA & SB[10] (Beaches[8] and non-designated shellfish areas)	Any regulated discharge - including stormwater runoff[4] subject to Phase I or II NPDES permits, NPDES wastewater treatment plant discharges[7,9], and combined sewer overflows[6].	Enterococci - geometric mean[5] <= 35 colonies per 100 mL and single sample <= 104 colonies per 100 mL	Not Applicable
	Nonpoint Source Stormwater Runoff[4]	Not Applicable	Enterococci -geometric mean[5] <= 35 colonies per 100 mL and single sample <= 104 colonies per 100 mL
SB (approved for shellfishing w/depuration)	Any regulated discharge - including stormwater runoff[4] subject to Phase I or II NPDES permits, NPDES wastewater treatment plant discharges[7,9], and combined sewer overflows[6].	Fecal Coliform <= median or geometric mean, MPN, of 88 organisms per 100 mL nor shall 10% of the samples be >=260 organisms per 100 mL	Not Applicable
	Nonpoint Source Stormwater Runoff[4]	Not Applicable	Fecal Coliform <= median or geometric mean, MPN, of 88 organisms per 100 mL nor shall 10% of the samples be >=260 organisms per 100 mL

[1] Waste Load Allocation (WLA) and Load Allocation (LA) refer to fecal coliform densities unless specified in table.
[2] In all samples taken during any 6 month period
[3] In 90% of the samples taken in any six month period;
[4] The expectation for WLAs and LAs for stormwater discharges is that they will be achieved through the implementation of BMPs and other controls.
[5] Geometric mean of the 5 most recent samples is used at bathing beaches. For all other waters and during the non-bathing season the geometric mean of all samples taken within the most recent six months, typically based on a minimum of five samples.
[6] Or other applicable water quality standards for CSO's
[7] Or shall be consistent with the Waste Water Treatment Plant (WWTP) National Pollutant Discharge Elimination System (NPDES) permit.
[8] Massachusetts Department of Public Health regulations (105 CMR Section 445)
[9] Seasonal disinfection may be allowed by the Department on a case-by-case basis.
[10] Segments identified as CSO have a long term control plan in place.

Note: this table represents waste load and load allocations based on water quality standards current as of the publication date of these TMDLs. If the pathogen criteria change in the future, MassDEP intends to revise the TMDL by addendum to reflect the revised criteria. Waste load allocation (WLA) as a concept in this document refers to pollutants discharged from pipes and channels that require a discharge permit (point sources). Load allocation refers to pollutants entering waterbodies through overland runoff (non point sources). A major difference between the two categories is the greater legal and regulatory control generally available to address point sources while voluntary cooperation added by incentives in some cases is the main vehicle for addressing non-point sources.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYM LIST

7Q10	Seven Day Ten Year Low Flow
ACEC	Area of Critical Environmental Concern
BMP	Best Management Practice
cfu	colony forming units
CSO	Combined Sewer Overflow
CWA	Clean Water Act, Federal
CWA § 303(d)	Section 303 (d) of the CWA and the implementing regulations at 40 CFR 130.7 require states to identify those waterbodies that are not expected to meet surface water quality standards after the implementation of technology-based controls and to prioritize and schedule them for the development of a total maximum daily load (TMDL).
CZM	Coastal Zone Management
DFW	Division of Fisheries and Wildlife
DMF	Division of Marine Fisheries
DWM	Division of Watershed Management
EEA	Executive Office of Energy and Environmental Affairs, formerly Executive Office of Environmental Affairs (EOEA)
EMC	Event Mean Concentration

EPA	United States Environmental Protection Agency
EQIP	Environmental Quality Incentive Program
GIS	Geographic Information System
IDDE	Illicit Discharge Detection and Elimination System
I/I	Infiltration and Inflow
LA	Load Allocation
LID	Low Impact Development
LTCP	Long Term Control Plan
LWSC	Lynn Water and Sewer Commission
MADPH	Massachusetts Department of Public Health
MassDEP	Massachusetts Department of Environmental Protection
MEP	Maximum Extent Practicable
MEPA	Massachusetts Environmental Policy Act
MG	Million Gallons
MHD	Massachusetts Highway Department
MOS	Margin of Safety
MPN	Most Probable Number
MSD	Marine Sanitary Device
MS4	Municipal Separate Storm Sewer Systems
NDA	No Discharge Area
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
ORW	Outstanding Resource Water
POTW	Publically Owned Treatment Works
RTI	Research Triangle Institute
SBCSO	Waters occasionally subject to short-term impairment of swimming or other recreational uses due to untreated CSO discharges in a typical year, and the aquatic life community may suffer adverse impact yet is still generally viable. In these waters, the uses for Class SB waters are maintained after the implementation of long term control measures described in the approved CSO long term control plan.
SFP	Supplemental CSO Facilities Plan (SFP)
SMCD	Second Modified Consent Decree
SRF	State Revolving Fund
SSO	Sanitary Sewer Overflows
SWMP	Stormwater Management Plan
SWPP	Stormwater Program Plan
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
USACOE	United States Army Corps of Engineers
VEMN	Voluntary Environmental Monitoring Network
WLA	Waste Load Allocation
WQA	Water Quality Assessment
WQS	Water Quality Standards
WWTP	Wastewater Treatment Plant

1.0 Introduction

Section 303(d) of the Federal Clean Water Act (CWA) and Environmental Protection Agencies (EPA's) Water Quality Planning and Management Regulations (40 CFR Part 130) require states to place waterbodies that do not meet established water quality standards on a list of impaired waterbodies (commonly referred to as the "303d List") and to develop Total Maximum Daily Loads (TMDLs) for listed waters and the pollutant(s) contributing to the impairment. In Massachusetts, impaired waterbodies are included in Category 5 of the "*Massachusetts Year 2008 Integrated List of Water: Part 2- Final Listing of Individual Categories of Waters*" (*2008 List*; MassDEP 2008a). Figure 1-1 provides a map of the North Coastal watershed with pathogen impaired segments indicated. As shown in Figure 1-1, many of the North Coastal waterbodies are listed as a Category 5 "impaired or threatened for one or more uses and requiring a TMDL" due to excessive indicator bacteria concentrations.

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

A major goal of this TMDL is to achieve meaningful environmental results with regard to the designated uses of the North Coastal waterbodies. These include water supply, commercial shellfish harvesting, fishing, boating, and swimming. This TMDL establishes the necessary pollutant load to achieve designated uses and water quality standards and the companion document entitled; "*Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts", (ENSR 2005),* provides guidance for the implementation of this TMDL.

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

1.1 Pathogens and Indicator Bacteria

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

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

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

Massachusetts now uses *E. coli* and *Enterococci* as indicator organisms of potential harmful pathogens in fresh water. The water quality standards (WQS) that apply for fresh water were revised in late 2006, and *E. coli* has replaced fecal coliform as the indicator organism for pathogens (MassDEP 2007). Fecal coliform are still used by Massachusetts Division of Marine Fisheries (DMF) in their classification of shellfish growing areas. *Enterococci* or *E. coli* are used as the indicator organism for freshwater beaches and for marine beaches *Enterococci* are used, as required by the Federal Beaches Environmental Assessment and Coastal Act of 2000 (Beach Act), an amendment to the CWA.

The North Coastal watershed pathogen TMDLs have been developed using fecal coliform as an indicator bacterium for shellfish areas and *Enterococci* for bathing in marine waters and generally *E. coli* for fresh waters. Any future changes in the Massachusetts pathogen water quality standards will apply to this TMDL at the time of the standard change. Massachusetts believes that the magnitude of indicator bacteria loading reductions outlined in this TMDL will be both necessary and sufficient to attain present WQS and any future modifications to the WQS for pathogens.

Figure 1-1 North Coastal Pathogen Impaired Segments

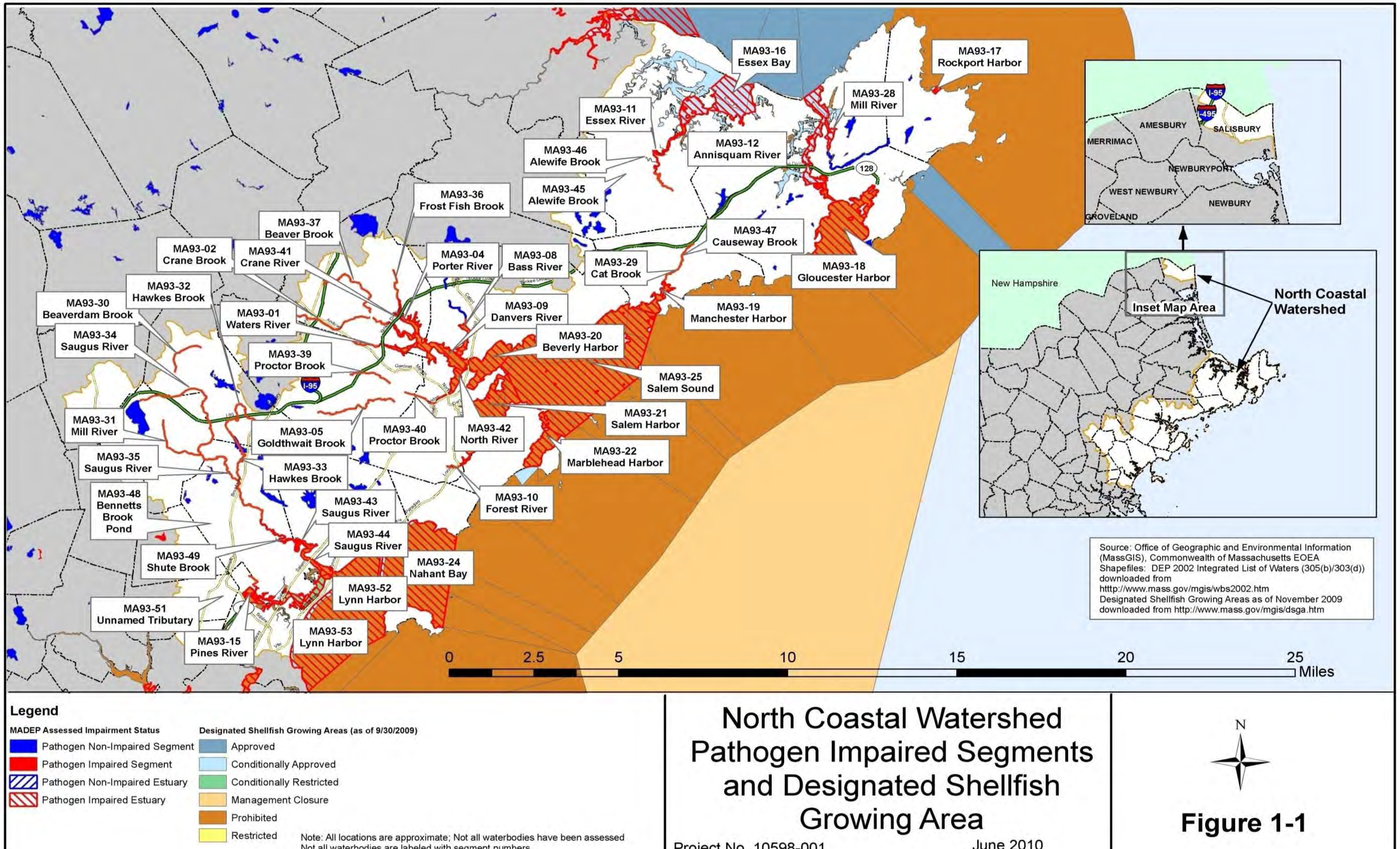
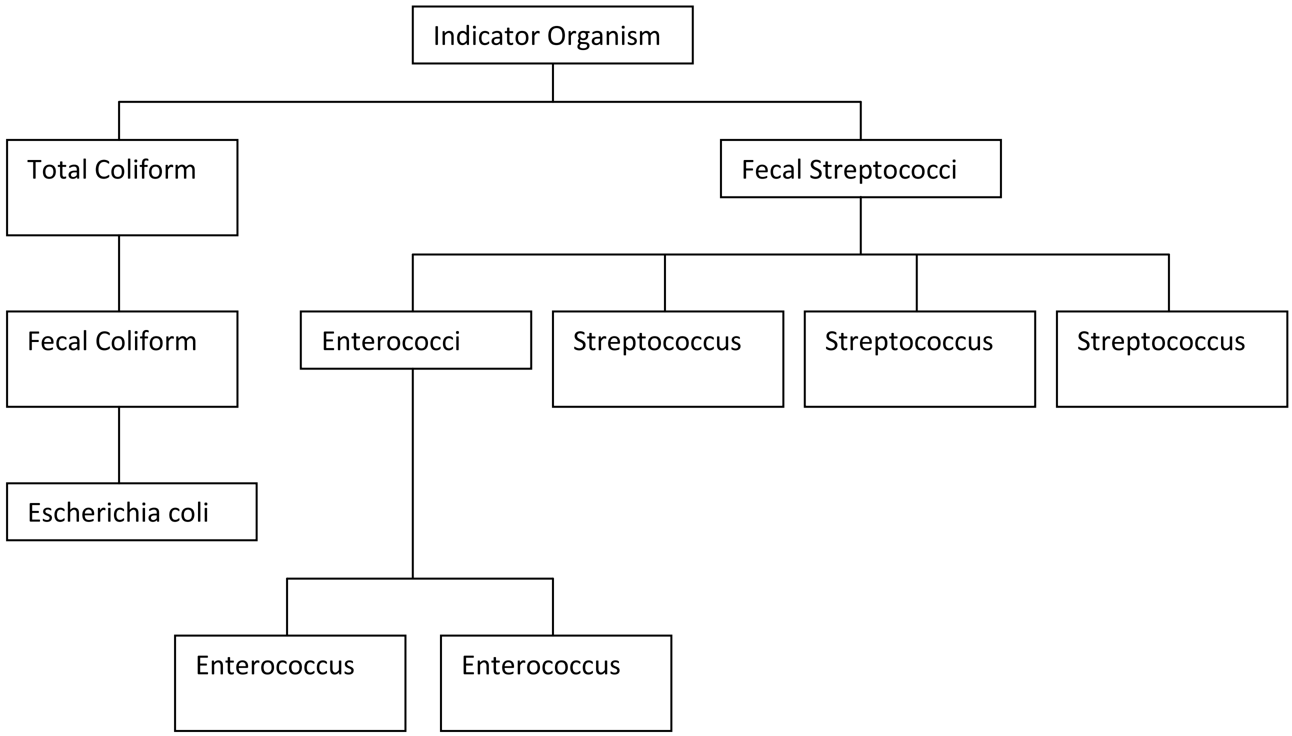


Figure 1-2 Relationships Among Indicator Organisms (USEPA 2001).



1.2 Comprehensive Watershed-based Approach to TMDL Development

Consistent with Section 303(d) of the CWA, the MassDEP has chosen to complete pathogen TMDLs for all waterbodies in the North Coastal watershed at this time, regardless of current impairment status (i.e., for all waterbody categories in the 2008 *Integrated List*). MassDEP believes a comprehensive management approach carried out by all watershed communities is needed to address the ubiquitous nature of pathogen sources present in the North Coastal watershed. Watershed-wide implementation is needed to meet WQS and restore designated uses in impaired segments while providing protection of desirable water quality in waters that are not currently impaired or not assessed.

As discussed below, this TMDL applies to the 43 pathogen impaired segments of the North Coastal watershed that are currently listed on the CWA § 303(d) list of impaired waters and determined to be pathogen impaired in the “North Coastal Watershed 1997/1998 Water Quality Assessment Report” (MassDEP WQA; MassDEP 2000a) (see Figure 1-1, Table 4-3). MassDEP recommends however, that the information contained in this TMDL guide management activities for all other waters throughout the watershed to help maintain and protect existing water quality. For these non-impaired waters, Massachusetts is proposing "pollution prevention TMDLs" consistent with CWA § 303(d)(3)[1].

The analyses conducted for the pathogen impaired segments in this TMDL would apply to the non-impaired segments, since the sources and their characteristics are equivalent. The waste load and/or load allocation for each source and designated use would be the same as specified herein. Therefore, the pollution prevention TMDLs would have identical waste load and load allocations based on the sources present and the designated use of the water body segment (see Table ES-2 and Table 7-1).

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

There are 83 waterbody segments assessed by the MassDEP in the North Coastal watershed (MassDEP 2006). These segments consist of 27 estuaries, all of which are pathogen impaired. Fifteen of the 16 river segments are pathogen impaired and none of the 40 lake segments are pathogen impaired and appear as such on the official impaired waters list (303(d) List) (Figure 1-1). Pathogen impairment has been documented by the MassDEP in previous reports, including the MassDEP WQA, resulting in the impairment determination. In this TMDL document, an overview of pathogen related water quality is provided to illustrate the nature and extent of the pathogen contamination on the North Shore. Additional data, not collected by the MassDEP or used to determine impairment status, may also be provided in this TMDL to illustrate the extent of the pathogen problem. Since pathogen impairment has been previously established only a summary is provided herein.

The watershed based approach applied to complete the North Coastal watershed pathogen TMDL is straightforward. The approach is focused on identification of sources, source reduction, and stepwise implementation of appropriate management plans. Once identified, sources are required to meet applicable WQS for indicator bacteria or be eliminated. This approach does not include water quality analysis or other approaches designed to link ambient concentrations with source loadings. For pathogens and indicator bacteria, water quality analyses are generally resource intensive and provide results with large degrees of uncertainty. Rather, this approach focuses on sources and required load reductions, proceeding efficiently toward water quality restoration activities.

[1] CWA Section 303(d)3: For the specific purpose of developing information, each State shall identify all waters within its boundaries which it has not identified under paragraph (1)(A) and (1)(B) of this subsection and estimate for such waters the total maximum daily load with seasonal variations and margins of safety, for those pollutants which the Administrator identifies under section 304(a)(2) as suitable for such calculation and for thermal discharges, at a level that would assure protection and propagation of a balanced indigenous population of fish, shellfish and wildlife.

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

MassDEP believes that segments ranked as high priority in Table ES-1 (or Table 6-1) are indicative of the potential presence of raw sewage and therefore they pose a greater risk to the public. Elevated dry weather bacteria concentrations could be the result of illicit sewer connections or failing septic systems. As a result, the first priority should be given to bacteria source tracking activities in those segments where sampling activities show elevated levels of bacteria during dry weather. Identification and remediation of dry weather bacteria sources is usually more straightforward and successful than tracking and eliminating wet weather sources. If illicit bacteria sources are found and eliminated it should result in a dramatic reduction of bacteria concentration in the segment in both dry and wet-weather. Segments that remain impaired during wet weather should be evaluated for stormwater BMP implementation opportunities starting with less costly non-structural practices first (such as street sweeping, and/or managerial approach using local regulatory controls with ongoing evaluation of the success of those programs. If it is determined that less costly approaches are not sufficient to address the issue then appropriate structural BMPs should be identified and implemented where necessary. Structural stormwater BMP implementation may require additional study to identify cost efficient and effective technology.

1.3 TMDL Report Format

This document contains the following sections:

- Watershed Description (Section 2) – provides watershed specific information
- Water Quality Standards (Section 3) – provides a summary of current Massachusetts WQS as they relate to indicator bacteria
- Problem Assessment (Section 4) – provides an overview of indicator bacteria measurements collected in the North Coastal watershed
- Identification of Sources (Section 5) – identifies and discusses potential sources of waterborne pathogens within the North Coastal watershed.
- Prioritization and Known Sources (Section 6) -- identifies, discusses, and prioritizes the known sources in all impacted segments within the North Coastal watershed.
- TMDL Development (Section 7) – specifies required TMDL development components including:
    - Definitions and Equations
    - Load and Waste Load Allocations
    - Margin of Safety
    - Seasonal Variability
- Implementation Plan (Section 8) – describes specific implementation activities designed to remove pathogen impairment. This section and the companion “Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation

Guidance Manual for Massachusetts" document should be used together to support implementing management actions.

- Monitoring Plan (Section 9) – describes recommended monitoring activities
- Reasonable Assurances (Section 10) – describes reasonable assurances the TMDL will be implemented
- Public Participation (Section 11) – describes the public participation process, and
- References (Section 12)
- Appendix A – Mass DEP Response to Public comments
- Appendix B – Wayland and Hanlon Memorandum

2.0 Watershed Description

The North Coastal watershed drains approximately 168 square miles of the Massachusetts' northshore (EOEA 2003). All or part of 24 Commonwealth communities, and a small portion of Seabrook New Hampshire, are within the North Coastal Drainage area. It extends from Salisbury to the City of Revere including the following communities Amesbury, Everett, Malden, Melrose, Saugus, Stoneham, Reading, Wakefield, Lynnfield, Lynn, Nahant, Swampscott, Marblehead, Salem, Peabody, Danvers, Beverly, Manchester, Wenham, Hamilton, Essex, Ipswich, Gloucester, and Rockport (MassDEP 2000a). This area supports a population of approximately 500,000 people (EOEA 2003).

The North Coastal watershed contains extensive areas of open space, rural towns, and highly urbanized communities (Table 2-1; Figure 2-1). The topography of the watershed is characterized by small hills, which reach altitudes of about 350 feet above sea level, and low stream gradients. There are a total of 85 lakes and ponds (39 greater than 10 acres) within the North Coastal Watershed (NCW) EOEA 2004). The North Coastal Watershed Lakes have a total surface area of 2,415 acres (MassDEP 2000a). The rivers within the North Coastal watershed are comparatively small, tidal, and historically have been heavily exploited (EOEA 2004). Barrier beach islands are a substantial portion of the coastal areas in the watershed. These barrier beaches include Salisbury Beach, Cranes Beach, Wingaersheek, and Revere Beach. Locations of public and semi-public beaches are illustrated on Figure 2-2. Detailed information regarding water quality at swimming beaches can be obtained from the beach quality annual reports available for download at the Massachusetts Department of Public Health (DPH) Website: mass.digitalhealthdepartment.com/public_21/index.cfm .

Surface waters in the watershed are commonly used for primary and secondary contact recreation (swimming and boating), viewing wildlife, habitat for aquatic life, lobster fishing, commercial shellfishing, and potable water. Offshore areas are protected against the disposal of treated or untreated sewage from vessels in this watershed (i.e., No Discharge Areas; see Figure 2-3).

Table 2-1 North Coastal Watershed Land Use as of 1999*.

Land Use Category	% of Total Watershed Area
Pasture	0.7
Urban Open	2.0
Open Land	3.3
Cropland	1.0
Woody Perennial	2.1
Forest	31.3
Wetland/Salt Wetland	7.1
Water Based Recreation	0.7
Water	0.2
General Undeveloped Land	48.4
Spectator Recreation	<0.1
Participation Recreation	2.5
> 1/2 acre lots Residential	7.5
1/4 - 1/2 acre lots Residential	13.3
< 1/4 acre lots Residential	11.6
Multi-family Residential	1.9
Mining	0.4
Commercial	5.2
Industrial	3.9
Transportation	3.1
Waste Disposal	2.2
General Developed Land	51.6

*Land use data are for the Massachusetts portion of the North Coastal watershed.

Figure 2-1 North Coastal Watershed Land Use as of 1999.

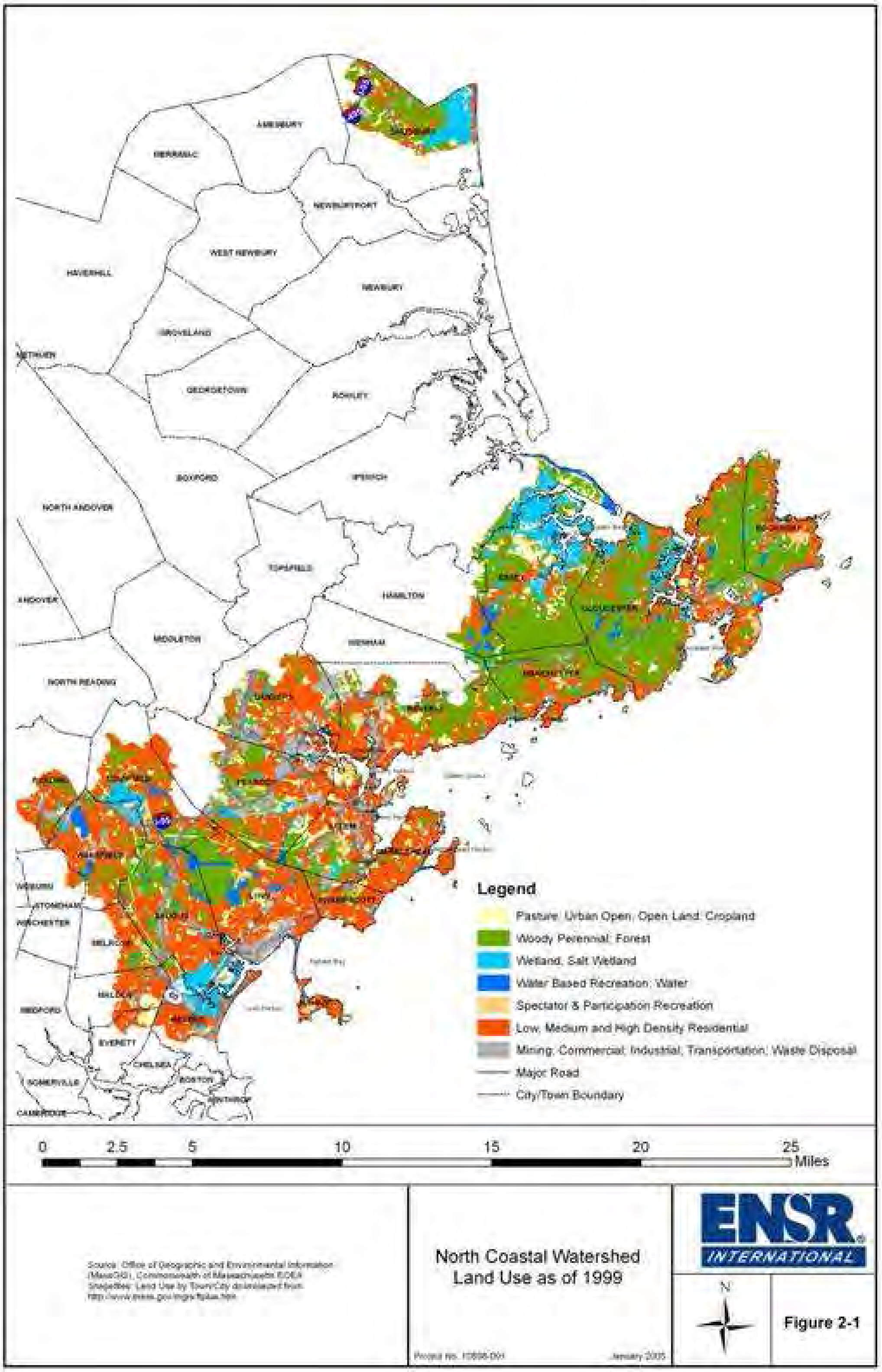


Figure 2-2 North Coastal Watershed Marine Locations with Pathogen Impairments.

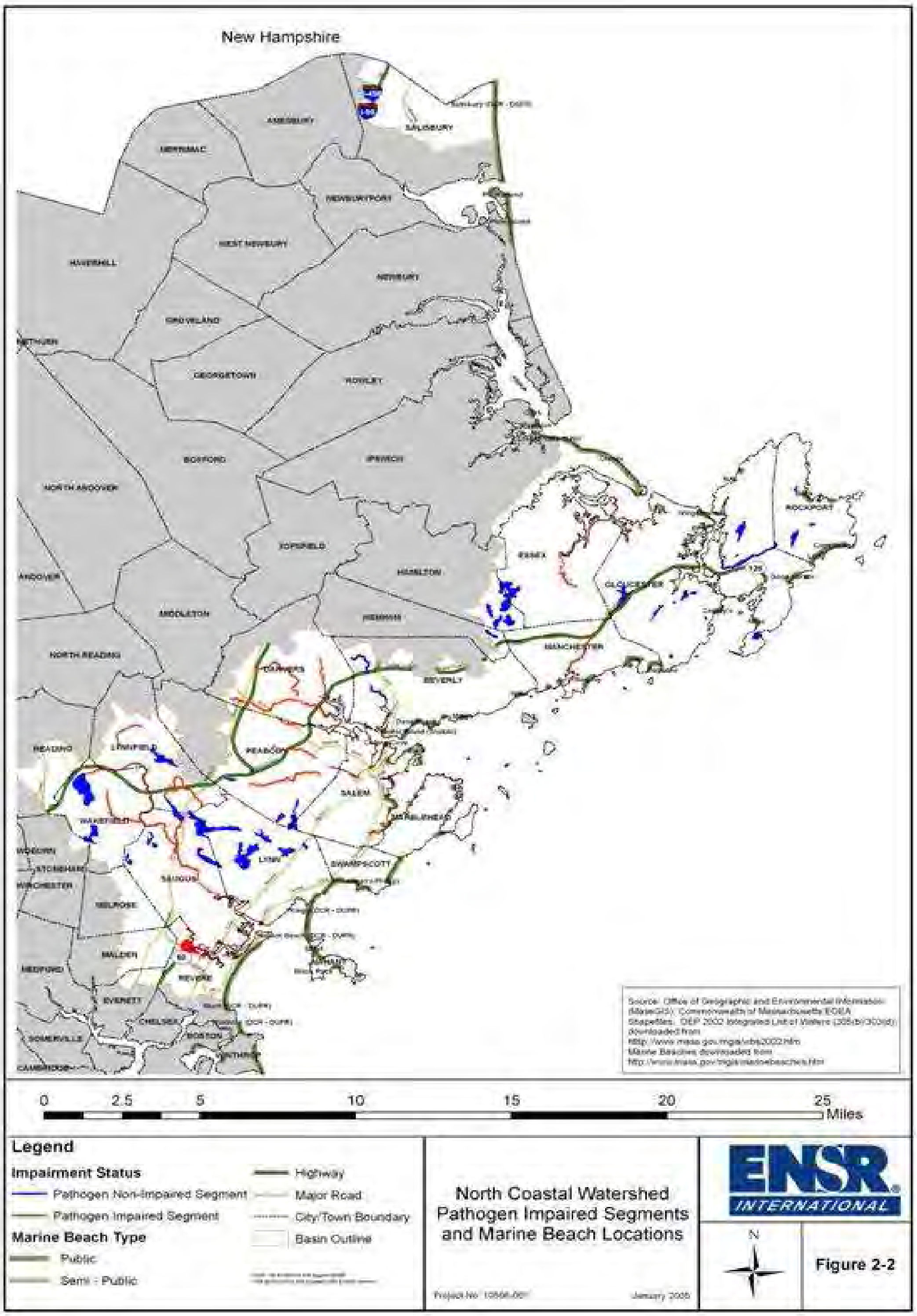


Figure 2-3 No Discharge Areas (Mass Bays Program 2010).

3.0 Water Quality Standards

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

The North Coastal Watershed contains waterbodies classified as Class A, B, SA, and SB. According the Mass Water Quality Standards these waters should be suitable for the following uses: (1) habitat for fish, other aquatic life, wildlife, (2) primary and secondary contact recreation, (3) shellfish harvesting in approved areas , and (4) should have consistently good aesthetic value (A, SA should be excellent). The pathogen impairments (exceedences of Fecal coliform, enterococci, and *E. coli* bacteria criteria) associated with the waterbody's of interest in this report affect primary contact recreation and shellfishing uses. In addition the North Coastal watershed includes waterbodies (Gloucester Harbor MA93-18, Nahant Bay MA93-24, Lynn Harbor MA92-52 , MA93-53 and Saugus River MA93-44) that receive combined sewer overflows (CSO) and have Long Term Control Plans (LTCP) in place. Because the WQS were in transition during the development of statewide pathogen TMDLs, and were formally changed after the draft reports were produced, the new bacteria indicator standards are presented in Table ES-1, and 7-1, and can be accessed at the following web address link: http://www.mass.gov/dep/service/regulations/314cmr04.pdf.

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

Massachusetts has revised its freshwater WQS in 2007 by replacing fecal coliform with *E. coli* and *Enterococci* as the regulated indicator bacteria in freshwater systems, as recommended by the EPA in the "Ambient Water Quality Criteria for Bacteria – 1986" document (USEPA 1986). The state had previously done so for public beaches through regulations of the Massachusetts Department of Public Health as discussed below. Up until January of 2007 Massachusetts used fecal coliform as the indicator organism for all waters except for marine bathing beaches, where the Federal BEACH Act requires the use of *Enterococci*. Massachusetts adopted *E. coli* and *Enterococci* for all fresh waters and Enterococci for all marine waters, including non-bathing marine beaches. Fecal coliform will remain the indicator organism for shellfishing areas, however.

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

> Water Quality Criteria: Microbial (Pathogen)
> http://www.epa.gov/waterscience/criteria/humanhealth/microbial/index.html#advisories
> Human Health Advisories: Fish and Wildlife Consumption Advisories
> http://www.epa.gov/waterscience/fish/
> Swimming Advisories:
> http:// www.epa.gov/ebtpages/humaadvisoriesswimmingadvisories.html

The North Coastal watershed contains waterbodies classified as Class B, Class SA, and Class SB. The standards that apply to these classifications are presented in Table 7-1, and at the web address link: http://www.mass.gov/dep/service/regulations/314cmr04.pdf.

Commercial shellfishing growing areas are classified by the Massachusetts Division of Marine Fisheries (DMF). The classification system is provided below (MassGIS 2005). Figure 1-1 provides designated shellfish growing areas status as of September 2009.

Approved – "Open for harvest of shellfish for direct human consumption subject to local rules and state regulations." (MassGIS 2005) "The area is shown to be free of bacterial contaminants under a variety of climatological and hydrographical situations (i.e. assumed adverse pollution conditions)." (MassDEP 2002a).

Conditionally Approved – "During the time area is approved it is open for harvest of shellfish for direct human consumption subject to local rules and state regulations." (MassGIS 2005) "This classification category may be assigned for growing areas subject to intermittent and predictable microbiological contamination that may be present due to operation of a sewage treatment plant, rainfall, and/or season." (MassDEP 2002a).

Restricted – "Open for harvest of shellfish with depuration subject to local rules and state regulations or for the relay of shellfishing" (MassGIS 2005) "A classification used to identify where harvesting shall be by special license and the shellstock, following harvest, is subject to a suitable and effective treatment process through relaying or depuration. Restricted growing areas are mildly or moderately contaminated only with bacteria." (MassDEP 2002a).

Conditionally Restricted – "During the time area is restricted it is only open for the harvest of shellfish with depuration subject to local rules and state regulations." (MassGIS 2005) "A classification used to identify a growing area that meets the criteria for the restricted classification except under certain conditions described in a management plan." (MassDEP 2002a).

Management Closure – "Closed for the harvest of shellfishing Not enough testing has been done in the area to determine whether it is fit for shellfish harvest or not." (MassDEP 2002a)

Prohibited – "Closed for harvest of shellfishing" (MassGIS 2005) "A classification used to identify a growing area where the harvest of shellstock is not permitted. Growing areas must also be classified as Prohibited if there is no or insufficient information available to make a classification decision." (MassDEP 2002a) or if conditions such as poor habitat or marina's preclude the use.

In general, shellfish harvesting use is supported (i.e., non-impaired) when shellfish harvested from approved open shellfish areas are suitable for consumption without depuration and shellfish harvested from restricted shellfish areas are suitable for consumption with depuration. For an expanded discussion on the relationship between the DMF shellfish growing areas classification and the MassDEP designated use support status, please see the "North Coastal Watershed 2002 Water Quality Assessment Report" (MassDEP 2002c). In the absence of water quality data, Massachusetts assessment methodology as of the date of this report is to assess waters as impaired for shellfishing if Division of Marine Fisheries (DMF) classifies waters as prohibited to shellfishing or if the water body is a receiving water for CSOs.

In addition to the WQS, the Commonwealth of Massachusetts Department of Public Health (MADPH) has established minimum standards for bathing beaches (105 CMR 445.000) under the State Sanitary Code, Chapter VII (www.mass.gov/Eeohhs2/docs/dph/regs/105cmr445.pdf). These standards have been adopted by the MassDEP as state surface WQS for fresh water and will apply to this TMDL. The MADPH bathing beach standards are generally the same as those which were recommended in the USEPA's "Ambient Water Quality Criteria for Bacteria – 1986" (USEPA 1986). The USEPA recommended the use of Enterococci as the indicator bacterium for marine recreational waters and Enterococci or *E. coli* for fresh waters. As such, the following MADPH standards have been established for bathing beaches in Massachusetts:

Marine Waters - No single Enterococci sample shall exceed 104 colonies per 100 mL and the geometric mean of the most recent five Enterococci levels within the same bathing season shall not exceed 35 colonies per 100 mL.

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

The Federal BEACH Act of 2000 established a Federal standard for marine beaches. These standards are essentially the same as the MADPH marine beach standard. The Federal BEACH Act and MADPH standards can be accessed at:
www.epa.gov/waterscience/beaches/rules/act.html, and
http://www.mass.gov/eohhs/docs/dph/regs/105cmr445.pdf, respectively.

Figure 2-2 provides the location of marine bathing beaches, where the MADPH Marine Waters and the Federal BEACH Act standards would apply. A map of freshwater beaches is not available at this time. However, a list of beaches (fresh and marine) by community with indicator bacteria data can be found in the annual reports on the testing of public and semi-public beaches provided by the MADPH. These reports are available for download from the MADPH website located at :http://www.mass.gov/eohhs/searchresults.html?output=xml_no_dtd&client=massgov&proxystylesheet=massgov&ie=UTF-8&sort=date%3AD%3AL%3Ad1&oe=UTF-8&q=bacteria+data+by+beach&site=EOHHSx

4.0 Problem Assessment

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

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

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

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

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

Table 4-1 Wachusett Reservoir Stormwater Sampling (MassDEP 2002b) [1].

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

1. original data provided in MDC Wachusett Stormwater Study (June 1997).

2. Grab samples collected for four storms between September 15, 1999 and June 7, 2000

Table 4-2 Lower Charles River Stormwater Event Mean Bacteria Concentrations (USGS 2002)[1].

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

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

Pathogen impaired estuary segments represent 100% of the total estuary area assessed (31.9 square miles). Pathogen impaired river segments represent 91% of the total river miles assessed (35.4 miles of 39 total river miles). In total, 43 segments, each in need of a TMDL, contain indicator bacteria concentrations in excess of the Massachusetts WQS for Class A, SA, B, or SB waterbodies (314 CMR 4.05)[1], the MADPH standard for bathing beaches[2] and/or the BEACH Act. The basis for impairment listings is provided in the 2008 Integrated List (MassDEP 2008). Data presented in the Water Quality Assessment (WQA) and other data collected by the MassDEP were used to generate the Integrated List. For more information regarding the basis for listing particular segments for pathogen impairment, please see the Assessment Methodology section of the MassDEP WAQ for this watershed.

A list of pathogen impaired segments requiring TMDLs is provided in Table 4-3. "The North Coastal watershed consists of several small rivers that drain directly into the ocean rather than the more common watershed definition surrounding one large river" (EOEA 2004). For this reason it is more accurate to discuss the character and problems on a sub-watershed level. In this report, the North Coastal watershed will be divided as in the WQA into the following sub-watersheds and harbors:

The Essex Bay System
Essex Bay
The Annisquam River System
Gloucester Harbor
Rockport Harbor
Salem Sound System
Manchester Harbor System
Beverly Harbor System
Marblehead Harbor
Salem Harbor
Nahant Bay
Saugus River System
Lynn Harbor

Additional details regarding each impaired segment including water withdrawals, discharges, use assessments and recommendations to meet use criteria are provided in the MassDEP WQA.

An overview of the North Coastal watershed pathogen impairment is provided in this section to illustrate the nature and extent of the impairment. Since pathogen impairment has been previously established and documented on the 2008 Integrated List, it is not necessary to provide detailed documentation of pathogen impairment herein. Data from the MassDEP WQA, Massachusetts Division of Marine Fisheries (DMF), Saugus River Watershed Council (SRWC) and the Salem Sound Coastwatch were reviewed and are summarized by segment below for illustrative purposes.

---

[1] or [2] **See Table ES-2, or Table 7-1, or web address link**: http://www.mass.gov/dep/service/regulations/314cmr04.pdf

Table 4-3 North coastal Watershed Pathogen Impaired Segments Requiring a TMDL. [1]

Segment ID	Segment Name	Segment Type, Class	Size[2]	Segment Description
Essex Bay System				
MA93-45	Alewife Brook, B	River	1.4	Headwaters, outlet Chebacco Lake, Essex to Landing Road, Essex.
MA93-46	Alewife Brook, SA	Estuary	0.01	Landing Road, Essex to confluence with Essex River, Essex.
MA93-11	Essex River, SA	Estuary	0.5	Source east of Southern Avenue to mouth at Essex Bay, Essex.
MA93-16	Essex Bay, SA	Estuary	1.0	Essex/Ipswich/Gloucester.
Annisquam River System				
MA93-28	Mill River, SA	Estuary	0.1	Outlet Mill Pond, Gloucester to confluence with Annisquam River, Gloucester.
MA93-12	Annisquam River, SA	Estuary	0.82	The waters from the Gloucester Harbor side of the Route 127 bridge, Gloucester to Ipswich Bay at an imaginary line drawn from Bald Rocks to Wigwam Point, Gloucester.
MA93-57 (formerly MA93-17)	Rockport Harbor, SB [3]	Estuary	0.35	Waters landward of an imaginary line from Gully Point, Rockport to Granite Pier, Rockport (including Back Harbor and a portion of Sandy Bay) (includes area formerly reported as segment MA93-17).
MA93-18	Gloucester Harbor, SB	Estuary	2.3	The waters landward of an imaginary line drawn between Mussel Point and the tip of the Dog Bar Breakwater, Gloucester excluding the Annisquam River.
Salem Sound System				
MA93-47	Causeway Brook, B	River	1.1	Headwaters, outlet Dexter Pond, Manchester to confluence with Cat Brook, Manchester.
MA93-29	Cat Brook, B	River	1.7	Headwaters north of Route 128 Manchester/Essex/Gloucester to confluence Manchester Harbor, Manchester. Miles 2.5-0.0.
MA93-19	Manchester Harbor, SB	Estuary	0.33	The waters landward of an imaginary line drawn between Gales Point and Chubb Point, Manchester excluding Cat Brook.
MA93-08	Bass River, SA	Estuary	0.12	Outlet of Shoe Pond north of Route 62 to confluence with Danvers River, Beverley.
MA93-36	Frost Fish Brook, B	River	1.0	Cabot Road, Danvers to Porter River confluence at Route 62, Danvers.
MA93-04	Porter River, SA	Estuary	0.13	Confluence with Frost Fish Brook at Route 62 to confluence with Danvers River, Danvers.
MA93-02	Crane Brook, B	River	1.8	Headwaters east of route 95, to inlet Mill Pond, Danvers.
MA93-41	Crane River, SA	Estuary	0.07	Outlet pump house sluiceway at Purchase Street, Danvers to confluence Danvers River, Danvers.
MA93-01	Waters River, SA	Estuary	0.09	Headwaters west of Route 128, Peabody/Danvers, to confluence with Danvers River, Danvers.
MA93-05	Goldthwait Brook, B	River	3.3	Outlet Cedar Pond, Peabody to confluence with Proctor Brook, Peabody.
MA93-39	Proctor Brook, B	River	2.9	Outlet of small pond in wetland north of Downing Road, Peabody to Grove/Goodhue Street bridge, Salem (formerly part of 93-05).

Segment ID	Segment Name	Segment Type, Class	Size[2]	Segment Description
MA93-42	North River, SA	Estuary	0.15	Downstream of Route 114 bridge (Proctor Brook becomes North River at this bridge), Salem to confluence with Danvers River, Salem (formerly part of MA93-06).
MA93-09	Danvers River, SA	Estuary	0.53	Confluence with Porter, Crane and Waters rivers, Danvers to mouth at Beverly Harbor, Beverly/Salem.
MA93-20	Beverly Harbor, SB [3]	Estuary	1.02	From the mouth of the Danvers River, Salem/Beverly to an imaginary line from Juniper Point, Salem to Hospital Point, Beverly.
MA93-40	Proctor Brook, SA	Estuary	0.01	Gove/ Goodhue Street bridge, Salem to Route 114 culvert, Salem (formerly part of MA93-06).
MA93-54 (formerly MA93-21)	Salem Harbor, SB [3]	Estuary	4.91	Waters landward of an imaginary line from Naugus Head, Marblehead to the northwest point of Bakers Island, Salem to Hospital Point, Beverly to Juniper Point, Salem (excluding Forest River) (formerly segment MA93-21 Salem Harbor and a portion of segment MA93-25 Salem Sound [waterbody code 93907]).
MA93-22	Marblehead Harbor, SA	Estuary	0.56	The waters landward of an imaginary line drawn northwesterly from the northern tip of Marblehead Neck to Fort Sewall, Marblehead.
MA93-55 (formerly MA93-25)	Salem Sound, SA [3]	Estuary	3.46	Northern portion of Salem Sound, waters landward of and within imaginary lines from Chubb Point, Manchester to Gales Point , Manchester to the northwest point of Bakers Island, Salem to Hospital Point, Beverly (formerly reported as a portion of segment MA93-25).
MA93-56 (formerly MA93-25)	Salem Sound, SA [3]	Estuary	2.55	Southern portion of Salem Sound, waters landward of and within imaginary lines from Fort Sewall, Marblehead to the Marblehead Lighthouse on Marblehead Neck, Marblehead to the northwest point of Bakers Island, Salem to Naugus Head, Marblehead (formerly reported as a portion of segment MA93-25).
MA93-24	Nahant Bay, SA	Estuary	5.1	The waters landward of an imaginary line drawn between Galloupes Point, Swampscott and East Point, Nahant.
Saugus River System				
MA93-34	Saugus River, B	River	3.1	Headwaters, outlet of Lake Quannapowitt, Wakefield (thru Reedy Meadow) to Lynn Water & Sewer Commission diversion canal, Wakefield/Lynnfield (canal diverts to Hawks Pond) (formerly part of segment MA93-13).
MA93-30	Beaverdam Brook, B	River	1.5	Headwaters west of Main Street, Lynnfield to confluence with Saugus River, Lynnfield.
MA93-35	Saugus River, B	River	5.4	From the Lynn Water & Sewer Commission diversion canal, Wakefield/Lynnfield to Saugus Iron Works, Bridge Street, Saugus (formerly part of segment MA93-13).
MA93-31	Mill River, B	River	2.0	From headwaters in wetlands north of Salem Street in Wakefield to confluence with Saugus River, Wakefield.

Segment ID	Segment Name	Segment Type, Class	Size[2]	Segment Description
MA93-32	Hawkes Brook, A	River	2.6	Headwaters at the Lynn/Lynnfield border to the outlet of Hawkes Pond in North Saugus.
MA93-33	Hawkes Brook, B	River	1.1	Outlet of Hawkes Pond, North Saugus to confluence with Saugus River, Saugus.
MA93-48	Bennetts Pond Brook, B	River	2.4	Headwaters east of Lynn Fells Parkway (in Bellevue Golf Course), Melrose to confluence with Saugus River, Saugus.
MA93-49	Shute Brook, SA	Estuary	0.01	Approximately 350 feet downstream from Central St., Saugus to the confluence with the Saugus River, Saugus.
MA93-50	Shute Brook, B	River	0.89	From the confluence with Fiske Brook, Saugus to approximately 350 feet downstream from Central St., Saugus.
MA93-43	Saugus River, SB	Estuary	0.04	Saugus Iron Works, Bridge Street , Saugus, to Lincoln Avenue/Boston Street, Saugus/Lynn (formerly part of segment (MA93-14).
MA93-44	Saugus River, SB	Estuary	0.36	Lincoln Avenue/Boston Street, Saugus/Lynn to mouth (east of Route 1A) at Lynn Harbor, Lynne/Revere (formerly part of 93-14).
MA93-51	Unnamed Tributary, SA	Estuary	0.02	Unnamed tributary locally known as "Town Line Brook" from Route 99, Malden to the confluence with the Pines River, Revere.
MA93-15	Pines River, SB	Estuary	0.58	Headwaters east of Route 1, Revere/Saugus to confluence with the Saugus River, Saugus/Revere.
MA93-52	Lynn Harbor, SB	Estuary	1.6	The "inner" portion of Lynn Harbor; the waters landward of an imaginary line from Black Rock Point, Nahant to the eastern edge of Point of Pines, Revere excluding the Saugus River (formerly part of 93-23).
MA93-53	Lynn Harbor, SB	Estuary	6.6	The "outer" portion of Lynn Harbor; the waters landward of an imaginary line drawn from Baileys Hill, Nahant to the eastern point of Winthrop Highlands, Winthrop to the seaward edge of the "inner" portion of Lynn Harbor (at an imaginary line drawn from Black Rock Point, Nahant to the eastern edge of Point of Pines, Revere, formerly part of segment 93-23).

1 Adapted from MassDEP 2000 a and MassGIS 2005.
2 Units = Miles for river segments and square miles for estuaries
3 The delineation of these waterbodies in the North Coastal Watershed Assessment Report (2002) reported in the 2008 Integrated List was not consistent with DWM's water quality standards. The delineations in this Table are consistent with the WQS and Integrated List accounting. A WQS clarification will be made during the next revision to avoid confusion in the future. Likewise a correction will be made to the North Coastal assessment report during the next assessment cycle for the North Coastal watershed.

This TMDL is based on the Mass WQS (2007) for fecal coliform in approved shellfish areas, E. coli for fresh water and Enterococcus for either salt or fresh water bathing respectively. Enterococci data are provided at the bottom of each table when data are available. The MassDEP has incorporated E. coli and Enterococci as indicator organisms for all waters other than shellfishing and potable water intake areas. Not all data presented herein were used to determine impairment listing, due to a variety of reasons (including data quality assurance and quality control). The MassDEP used only a subset of the available data to generate the Integrated List. Other data presented in this section are for illustrative purposes only.

Data from the Massachusetts Division of Marine Fisheries (DMF) were used, in part, as the basis for pathogen impairment for many of the estuarine areas (Figure 1-1). Numerous samples have been collected throughout the North Coastal watershed by the DMF. DMF has a well-established and effective shellfish monitoring program that provides quality assured data for each shellfish growing area. In addition, each growing area must have a complete sanitary survey every 12 years, a triennial evaluation every three years and an annual review in order to maintain a shellfishing harvesting classification with the exception of those areas already classified as Prohibited. The National Shellfishing Sanitation Program establishes minimum requirements for sanitary surveys, triennial evaluations, annual reviews and annual fecal coliform water quality monitoring and includes identification of specific sources and assessment of effectiveness of controls and attainment of standards. "Each year water samples are collected by the DMF at 2,320 stations in 294 growing areas in Massachusetts's coastal waters at a minimum frequency of five times while open to harvesting" (DMF 2002a). Due to the volume of data collected by the DMF, only a small sub-set of these data are provided herein. For the most recent indicator bacteria sampling data, please contact your local city or town shellfish constable or DMF's shellfishing project.

Available bacteria data are summarized in the following section. The primary sources of data include but are not limited to DMF, CZM, MassDEP, Salem Sound Coastwatch, and the Saugus River Watershed Council. These data, with related data discussion can be found at:

Division of Marine Fisheries (2002). The Marine Resources of Salem Sound, 1997. Available for download at http://www.salemsound.org/PDF/salem_sound_report_tr6.pdf

Massachusetts Department of Environmental Protection (2000). North Coastal Watershed 1997/1998 Water Quality Assessment Report. Available for download at: www.mass.gov/dep/water/resources/wqassess.htm.

Saugus River Watershed Council (2004). Saugus River Watershed 2003 Water Quality Report. Available for download at: http://www.saugusriver.org.

Salem Sound Coastwatch (2004). Salem Sound Clean Beaches and Streams Program 2004 Report. Salem Sound Coast Watch. Available for download at: http://www.salemsound.org/.

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

The MADPH publishes annual reports on the testing of public and semi-public beaches for both marine and fresh waters. These documents provide water quality data for each bathing beach by community and note if there were exceedances of water quality criteria. There is also a list of communities that did not report testing results. These reports are available for download from the MADPH website either at mass.digitalhealthdepartment.com/public_21/index.cfm for marine beaches or for both marine and freshwater beaches by entering "BEACH REPORTS" in the search box at the EEOH home page.

Marine and freshwater beach status is highly variable and is therefore not provided in each segment description. Please see the MADPH annual beach report for specific details regarding swimming beaches.

The purpose of this section of the report is to briefly describe the impaired waterbody segments in the North Coastal watershed. For more information on any of these segments, see the "North Coastal Watershed 1997/1998 Water Quality Assessment Report" on the MassDEP website: www.mass.gov/dep/water/resources/wqassess.htm.

The Essex Bay System

The western drainage area of the Essex Bay system is comprised of Castle Neck Creek, Hog Island Channel, and the Essex River, which has four tributaries. The Essex River tributaries include Soginese Creek, Lufkin Creek, Ebben Creek and Alewife Brook. Walker Creek, Lanes Creek, and Farm Creek also discharge into Essex Bay along its southeastern shore (MassDEP 2000a). The Essex Bay system drains into Ipswich Bay. Two segments of the Essex Bay system, the Essex River and Essex Bay, are impaired due to excessive indicator bacteria concentrations.

Alewife Brook Segment MA93-45

This segment is a 1.4 mile Class B tributary which runs from its headwaters at the outlet of Chebacco Lake, Essex to Landing Road, Essex. This segment is in the community of Essex which has MS4 coverage (MAR041239) under the NPDES Program (MassDEP 2002c).

Bacteria sampling was conducted by MassDEP staff in Alewife Brook upstream from Apple Street in Essex (W0879) as part of the 2002 North Coastal Drainage Area water quality surveys (Table 4.4 below). Fecal coliform bacteria counts ranged from 20 to 19,000 cfu/100 mL with a geometric mean of 280 cfu/100 mL. E. coli bacteria counts ranged from 59- 400 cfu/100mL. The highest fecal coliform bacteria count likely represented the influence of a local storm event (MassDEP 2002c). However, it should also be noted that the Town of Essex had problems with contaminated storm drains resulting from failing septic systems, including a drain at Apple Street (Brander 2006d). The Town posted contaminated storm drains with signs. As part of a Court Decree, Essex has been inspecting Title 5 systems town-wide. The remediation of problems has included removing direct discharges, upgrading systems, and connecting to the sewer system. As of the date of this report the status of storm drain discharges to Alewife Brook is unknown, however, it was reported that failing septic systems were mitigated by December 2006 (Goodwin 2006).

Table 4-4 Summary of Fecal Coliform, E. coli, and Enterococci for Alewife Brook MA93-45 (MassDEP, 2002).

Site Description	Min	Max	Geometric Mean	Number Samples
	(cfu/100 mL)			
Alewife Brook (which flows into this Essex River MA93-11 segment) upstream of Apple Street in Essex, MASSDEP 2002	20 FC 59 EC 10 E	19,000 FC (wet weather) 400 EC 120,000 E	280 Not available 302	5 4 5
FC = fecal coliform EC = E. coli E = enterococci				

Alewife Brook Segment MA93-46

This segment is a 0.01 m^2 Class SA estuary which runs from Landing Road, Essex to confluence with Essex River. The Essex Housing Authority (MA0029564) is authorized to discharge 0.015 MGD treated wastewater to this segment. The segment is in the community of Essex (MAR041239) which has MS4 coverage under the NPDES program (MassDEP 2002c).

No bacteria data were collected from this segment of Alewife Brook, although samples were collected both upstream and downstream from this segment. It should be noted that elevated fecal coliform bacteria counts were documented in the freshwater reach just upstream of the brook (see Segment MA93-45, Table 4-4 above) while lower counts were documented in the downstream segment of the Essex River (see Table 4-5 below). The Town of Essex is under a consent order to remediate contaminated storm drains, some of which are known to discharge to Alewife Brook (Brander 2006c). Failing septic systems were reported to be addressed in December 2006 (Goodwin 2006). DMF shellfish status indicates that Area N7.2, which comprises the majority of this segment area, is listed as prohibited (DMF 2006).

Essex River Segment MA93-11

This segment is a 0.5 mi^2 Class SA tidal estuary located from east of Southern Avenue to the mouth of Essex Bay, Essex. This area is also classified as an ACEC/ORW by EOEA. The community of Essex (MAR041239) has MS4 coverage under the NPDES program (MassDEP 2002c).

The MassDEP conducted sampling five times between May and September 2002 at Station ER01, Route 133 (Main St.) crossover of Essex River in Essex (data summarized in Table 4-5 below). Fecal coliform bacteria (5 samples) results ranged between 6 - 1,000 cfu/100 mL. E coli bacteria results (4 samples) ranged between 6- 360 cfu/100mL. High counts were observed during dry weather conditions (MassDEP 2002c). During the period where samples were collected, a number of failed septic systems were identified. Since that time, much of the problem area where these failed systems had previously identified has been sewered and tied into the Gloucester WWTP (Brander, 2006).

Bacteria sampling was conducted by MassDEP staff in Alewife Brook (which flows into this Essex River MA93-11 segment) upstream of Apple Street in Essex (W0879) (data summarized in Table

4-4 above) as part of the 2002 North Coastal Drainage Area water quality surveys. It should be noted that the town of Essex sewer project and recent tie-in with the Gloucester WWTP will probably avert such high counts in the upper Alewife Brook area in the future. Shellfishing growing areas status: Conditionally Approved for 0.72 mi^2; Prohibited for 0.18 mi^2 (Figure 1-1).

Table 4-5. Fecal Coliform, E. coli, and enteroccoci for Essex River MA93-11 (MassDEP, 2002).

Site Description	Min	Max	Geometric Mean	Number Samples
	(cfu/100 mL)			
(Main St.) crossover of Essex River in Essex, MassDEP 2002	6 FC 6 EC 10 E	1,000 FC 360 EC (dry weather) 240 E	52 NA 36	5 4 5
FC = fecal coliform EC = E. coli E = enterococci				

Essex Bay Segment MA93-16

This segment is a 1.0 mi^2 Class SA tidal estuary located in three communities, Essex, Ipswich and Gloucester. The communities of Essex (MAR041239), Ipswich (MAR041199), and Gloucester (MAR041192) have coverage under MS4 in the NPDES Program (MassDEP 2002c).

The DMF has done periodic ambient fecal coliform bacteria sampling within this segment. During 1988- 1992 surveys, 16 stations were sampled an average of 30 times each. During 1999-2001, 17 stations were sampled 36 times. The data are summarized in Table 4-6 below. Shellfishing growing areas status: Conditionally Approved (Figure 1-1).

Table 4-6 Summary of DMF Fecal Coliform Data 1988-1992; 1999-2001 for Essex Bay MA93-16.

Site Descriptions	Dry and Wet Weather* Geometric Mean Minimum	Dry and Wet Weather* Geometric Mean Maximum	Number of Samples > 34 or 43 MPN	Number Samples
	cfu/100 mL			
16 ambient stations throughout segment, 1988-1992	3.2	35.8	40 samples above 43	485
17 ambient stations throughout segment 1999-2001 (many stations the same as 1988-92 surveys)	3.15	5.88	10 samples above 34	288
*Wet weather results 1988-92 vastly exceed dry weather results				

There is one public swimming area at Crane Beach. No postings occurred during the swimming seasons 2003-2010.

The Annisquam River System

The Annisquam River system, which is also hydraulically connected to Gloucester Harbor through the Blynman Canal, includes the Jones River, Little River and the Mill River. The Mill River sub-watershed is comprised of Alewife Brook, Babson Reservoir, an unnamed tributary between Babson Reservoir and Mill Pond, and the Mill River (MassDEP 2000a). The Annisquam River system drains into Ipswich Bay. Four segments of the Annisquam River system, the Mill and Annisquam Rivers and Rockport and Gloucester Harbors, are impaired due to excessive levels of indicator bacteria.

Mill River Segment MA93-28

This segment is a 0.1 mi^2 Class SA tidal estuary. It lies between the outlet of Mill pond and the confluence of the Annisquam River in central Gloucester. The Riverside Avenue Pumping Station Bypass for Gloucester holds a NPDES permit (MA0100625) authorizing discharge of 0.015 million gallons per day (mgd) four times per year (MassDEP 2002c). The community of Gloucester (MAR041192) has MS4 coverage under the NPDES program.

MassDEP, Division of Watershed Management (DWM) conducted sampling between May and September 2002 (data summarized in Table 4-7 below) at Station MR01, downstream of Route 127 (Washington St. Bridge), Gloucester. Fecal coliform bacteria results (5 samples) ranged between <6 - 52 cfu/100 mL. E coli bacteria results (4 samples) ranged between <6- 39 cfu/100mL (MassDEP 2002c).

Table 4-7. Summary of Fecal Coliform, E coli, and Enterococci Data for Mill River MA93-28 (MassDEP 2002).

Site Description	Min	Max	Geometric Mean	Number Samples
	cfu/100 mL			
Station MR01, downstream of Route 127 (Washington St. Bridge), Gloucester, MassDEP 2002	<6 FC <6 EC <6 E	52 FC 39 EC 39 E	17 FC NA 11 E	5 4 5
FC = fecal coliform EC = E. coli E = enterococci				

Shellfishing growing area status: Conditionally Approved (Figure 1-1).

Annisquam River MA93-12

This segment is a 0.82 mi^2 Class SA tidal estuary. It starts at the confluence with the Mill River and runs to Ipswich Bay. The City of Gloucester Pumping Station Bypass holds an NPDES permit MA0100145) authorizing two outfall discharges to the river (MassDEP 2002c). The community of Gloucester (MAR041192) has MS4 coverage under the NPDES program. The MassDEP WQA also lists the Cape Ann Marine vessel sewage pump-out as a discharger in the segment.

The DMF has been conducting ambient water quality sampling within this segment between 2005- 2010. The data are summarized in Table 4-8 below.

Table 4-8. Summary of DMF Fecal Coliform Data 2005- 2010 for Annisquam River MA93-12.

Site Description	Min	Max	Geometric Mean	Number Samples
	cfu/100 mL			
22 ambient stations throughout segment 10/2005- 9/2010	2	51	3	1,637

There is one public swimming area within this segment, Wingearsheek Beach. The city of Gloucester has been conducting Enterococcus bacteria sampling at this site a number of times each summer 2003- 2010. These are summarized in Table 4-9 below. There was 1 posting during the swimming seasons 2003-2010. Shellfishing growing area status: Conditionally Approved (Figure 1-1).

Table 4-9. Summary of Enterococcus Data (Town of Gloucester) 2003- 2010 for Annisquam River MA93-12.

Site Description	Min	Max	Number Samples
	cfu/100 mL		
At Wingaersheek Beach	<2	1,014	117

Rockport Harbor MA93-57(formerly MA-93-17)

This segment is a 0.35 mi^2 Class SB estuary. MassDEP defines this segment as the waters landward of an imaginary line from Gully Point, Rockport to Granite Pier, Rockport (including Back Harbor and a portion of Sandy Bay) (includes area formerly reported as segment MA93-17)[1]. This waterbody receives treated discharge from the Rockport WWTP (MA0100145) (0.8 MGD). The Town of Rockport Cape Ann Lighthouse (MA0090654) discharges 0.0012 MGD of treated sanitary wastewater to the Atlantic Ocean (Class SA) from the facility on Thatchers Island, which is approximately one mile east of Rockport. The community of Rockport (MAR041217) has MS4 coverage under the NPDES program (MassDEP 2002c). The MassDEP WQA also lists the Rockport Harbor vessel sewage pump-out facility in this segment (MassDEP 2002c). Shellfishing growing area status: Prohibited (Figure 1-1). The town of Rockport has done Enterococcus bacteria sampling at Old Garden Beach, which is geographically just adjacent to the east of Rockport Harbor proper. Sampling results are summarized in Table 4-10 below.

[1] The delineation of these waterbodies in the North Coastal Watershed Assessment Report (2002) reported in the 2008 Integrated List was not consistent with DWM's water quality standards. The delineations in this Table are consistent with the WQS and future Integrated List accounting. A WQS clarification will be made during the next revision to avoid confusion in the future. Likewise a correction will be made to the North Coastal assessment report during the next assessment cycle for the North Coastal watershed.

Table 4-10. Summary of Enterococcus Data (Mass DPH 2008-2010) 2003- 2010 for Rockport Harbor Segment MA93-57.

Site Description	Min	Max	Geometric Mean	Maximum (90% percentile)	Number Samples
	cfu/100 mL				
At Old Garden Beach	<2	84	11	45	20

According to the town Board of Health, there have been no beach postings or closures, at Old Garden Beach 2003-2010. This beach is located just outside, ¼ to ½ mile, to the east of the immediate inner Rockport Harbor area.

Gloucester Harbor Segment MA93-18

This segment is a 2.3 mi^2 Class SB/CSO estuary located in South Gloucester. The MassDEP WQA defines Gloucester Harbor as the waters between an imaginary line drawn between Dog Bar Breakwater and Mussel point. The only major facility is the Gloucester Water Pollution Control Facility (MA0100625) on the Annisquam River with the outfall located south of Dog Bar Breakwater (CZM 2004). The treatment plant discharges outside the harbor, but the effluent may affect the estuary due to tidal influences (EOEA 2004). Five CSOs, under permit MA0100625, as well as one pump station bypass outfall, discharge to Gloucester Harbor (MassDEP 2002c). They are located in the North Channel, Harbor Cove, and Pavilion Beach. United States Coast Guard Outfall #1 (MA0100625) is a minor waste water treatment facility discharging to the harbor. The community of Gloucester (MAR041192) has MS4 coverage under the NPDES program. There are 17 storm drains that discharge an annual estimated 575 million gallons of stormwater to Gloucester Harbor (CZM 2004).

There are four public beaches in outer Gloucester Harbor: Cressy's, Half Moon, Pavillion, and Niles beaches. The town of Gloucester conducted weekly Enterococci bacteria testing at 3 major beaches within the harbor area, June- September during the years 2003- 2010. The results are summarized in Table 4-11 below.

Table 4-11. Summary of Enterococcus Data (Town of Gloucester) 2003- 2010 for Gloucester Harbor MA93-18.

Site Description	Min	Max	Number Samples
	cfu/100 mL		
Cressy's Beach	<2	262	83
Pavillion Beach	<2	158	83
Niles Beach	<2	70	78

According to the Final Combined Sewer Overflow Revised Long-Term Control Plan submitted by Metcalf and Eddy on behalf of the City of Gloucester, the baseline CSO volumes for a year with typical rainfall (Table 4-12 below) ranged between .33 and 13.04 million gallons, while the number of events ranged between 8 and 53 events per year (Brander 2006c).

Table 4-12. Baseline Gloucester Harbor CSO Activations and Volumes in a Typical Year.

Discharge Point	Description	Annual Discharge Volume (MG)	Activations (Events/Year)
002	Mansfield Street Drain Western Ave CSO	13.04	33
004	Rogers Street CSO	0.66	9
005	Main Street CSO	10.96	53
006	East Main Street CSO	0.33	10
006A	East Main Street CSO	0.44	8
009	Hartz Street Pump station Bypass		*
003	Fort Square Bypass	Eliminated	
007	State Fish Pier "tide gate"		
008	Beacon Marine Bypass		
*Note: during larger wet weather events this overflow occurs in an area with a separate sewer system and is considered a sanitary sewer overflow, which is not permitted. The City is proceeding with construction work in the Hartz St. area to upgrade a number of pump stations and perform I/I abatement work, which is intended to mitigate the frequency and duration of SSO discharges at this location (Brander 2006c).			

The City submitted a Final Combined Sewer Overflow Long-Term Control Plan in June 2005. The recommended plan includes $14.6 million in system improvements, largely consisting of sewer separation projects. This work is expected to dramatically reduce the frequency and volume of CSO discharges, reducing discharge events from 53 to 2, and reducing annual volume from 25 million gallons to 0.44 million gallons. This will result in improved water quality at Pavilion Beach and Gloucester's Inner Harbor.

The City, DEP, and EPA entered into a Consent Decree on September 2, 2005 which established a schedule for completing the sewer separation work. The work will proceed under a number of separate construction contracts, and is expected to be complete by June 2012. It should also be noted that Gloucester Harbor has a boat pumping facility funded by the Clean Vessel Act to provide free boat pumpouts (MA DFG, 2006).Shellfishing growing area status: Prohibited (Figure 1-1).

The Salem Sound System

The Salem Sound area is comprised primarily of four major drainage systems. These systems flow to either the Manchester, Beverly, Salem or Marblehead Harbors (MassDEP 2000a). The drainage system that discharges to Beverly Harbor runs through an urbanized area including sections of Salem, Peabody, Danvers, and Beverly. Excluding the four drainage systems, Salem Sound is broadly defined as the waters inside of an imaginary line drawn from Marblehead Light northeast to the southwestern point on Bakers Island, Beverly and from the northwestern point on Bakers Island to Gales Point, Manchester. Chubb Creek is the only named stream discharging directly to Salem Sound (MassDEP 2002c). There are 21 segments impaired for indicator bacteria in the Salem Sound System.

The Division of Marine Fisheries (DMF) conducted a special study throughout the Salem Sound Area in 1997. The data collected were part of the published report, "The Marine Resources of Salem Sound, 1997" (see Table 4-11 for bacteria data, and Figure 4-1 for sampling locations) (DMF 2000b).

MassDEP sponsored a special Federal Grant Project, ID# 2002-01/604. A final report for the project was produced, "Shoreline Survey and Water Quality Sampling of Stormwater Discharge Locations along the Salem Sound Shoreline". The consultant, Horsley- Witten Group, Inc., of Sandwich MA, conducted the study which consisted of dry weather screening of selected stormwater outfalls throughout the Salem Sound and Harbor Areas (Horsley- Witten, Inc. 2005).

Salem Sound Coastwatch, a local watershed conservation group, collected water quality samples from stormwater outfalls and coastal streams in Salem Sound as part of their Clean Beaches and Streams Program. The results of their 2004 and 2005 sampling and bacterial analysis in Salem Sound for outfall pipes/streams are shown in Table 4-13 (for 2004), and Table 4-15 (for 2005) (SRWC 2004). Figure 4-1 shows sampling locations. Table 4-14 presents the results from beach water sample analyses conducted by municipalities in Salem Sound (SSCW 2004). Summary statistics for fecal coliform sampling in river, shore, and marine locations is provided in Table 4-16.

Table 4-13. Salem Sound Coastwatch – 2004 Water Quality Monitoring for Results from Outfall Pipes and Streams in the Salem Sound Watershed (SSCW 2004)[1].

Beach Sampled and Location	Site #	Dry Weather (cfu/100 mL)	Wet Weather (cfu/100 mL)
		Min ↔ Max (n) = # samples	Min ↔ Max (n) = # samples
Marblehead			
Stramski Beach - Stream draining across beach	722	300 ↔ 1,500 (6)	1,300 ↔ 6,400 (2)
Stramski Way - near parking lot after playground	722a	<100 ↔ 2,100 (6)	1,200 ↔ 7,400 (2)
Stramski Way - near field	722b	<100 ↔ 3,300 (6)	100 ↔ 21,000 (2)
Hawthorne Pond - end of street	750a	<100 ↔ 100 (3)	NS
Hawthorne Pond -	750b	<100 ↔ 200 (3)	NS
Hawthorne Pond - boardwalk	750c	<100 ↔ 400 (2)	NS
Beverly			
Dane St. Beach - N. storm drain	322	<100 ↔ 500 (6)	100 (1)
Lawrence Street Brook at beach	321	<100 ↔ 300 (6)	300 ↔ 5,800 (2)
Rice Beach - Stream draining across beach	214	<100 ↔ 900 (6)	400 ↔ 16,000 (2)
Brackenberry Beach - Stream across beach	213	100 ↔ 700 (6)	400 ↔ 1,300 (2)
Northern storm drain at beach	213a	100 ↔ 3,300 (6)	300 ↔ 31,000 (2)
Storm drain at beach	222	100 ↔ 900 (5)	<100 ↔ 13,000 (2)
Danvers			
Holton-Richmond School-field	400a	200 ↔ 1,600 (6)	100 ↔ 3,900 (2)

Beach Sampled and Location	Site #	Dry Weather (cfu/100 mL)	Wet Weather (cfu/100 mL)
		Min ↔ Max (n) = # samples	Min ↔ Max (n) = # samples
Bunky's Marina - Porter River	401a	<100 ↔ 200 (5)	<100 ↔ 4,500 (2)
Sandy Beach - outfall pipe	430	<100 ↔ 1,600 (5)	500 ↔ 44,000 (2)
Sandy Beach - downstream of outfall pipe	430a	<100 ↔ 200 (2)	<100 ↔ 1,900 (2)
Crane River Marina	431a	<100 (1)	NS
Eden Glen Road	491b	<100 ↔ 200 (3)	<100 (1)
Manchester			
Bennett's Brook - at Bennett St.	149	<100 ↔ 1,700 (6)	200 ↔ 6,400 (2)
Bennett's Brook - Forster Rd.	149a	<100 ↔ 500 (2)	100 ↔ 400 (2)
Raymond Street	150	100 ↔ 200 (3)	500 (1)
Salem			
Juniper Beach - storm drain on beach	620	200 ↔ 69,000 (6)	600 ↔ 100,000 (2)
Juniper Beach - storm drain	620 **	1,400 ↔ 950,000 (6)	2,800 ↔ 160,000 (2)
Palmer Cove - storm drain at Shetland Park	629	400 ↔ 2100 (6)	400 1 ↔ 5,000 (2)
Palmer Cove-storm drain below Playground	631	<100 ↔ 35,000 (6)	300 ↔ 20,000 (2)
Willow Ave. Beach - storm drain on beach	642	100 ↔ 8,000 (3)	1,800 ↔ 14,000
Collins Cove - Arbella St. stairs	527	400 (1)	6,600 (1)
Willows Pier	546	NS	NS
North River - off Commercial St. near Rt. 114	537	100 ↔ 1,100 (6)	300 ↔ 3,800 (2)
North River - south side, capped outfall	557	<100 (3)	NS
North River - off Commercial St. by footbridge	559	600 ↔ 1,600 (3)	500 ↔ 13,000 (2)
Derby Wharf	630	<100 ↔ 1,400 (3)	500 ↔ 12,000 (2)
Pioneer Village	634	500 (1)	NS

NS – Not sampled
All samples collected at low tide, dry weather samples collected on 6/8, 6/22, 7/6, 7/20, 8/3, and 9/14. Wet weather samples collected on 8/17 and 8/31.
Enterococci analysis.
** Fecal coliform data collected at this location

Table 4-14. Salem Sound Bathing Beaches Tested by Local Boards of Health for Enterococci 2004 Swimming Season. (SSCW 2004).

City and Beach Sampled	Geometric Mean (cfu/100 mL) (including rain events)	Range (cfu/100 mL) Min ↔ Max
Beverly		
Brackenbury Beach	9	2 – 36
Dane St. (mid-beach)	11	2 – 80
Goat Hill1	10	2 – 115
Independence Park	9	2 – 174
Lynch Park	11	2 – 146
Mingo Beach	18	2 – 95
Ober Park8	8	2 – 46
Rice Beach	5	2 – 44
Sandy Point	9	2 – 134
West Beach	14	2 – 56
Woodbury Beach	10	2 – 380
Danvers		
Sandy Beach East	32	2 – 755
Sandy Beach West	28	2 – 870
Manchester		
Black Beach	10	1 – 97
Magnolia Beach	7	1 – 97
Manchester Bath and Tennis	4	1 – 61
Singing Beach	3	1 – 22
Singing Beach (right of pkg. lot)	3	1 – 17
Tucks Point Beach	9	1 – 87
West Manchester Beach	16	1 – 190
White Beach	9	1 – 89
Marblehead		
Crocker Park	6	2 – 31
Devereaux Beach	6	2 – 460
Gas House Beach	12	2 – 220
Grace Oliver Beach	13	2 – 440
Stramski Beach	8	2 – 49
Village Beach1	19	2 – 185
Salem		
Collins Cove	8	2 – 32
Dead Horse Beach	6	2 – 80
Forest River Point	10	2 – 52
Juniper Point	9	2 – 28
Mackey Beach	7	2 – 71
Naumkeag	11	2 – 96
Ocean Ave. Beach	31	1 – 1100
Osgood Beach	6	2 – 77
Pickman Park	32	1 – 210

City and Beach Sampled	Geometric Mean (cfu/100 mL) (including rain events)	Range (cfu/100 mL) Min ↔ Max
Pioneer1	13	2 – 320
Steps Beach	4	1 – 24
Willow Ave	33	.1 – 490
Willows Pier	8	1 – 33
Winter Island	7	2 – 48

Table 4-15. Salem Sound Coastwatch – 2005 Water Quality Monitoring Results from Outfall Pipes and Streams in the Salem Sound Watershed (SSCW 2004)1.

Beach Sampled and Location	Site #	Dry Weather (cfu/100 mL)	Wet Weather (5/24/05) (cfu/100 mL)
		Min ↔ Max (n) = # samples	
Marblehead			
Stramski Beach - Stream draining across beach	722	75 ↔ 6,932 (7)	364
Stramski Way - near parking lot after playground	722a	91 ↔ > 9,678 (8)	587
Stramski Way -	722b	nd ↔ 7,945 (8)	1,664
Dollibar cove Creek – Grace Oliver Beach	700	52 ↔ 507 (5)	6,270
Riverhead Beach Culvert - left	701a	124 ↔ 384 (7)	933
Riverhead Beach Culvert - right	701b	81 ↔ 1,164 (7)	953
Prescott Beach Culvert	800	21 ↔ 100 (2)	NS
Beverly			
Dane St. Beach - N. storm drain	322	4 ↔ 239 (8)	1,041
Lawrence Street Brook at beach	321	34 ↔ 744 (8)	193
Rice Beach - Stream draining across beach	214	54 ↔ 6,932 (4)	373
Rice Beach - Stream draining under shed	214a	44 ↔ 5,199 (6)	165
Brackenberry Beach - Stream across beach	213	167 ↔ 518 (8)	116
Northern storm drain at beach	213a	21 ↔ 826 (7)	48
Storm drain at beach	222	77 ↔ 2,452 (7)	229
Wilson Street – beech seepage	350s	NS	NS
Kernwood bridge - Beverly	352	12 ↔ 820 (4)	NS
Danvers			
Sandy Beach - outfall pipe	430	147 (1)	NS
Manchester			

Beach Sampled and Location	Site #	Dry Weather (cfu/100 mL)	Wet Weather (5/24/05) (cfu/100 mL)
		Min ↔ Max (n) = # samples	
Bennett's Brook - at Bennett St.	149	12 ↔ 2,452 (7)	NS
Coolidge Point – Black Beach	151	48 ↔ 5,654 (8)	140
Salem			
North River- Upstream 114 overpass, Commercial Street	537	229 ↔ 9,678 (8)	2,460
North river – Commercial Way near foot bridge	559	21 ↔ 5,654 (8)	38,730
Juniper Beach - storm drain on beach	620	126 ↔ 198,630 (8)	4,100
Palmer Cove - storm drain at Shetland Park	629	405 ↔ 3,266 (8)	825
Darby Warf Storm Drain	630	395 ↔ 9,678 (8)	32,700
Palmer Cove-storm drain below Playground	631	4 ↔ > 4,480 (8)	34
Willow Ave. Beach - storm drain on beach	642	215 ↔ >24,196 (8)	51,720

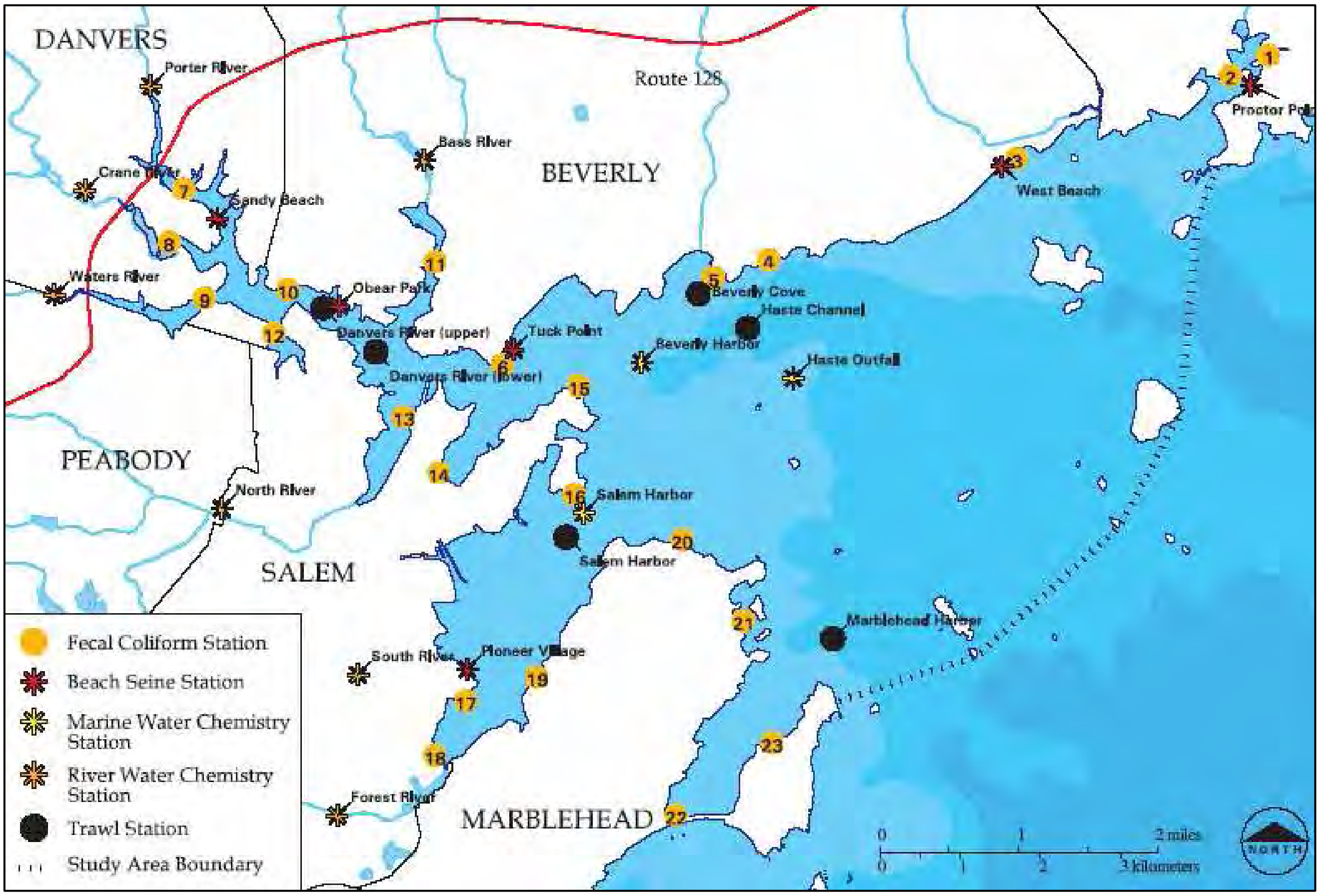
1 - Enterococci analysis

NS – not sampled. Wet weather samples collected on 5/24. Dry weather samples collected on 6/7, 6/21, 7/5, 7/26, 8/9, 8/23, 9/6, 9/20.

Table 4-16. Summary Statistics for Fecal Coliform Levels in River, Shore, and Marine Stations in Salem Sound, 1997 (DMF 2002b).

Station	Samples (No.)	Min. (fcc/100 ml)	Max. (fcc/100 ml)	Geo. Mean (fcc/100 ml)	> 43 (%)	> 260 (%)
SHORE						
Manchester Harbor						
Masconomo Park	20	3	1587	36	30	20
Manchester YC	20	3	110	16	25	0
Beverly Shore						
West Beach	18	3	347	19	28	11
Mingo Beach	18	3	900	38	50	17
Lynch Park	18	<3	87	9	11	0
Tuck Point	18	3	900	16	22	6
Danvers River						
Porter River	17	7	1587	67	59	12
Crane River	18	12	1587	172	94	28
Waters River	18	3	169	34	50	0
Fosters Point	18	3	347	26	22	6
Bass River	18	19	1587	96	72	17
Kernwood River	18	3	900	52	56	6
North River	18	3	900	118	83	33
Salem Shore						
Collins Cove	15	3	>2400	49	53	20
Willows Pier	18	3	>2400	31	44	11
Winter Island	18	3	110	6	6	0
Forest River Park	18	3	532	49	50	11
Forest River	18	3	347	55	61	11
Marblehead Shore						
Village Street	18	3	1587	11	22	6
Fluen Point	18	3	169	10	28	0
Browns Island	18	3	169	10	17	0
Inner Harbor	18	3	>2400	42	67	11
Eastern YC	18	3	>2400	10	17	6
RIVER						
Sawmill Brook	11	28	>2400	336	100	55
Bass River	5	4	133	15	40	0
Porter River	11	243	>2400	1149	100	91
Crane River	11	7	900	266	100	64
Waters River	11	14	>2400	446	100	73
North River	11	900	>2400	2009	100	100
South River	4	87	>2400	437	100	50
Forest River	3	7	99	21	50	0
MARINE						
Haste Outfall (plume)	3	14	347	82	66	33
Haste Outfall	9	<3	243	15	66	0
Beverly Cove	7	<3	133	4	14	0
Beverly Harbor	9	<3	4	2	0	0
Upper Danvers River	8	<3	97	7	37	0
Lower Danvers River	9	<3	61	10	33	0
Salem Harbor	9	<3	4	2	0	0
Marblehead Harbor	8	<3	>2400	8	12	12

Figure 4-1 Location of Sampling Points for DMF Study of Salem Sound Marine Resources, 1997 (DMF 2002b). Numbers used to designate sampling location.



Causeway Brook Segment MA93-47

This is a 1.1 mile in length, Class B tributary, which runs from the outlet of Dexter Pond, Manchester to confluence with Cat Brook, Manchester. The community of Manchester (MAR041207) has MS4 coverage under the NPDES program (MassDEP 2002c).

Bacteria sampling was conducted by DWM staff in Causeway Brook near Lincoln Street in Manchester (W0888) as part of the 2002 North Coastal Drainage Area water quality surveys (See Table 4-17 below). Fecal coliform bacteria counts ranged from 20 to 10,000 cfu/100 mL with a geometric mean of 299 cfu/100 mL. E coli bacteria results ranged between 59- 1,500 cfu/100mL. The highest fecal coliform bacteria count likely represented the influence of a local storm event (MassDEP 2002c).

Table 4-17. Summary of Fecal Coliform, E coli, and Enteroccoci Data for Causeway Brook MA93-47 (MassDEP, 2002).

Site Description	Min	Max	Geometric Mean	Number Samples
	cfu/100 mL			
Station WO888, near Lincoln Street in Manchester (DEP 2002)	20 FC 58 EC 78 E	1,000 FC 1,500 EC 930 E	188 Not available 349	5 4 5
FC = fecal coliform EC = E. coli E = enterococci				

Cat Brook Segment MA93-29

This segment is 1.7 mile Class B Brook. It flows from the boundary of Manchester, Essex, and Gloucester, north of Route 128, southwest through Manchester and into Manchester Harbor. Cat Brook belongs to the Manchester Harbor Drainage System. Causeway and Sawmill Brooks are the two named tributaries of Cat Brook. Downstream of Sawmill Brook, Cat Brook is sometimes referred to as Sawmill Brook. The community of Manchester (MAR041207) has MS4 coverage under the NPDES program (MassDEP 2002c).

During a 1997 and 1998 survey, MassDEP collected 11 samples on Cat Brook, and DMF collected 11 samples from sites on Sawmill Brook (immediately upstream of Cat Brook), (see Table 4-18 below). Fecal coliform levels in the 1997-8 MassDEP samples from stations SM01 and SM02 ranged from < 20 to 920 cfu/100 mL (8 samples collected) (MassDEP 2002a). Samples collected between April and October, 1997 all exceeded 400 cfu/100 mL. E. coli values ranged from <20 to 620 cfu/100 mL (6 samples collected) (MassDEP 2002c).

MassDEP conducted sampling five times between May and September 2002 at Station SM03, Cat Brook, Lincoln St. crossover of Cat Brook Manchester. Fecal Coliform results ranged between 20- 6,800 cfu/100 mL. E coli results ranged between 20- 440 cfu/100mL. The highest counts were likely influenced by local rain events (MassDEP 2002c).

Fecal coliform levels in DMF samples from Sawmill Brook (Marine Resources of Salem Sound, 1997 Study) collected between April and October, 1997 ranged from 133 to > 2,400 cfu/100 mL, with 50% exceeding 200 cfu/100 mL (11 samples collected) (Table 4-18 below). On the two dry weather sampling days, fecal coliform levels exceeded 400 cfu/100 mL (MassDEP 2002a)(DMF 2000b).

Table 4-18. Summary of Fecal Coliform, E. Coli, and Enterococci Data for Cat Brook MA93-29 (MassDEP 2002).

Site Description	Min	Max	Geometric Mean	Number Samples
	cfu/100 mL			
Station SM03,Lincoln St. crossover of Cat Brook Manchester (MassDEP 2002)	20 FC 20 EC 78 E	6,800 FC 440 EC (wet weather) 930 E	379 Not available 223	5 4 5
FC = Fecal coliform EC - E. Coli E = enterococci				

Manchester Harbor Segment MA93-19

This segment is a 0.33 mi^2 Class SB estuary. The MassDEP WQA defines the harbor as the waters inside an imaginary line drawn Gales Point and Chubb Point. The Manchester WWTP (MA0100871) discharges to an area off the southwest coast from Proctor's Point (Class SA waterbody), just to the southeast of the inner harbor. The community of Manchester (MAR041207) has MS4 coverage under the NPDES program (MassDEP 2002c). The MassDEP WQA lists the vessel sewage pump-out facilities at Manchester Marina and Crocker's Boat Yard, both in Manchester, as being located within the harbor.

During the 1997 primary contact recreation season, the DMF (as part of the Marine Resources of Salem Sound, 1997 Report) collected a total of 40 fecal coliform samples from two stations in Manchester Harbor, (see Table 4-16 above, and Table 4-19 below). The results ranged between 3- 1,587 cfu/100mL (DMF 2002b).

A survey was conducted along the Salem Sound shoreline in 2004 (see Table 4-19 below) to create an inventory of observable stormwater pipe outfalls 12" or more in diameter. Sampling occurs during dry weather for the purpose of screening for possible illicit connections. Two rounds of bacteria sampling occurred between October 5, and November 4, involving 3 observed outfalls in Manchester Harbor. One fecal coliform bacteria sample result was 4,600 cfu/100mL. Enterococci ranged between <2- 125 cfu/100 mL over the two survey dates (Horsley Witten Group 2005).

Table 4-19. Summary of Fecal Coliform and Enteroccoci Data, for Manchester Harbor MA93-19 (Horsley- Witten Group, 2004).

Site Description	Min	Max	Number Samples
	cfu/100 mL		
Sampling of 3 outfalls in Manchester Harbor, MAN-1-3, MAN-1-12, MAN-1-14 (Horsley- Witten Group 2004)	--- <2 E	4,600 FC 125 E	1 7
FC = fecal coliform, E = enterococci			

There are two beaches along the outer western shoreline of Manchester Harbor: West Manchester and Tuck's Point beaches. Weekly Enterococci bacteria testing indicated no postings in 2002 or 2003, however, West Manchester Beach was posted twice in 2004 for a total of 12 days (MA DPH 2003, 2004, 2005b, and SSCW 2004). The West Manchester Beach was closed June 30 to July 7, 2004 and closed July 28 to August 4, 2004 (SSCW 2004). Shellfishing growing areas status: Prohibited (Figure 1-1).

Bass River Segment MA93-08

This segment is a 0.12 m^2 Class SA river that drains the majority of southwest Beverly. The Bass River lies in a highly urbanized portion of the Beverly Harbor drainage system with industrial practices located close to the river. The MassDEP WQA indicates that Communications and Power Industries, Beverly Microwave Division, formerly known as Varian Associates,(MAG6250520), is authorized to discharge non-contact cooling water and stormwater to this segment. The community of Beverly (MAR041181) has MS4 coverage under the NPDES program (MassDEP 2002c).

The MassDEP collected one sample from the river in 1998 during wet weather (data summarized in Table 4-20 below). The fecal coliform count was 4,000 cfu/100 mL and the E. coli count was 1000 cfu/100 mL (MassDEP 2002a).

A survey was conducted along the Salem Sound shoreline in 2004 to create an inventory of observable stormwater pipe outfalls 12" or more in diameter. Sampling occurs during dry weather for the purpose of screening for possible illicit connections. Two fecal coliform samples were collected on October 5: the readings were 1,300 and 4,600 cfu/100mL (see Table 4- 20 below). Enterococci ranged between <2 - 264 cfu/100 mL on October 5, and between 58- 2,600 on November 4 (Horsley- Witten Group 2005).

Table 4-20. Summary of Fecal Coliform and E. Coli Data (DEP) 1998; and (Horsley- Witten Group) 2004, for Bass River MA93-08.

Site Description	Min	Max	Number Samples
	cfu/100 mL		
Salem Sound (1997), Bass River	19 FC	1587 FC	19
Bass River (MassDEP 1998)		4,000 FC 1,000 EC	1 1
Bass River Area Discharge Pipes (Horsley Witten Group 2004)	1,300 FC (dry weather)	4,600 FC (dry weather)	2
FC = Fecal coliform EC - E. Coli E = enterococci			

There is one beach along the shoreline of this segment of the Bass River, Goat Hill Beach, near the confluence with the Danvers River. This beach was tested weekly for bacteria during the summers of 2002, 2003, and 2004. There was one posting because of elevated Enterococci bacteria counts in 2003 (totaling two days) and one posting (totaling seven days) in 2004. There were no postings reported in 2002 (MA DPH 2003, MA DPH 2004, and MA DPH 2005b).

Shellfishing growing areas status: Prohibited (Figure 1-1).

Frost Fish Brook Segment MA93-36

This segment is a 1.0 mile Class B river. The headwaters of Frost Fish Brook are south of Putnamville Reservoir in Danvers. The brook flows from this location to its confluence with the Porter River in Danvers at the Route 62 Bridge. The community of Danvers has MS4 coverage (MAR041188) under the NPDES program (MassDEP 2002c).

In 2002, fecal coliform bacteria samples were collected by MassDEP between May and September at Station FF00, downstream of crossover bridge, Route 62, Danvers. The counts ranged between 20-14,000 cfu/100 mL. E coli counts ranged between 78- 13,000 cfu/100mL and enteroccoci ranged from 330 to 2,400 cfu/100mL (MassDEP 2002c).

Table 4-21. Summary of Fecal Coliform and E. Coli Data (MassDEP) 2002 for Frost Fish Brook MA93-36.

Site Description	Min	Max	Geometric Mean	Number Samples
	cfu/100 mL			
Station FF00, downstream of crossover bridge, Route 62, Danvers, MassDEP 2002	20 FC 78 EC 330 E	14,000 FC 13,000 EC 2,400 E	2,479 1,607 1,060	5 5 5
FC = fecal coliform EC = E. coli E = enterococci				

Porter River Segment MA93-04

This segment is a 0.13 mi^2 Class SA estuary. This segment of the Porter River is located between the river's confluence with Frost Fish Brook and its confluence with the Danvers River. The community of Danvers has MS4 coverage (MAR041188) under the NPDES program (MassDEP 2002c).

During the 1997 primary contact recreation season, the DMF collected eleven fecal coliform samples from this segment (see Table 4-16 above, and Table 4-22 below). Sample results ranged between 243 to >2,400 cfu/100 mL. Ninety- one percent of the samples contained over 260 cfu/100 mL, including two samples collected during dry weather conditions (MassDEP 2002a)(DMF 2002b).

A survey was conducted along the Salem Sound shoreline in 2004 to create an inventory of observable stormwater pipe outfalls 12" or more in diameter. Sampling occurs during dry weather for the purpose of screening for possible illicit connections. Two rounds of bacteria sampling occurred between October 5, and November 4, involving 6 observed outfalls in Porter River area. Two fecal coliform samples (see Table 4-22 below) on October 5 were 120 and 2,800 respectively. E Enteroccoci ranged between 21 - 130 cfu/100 mL on October 5, and between 15 - 4,500 cfu/100 mL on November 4 (Horsley- Witten Group 2005).

Table 4-22. Summary of Fecal Coliform Data (Salem Sound) 1997, and (Horsley- Witten Group) 2004, for the Porter River MA93-04.

Site Description	Min	Max	Geometric Mean	Number Samples
	cfu/100 mL			
Porter River (Salem Sound 1997)	243 FC	>2,400 FC	1,149	11
Porter River Area (Horsley-Witten 2004), Station D18-D34	21 E 120 FC (dry weather)	4,500 E 2,800 FC (dry weather)	93	12 2
FC = fecal coliform EC = E. coli E = enterococci				

Weekly testing for Enterococci bacteria during the swimming season has been conducted at Sandy Beach, Danvers during the summers of 2002, 2003, and 2004. There was one posting reported because of elevated Enterococci bacteria counts in 2003 (totaling 13 days) and one posting reported in 2004 (totaling five days). There were no postings reported in 2002. Suspected sources of pollution in this segment include illicit connections/hookups to storm sewers, marinas/boating pumpout releases, and marinas/boating sanitary on-vessel discharges. Shellfishing growing areas status: Prohibited (Figure 1-1).

Crane Brook Segment MA93-02

This segment is a 1.8 mile in length and designated as a Class B warm water fishery. Crane Brook flows from its headwaters west of the Newburyport Turnpike in Danvers to Mill Pond, also in Danvers. The community of Danvers has MS4 coverage (MAR041188) under the NPDES program (MassDEP 2002c).

MassDEP sampled for fecal coliform and E. coli bacteria in Crane Brook at two locations, (Stations CR04 and CR02), in 1997 and 1998. Fecal coliform levels ranged from 80 to 900 cfu/100 mL. E. coli ranged from 20 to 120 cfu/100mL (MassDEP 2002a).

MassDEP also conducted sampling on five occasions between May and September 2002 at station CR02 at Pine Street crossover in Danvers. Fecal coliform bacteria results ranged between <20 - 17,000 cfu/100 mL. E coli bacteria results ranged between <20- 820 cfu/100mL and enteroccoci ranged from 160 to 1,000 cfu/100mL (MassDEP 2002c).

Table 4-23. Summary of Fecal Coliform and E. Coli Data (MassDEP) 2002 for the Crane Brook MA93-02.

Site Description	Min	Max	Geometric Mean	Number Samples
	cfu/100 mL			
CR02 at Pine Street crossover in Danvers (MassDEP 2002)	<20 FC <20 EC 160 E	17,000 FC 820 EC 1,000 E	378 FC Not available 420 E	5 4 5
FC = fecal coliform EC = E. coli E = enterococci				

Crane River MA93-41

This segment is a 0.07 mi^2 Class SA waterbody. This segment of the Crane River runs from the pump house sluiceway on purchase Street in Danvers to its confluence with the Danvers River. The community of Danvers has MS4 coverage (MAR041188) under the NPDES program (MassDEP 2002c). Shellfishing growing areas status: Prohibited (Figure 1-1).

MassDEP sampled for fecal coliform and E coli bacteria at one station (CR01) in both 1997-8 and 2002. In 1997-8, fecal coliform bacteria levels (6 samples) ranged between 80- 2,400 cfu/100mL, and E coli bacteria levels (6 samples) ranged between <20- 400 cfu/100mL (MassDEP 2002a).

In 2002, bacteria samples were collected 6 times during the season with results that ranged between 10- 680 cfu/100mL (fecal coliform), <20- 84 cfu/100mL (E. coli), and 20 to 1,200 cfu/100 mL (enteroccoci) (MassDEP 2002c).

Table 4-24. Summary of Fecal Coliform and E. Coli Data (MassDEP) 2002 for the Crane River MA93-41.

Site Description	Min	Max	Geometric Mean	Number Samples
	cfu/100 mL			
CR01 ,upstream/ west of Ash St., Danvers (MassDEP, 2002)	10 FC 10 EC 20 E	680 FC 84 EC 1,200 E	99 FC 25 EC 130 E	6 5 6
FC = fecal coliform EC = E. coli E = enterococci				

Waters River Segment MA93-01

This segment is a 0.09 mi^2 Class SA tidal estuary. The Waters River flows from its headwaters near the Peabody/Danvers line upstream of Mount Pleasant Drive in Peabody to its confluence with Danvers River in Danvers. The communities of Danvers and Peabody have MS4 coverage (MAR041188, and MAR041216) under the NPDES program (MassDEP 2002c).

The MassDEP sampled the Waters River for fecal coliform and E. coli at one station (WA01) on six occasions between 1997 and 1998. Fecal coliform counts (6 samples) ranged from 200 to 3,200 cfu/100 mL and E. coli ranged from 20 to 1,200 cfu/100 mL (MassDEP 2002a). The DMF collected fecal coliform samples on 11 occasions in 1997 from the Waters River, (Table 4-16 above, and Table 4-25 below). Seventy-three percent of the samples exceeded 260 cfu/100 mL. Values ranged between 14- >2,400 cfu/100 mL (MassDEP 2002a) (DMF 2002b). Shellfishing growing areas status: Prohibited (Figure 1-1).

MassDEP carried out fecal coliform sampling on five occasions at Station WA00 between May and September 2002. Sample results ranged between 6 - 140 cfu/100 mL (fecal coliform), <6- 180 cfu/100mL (e. coli) and <6 to 180 cfu/100/mL (Enteroccoci) (MassDEP 2002c). Based on these data water quality appears to have improved since the initial survey in the late 1990's.

Table 4-25. Summary of Fecal Coliform, E. Coli and Enterococci data, Waters River MA93-01 (Salem Sound, 2007,Mass DEP 2002).

Site Description	Min	Max	Geometric Mean	Number Samples
	cfu/100 mL			
Waters River (Salem Sound, 1997)	14 FC	>2,400 FC	Not available	11
Station WA00, at Water Street (Route 35),(MassDEP, 2002)	6 FC <6 EC 6 E	140 FC 180 EC 84 E	29 FC Not available 23 E	5 4 5
FC = fecal coliform EC = E. coli E = enterococci				

Goldthwait Brook Segment MA93-05

This segment is a 3.3 mile Class B, Warm Water Fishery. Goldthwait Brook flows from Cedar Pond to its confluence with Proctor Brook in the center of Peabody. Goldthwaite Brook flows through Craig's Pond and is joined by Tapley Brook near the Eastman Gelatin Corp. facility. The MassDEP WQA lists three NPDES permitted discharges. NPDES permits include non-contact cooling water and stormwater discharges from Eastman Gelatine Corporation (MA0003956), filter backwash from the Coolidge Avenue Water Treatment Facility (MAG640006), and a discharge permit from the Stahl Finishing Hazardous Waste Site (MA0028215) (MassDEP 2000a). The community of Peabody has MS4 coverage (MAR041216) under the NPDES program (MassDEP 2002c).

The MassDEP collected fecal coliform and E. coli bacteria samples on two occasions from Goldthwait Brook in 1997 and 1998 . Fecal coliform counts were <20 and 40 cfu/100 mL and both E. coli counts were <20 cfu/100 mL (MassDEP 2002a).

In 2002, MassDEP conducted fecal coliform sampling on five occasions between May and September at Station GB01, at Foster Street crossover in Peabody. Sample results ranged between 78 - 8,000 cfu/100 mL (fecal coliform), 10- 590 cfu/100mL (E. coli) and 13 to 55,000 cfu/100 mL (enteroccoci). The highest count was reported to represent the influence of a local storm event (MassDEP 2002c).

Table 4-26. Summary of Fecal Coliform, E. Coli, and Enteroccoci Data (MassDEP) 2002 for the Goldthwaite Brook MA93-05.

Site Description	Min	Max	Geometric Mean	Number Samples
	cfu/100 mL			
Station GB01, at Foster Street crossover in Peabody (MassDEP, 2002)	78 FC 10 EC 13 E	8,000 FC 590 EC 55,000 E	450 FC Not available 273 E	5 4 5
FC = fecal coliform EC = E. coli E = enterococci				

Proctor Brook Segment MA93-39

This segment of Proctor Brook is a 2.9 mile Class B waterbody. This segment begins in a wetland just north of Downing Road in Peabody and ends at the Goodhue Street Bridge. There are presently two NPDES permitted discharges (MassDEP 2000a) that include an overflow discharge (MA640028) from the Peabody Municipal Light Plant cooling pond, and a former 21E discharge (MA0033723),now a multisector general stormwater permit, from Federal Express (MassDEP 2000a). The communities of Peabody and Salem have MS4 coverage (MAR041216 and MAR041219) under the NPDES program (MassDEP 2002c).

The MassDEP sampled Proctor Brook for fecal coliform and E. coli on six occasions between 1997 and 1998. Fecal coliform counts ranged from 640 to 50,000 cfu/100 mL and E. coli ranged from 200 to 6,000 cfu/100 mL (MassDEP 2002a). During 1997 the DMF also collected fecal coliform samples on Proctor Brook (identified by DMF in their report as 'North River') downstream from the face of Howley St. culvert in Peabody on 11 occasions. Fecal coliform results showed all samples were greater than 900 cfu/100 mL. The geometric mean was 2009 cfu/100mL, which was the highest geometric mean reading for any one station location in the entire DMF "Marine Resources of Salem Sound, 1997" study. Dry weather values were >2,400 cfu/100 mL (MADEP 2002a) (DMF 2000b).

In 2002, MassDEP conducted sampling at Station PB03 MassDEP between May and September with results ranging between 330 - 3,000 cfu/100 mL (fecal coliform) 20- 1,300 cfu/100mL (e. coli), and 71 - 5,800 cfu/100/mL (Enterococci) (MassDEP 2002c).

Table 4-27. Summary of Fecal Coliform, E. Coli and enteroccoci Data for Proctor Brook MA93-39 (Salem Sound 1997, MassDEP, 2002).

Site Description	Min	Max	Geometric Mean	Number Samples
	cfu/100 mL			
Proctor Brook, called 'North River' by DMF (Salem Sound 1997)	900 FC	>2,400 FC (dry weather)	2009	11
Station PB03, at Grove Street crossover in Salem (MassDEP 2002)	330 FC 20 EC 71 E	3,000 FC 1,300 EC 5,800 E	1,054 FC 280 402	5 5 5
FC = fecal coliform EC = E. coli E = enterococci				

North River Segment MA93-42

The North River estuary is a 0.15 mi^2 Class SA waterbody. This estuary lies between the Route 114 bridge/culvert in Salem and its confluence with the Danvers River. The community of Salem has MS4 coverage (MAR041219) under the NPDES program (MassDEP 2002c).

A survey was conducted along the Salem Sound shoreline in 2004 to create an inventory of observable stormwater pipe outfalls 12" or more in diameter. Sampling was conducted during dry weather for the purpose of screening for possible illicit connections. Two rounds of bacteria sampling occurred between

October 5, and November 4, involving 3 observed outfalls in North River area (see Table 4-28 below). One fecal coliform sample was 1,400 cfu/100 mL. Enterococci ranged between 7- 164 cfu/100 mL on both survey days (Horsley Witten Group 2005). Shellfishing growing areas status: Prohibited (Figure 1-1).

Table 4-28. Summary of Fecal Coliform and Enterococci Data for North River MA93-42 (Horsley and Witten, 2004).

Site Description	Min	Max	Geometric Mean	Number Samples
	cfu/100 mL			
3 observed outfalls in North River area (Horsley-Witten Group 2004), Stations S3-1, S3-2 and S3-3	 7 E	1,400 FC 164 E	Not available 39 E	1 6
FC = Fecal coliform E = enterococci				

Danvers River Segment MA93-09

This segment is a 0.53 mi^2 Class SA estuary. The Danvers River estuary is formed at the confluence of the Porter, Crane and Waters Rivers near Danversport. The estuary discharges into Beverly Harbor. The Bass River and the North River also flow into the Danvers River upstream of its confluence with Beverley Harbor. The vessel sewage pump-out facilities at the Danversport Yacht Club in Danvers is located within this segment (MassDEP 2000a). The communities of Danvers, Beverly, Peabody, and Salem, have MS4 coverage (MAR041188, MAR041181, MAR041216, MAR041219) under the NPDES program (MassDEP 2002c).

DMF conducted fecal coliform sampling at seven stations (total of 125 samples) in the Danvers River in 1997 (see Table 4-16). Sample results ranged between 3- 1,587 cfu/100mL. Fifteen percent of the samples were > 260 cfu/100mL (DMF 2002b).

MassDEP conducted fecal coliform sampling on five occasions between May and September 2002 at Station DR01, at Kernwood Street crossover in Beverly/Salem (see Table 4-29 below). Pathogen results ranged between 6 – 73 cfu/00 mL (fecal coliform), <6- 32 cfu/100mL (E. coli), and <6 to 13 cfu/100/mL (Enteroccoci) (MassDEP 2002c). In 2004 a survey was conducted along the Salem Sound shoreline to create an inventory of observable stormwater pipe outfalls 12” or more in diameter. Sampling is conducted during dry weather for the purpose of screening for possible illicit connections. Two rounds of bacteria sampling occurred between October 5, and November 4, involving one observed outfall in the Danvers River area. Enterococci were detected at a concentration 5 cfu/100 mL (Horsley Witten Group 2005). Shellfishing growing areas status: Prohibited (Figure 1-1).

Table 4-29. Summary of Fecal Coliform Data for Danvers River MA93-09 (MassDEP, 2002).

Site Description	Min	Max	Number Samples
	cfu/100 mL		n
Kernwood Street crossover in Beverly/Salem (MassDEP),2002	6 FC <6 EC <6 E	73 FC 32 EC 13	4 4 4
FC = fecal coliform, EC = E. coli, E = enterococci			

Beverly Harbor Segment MA93-20

This segment is a 1.02 mi^2 Class SB waterbody. Beverly Harbor is runs from the mouth of the Danvers River, Salem/Beverly to an imaginary line from Juniper Point, Salem to Hospital Point, Beverly. The communities of Danvers, Beverly, Peabody, and Salem, have MS4 coverage (MAR041188, MAR041181, MAR041216, MAR041219) under the NPDES program (MassDEP 2002c). There is also a vessel sewage pump-out facility at the Ferryway Public Landing in Beverly. There are 10 public swimming areas within this segment area. Weekly testing for Enterococci bacteria during the swimming season for years 2002 to 2004 has been conducted at ten beaches within this segment. (MassDEP 2006). These beaches include:

Rice Beach, Beverly - There was one posting reported because of elevated Enterococci bacteria counts in 2003 (totaling two days).

Lynch Beach, Beverly - There was one posting reported because of elevated Enterococci bacteria counts in 2004 (totaling seven days).

Woodbury Beach, Beverly - There was one posting reported because of elevated Enterococci bacteria counts in 2003 (totaling two days) and one posting (totaling one day) in 2004.

Dane Street Beach, Beverly - There was one posting reported because of elevated Enterococci bacteria counts in 2003 (totaling two days).

Independence Park Beach, Beverly - There were two postings reported because of elevated Enterococci bacteria counts in 2004 (totaling nine days).

Sandy Point Beach, Beverly - There was one posting reported because of elevated Enterococci bacteria counts in 2003 (totaling two days) and one posting (totaling one day) in 2004.

Collins Cove Beach, Salem - There were no postings reported for 2002, 2003, or 2004.
Dead Horse Beach, Salem - There were no postings reported for 2002, 2003, or 2004.

Willows Pier Beach, Salem - There were no postings reported for 2002, 2003, or 2004.

Juniper Point Beach, Salem - There were no postings reported for 2002, 2003, or 2004.

DMF sampled nine times for fecal coliform in Beverly Harbor in 1997. Sample results ranged between <2- 4 cfu/100mL. The geometric mean was 2 cfu/100mL (DMF 2002b).

Another survey was conducted along the Salem Sound shoreline in 2004 to create an inventory of observable stormwater pipe outfalls 12" or more in diameter. Sampling was carried out during dry weather for the purpose of screening for possible illicit connections. Two rounds of bacteria sampling occurred between October 5, and November 4, that involved 3 observed outfalls in the Beverly Harbor area. One fecal coliform sample reading was 1,000 cfu/100mL. Two Enterococci levels were 54 and 1,200 cfu/100 mL (Horsley- Witten Group 2005) (see Table 4-30 below).

Table 4-30. Summary of Fecal Coliform Data and Enterococci Data (Horsley and Witten Group, 2004) for the Beverly Harbor Segment MA93-20.

Site Description	Min	Max	Number Samples
	cfu/100 mL		n
stormwater pipe survey, 5 outfalls,(Horsley-Witten Group 2004)	 54 E	1,000 FC 1,200 E	1 2
FC = fecal coliform E = enterococci			

Salem Sound Coastwatch sampled a number of stations in the area of this segment in 2004-5 for fecal coliform. Wet weather results in 2004 included at least several counts in excess of 11,900 cfu/100mL, up to a maximum of 31,000 cfu/100 mL. Dry weather results 2004-5 included several counts over 1,000 cfu/100mL, with a maximum of 3,300 cfu/100mL (see Table 4-13, and Table 4-15 above) (SSCW 2004). Shellfishing growing areas status: Prohibited (Figure 1-1).

Proctor Brook Segment MA93-40

This is a Class SA segment, 0.01 m^2 in area, which runs from Grove/Goodhue Street Bridge, Salem, to Route 114 culvert, Salem. The community of Salem has coverage (MAR041219) under the NPDES MS4 program (MassDEP 2002c).

Salem Sound Coastwatch has been conducting Enterococcus bacteria sampling at two outfalls near the Commercial Street Overpass, Salem, from six to eleven times during the warmer parts of each year from 2004- 2010. The results are summarized in Table 4-31 below. It should be pointed out that Proctor Brook is also known as the North River, and is identified as such by the Salem Sound Coastwatch organization.

Table 4-31. Summary of Enterococci Data for Proctor Brook MA93-40 (Salem Sound, 2010).

Site Description	Min	Max	Geometric Mean	Number Samples
Enterococcus	cfu/100 mL			n
Outfall upstream of Rte. 114 overpass, Commercial Street, #537 (2010)	170 E	2700 E	772 E	6
Outfall off Commercial street near foot bridge, #559 (2010)	405 E	16,000 E	2,087 E	6
E = enterococci				

It should be noted that elevated bacteria sampling results (>2,000 cfu/100ml) occurred following both wet as well as dry weather periods at both outfall locations. DMF does not manage this waterbody as an active shellfishing growing areas in accordance with the requirements of National Shellfish Sanitation Program (NSSP).

Salem Harbor Segment MA93-54 (formerly MA93-21)

Salem Harbor is a 4.91 mi^2 Class SB estuary. MassDEP defines the harbor as the waters landward of an imaginary line from Naugus Head, Marblehead to the northwest point of Bakers Island, Salem to Hospital Point, Beverly to Juniper Point, Salem (excluding Forest River) (formerly segment MA93-21 Salem Harbor and a portion of segment MA93-25 Salem Sound [waterbody code 93907])[4]. This waterbody receives effluent from the South Essex Sewerage District Outfall – (MA0100501) in Salem Massachusetts. In addition, MassDEP WQA lists several NPDES permitted outfalls associated with the Dominion Energy Salem Harbor, LLC (power station) facility (MA0005096) into the Harbor including:

> Outfall 001: discharging condenser cooling water, boiler blowdown, reboiler and evaporator blowdown, freshwater storage tank overflow, service water, boiler blowdown tanks, and stormwater,
>
> Outfall 006: discharging wastewater treatment service ash settling point, seal water, floor & equipment drains, blowdown and stormwater,
>
> Outfall 005 and 007: discharging intake screen wash water, and
>
> Outfall 15: discharging emergency spillway overflow.

The communities of Salem (MAR041219), and Marblehead (MAR041047) have MS4 coverage under the NPDES program. There is also a vessel sewage pump-out facility at Winter Island, Salem that transfers pump-out waste to SESD Wastewater Treatment Plant for further processing (MassDEP 2002c).

There are 10 public swimming areas within this segment area. Weekly testing for Enterococci bacteria during the 2002-2004 swimming season has been conducted at ten beaches within this segment including:

> **Steps Beach, Salem** - There was one posting reported because of elevated Enterococci bacteria counts in 2002 (total one days).
>
> **Winter Island Beach, Salem** - There were no postings reported for any of these years.
>
> **Rice Beach, Beverly** - There was one posting reported because of elevated Enterococci bacteria counts in 2003 (total two days).
>
> **Willow Avenue Beach, Salem** - There was one posting reported because of elevated Enterococci bacteria counts in 2002 (total 29 days) and seven postings reported in 2004 (total 35 days).
>
> **Ocean Avenue Beach, Salem** - There was one posting reported because of elevated Enterococci bacteria counts in 2004 (total seven days).
>
> **Pioneer Beach, Salem** - There was one posting reported because of elevated Enterococci bacteria counts in 2002 (total three days).
>
> **Forest River Point Beach, Salem** - There were no postings between 2002-2004 for this location.

[4] The delineation of these waterbodies in the North Coastal Watershed Assessment Report (2002) reported in the 2008 Integrated List was not consistent with DWM's water quality standards. The delineations in this Table are consistent with the WQS and future Integrated List accounting. A WQS clarification will be made during the next revision to avoid confusion in the future. Likewise a correction will be made to the North Coastal assessment report during the next assessment cycle for the North Coastal watershed.

Osgood Beach, Salem - There were no postings between 2002-2004 for this location.

Village Street Beach, Salem - There were no postings between 2002-2004 for this location.

Sunset Road Beach, Salem - There were no postings between 2002-2004 for this location.

Stramski Beach, Salem - There was one posting reported because of elevated Enterococci bacteria counts in 2002 (total three days), two postings reported in 2003 (total three days), and seven postings reported in 2004 (total 48 days).

Salem Sound Coastwatch sampled a number of stations in the area of this segment in 2004-5 for fecal coliform. Results included at least several counts in excess of 20,000 cfu/100mL, up to two maximums of 160,000 and 950,000 cfu/100 mL (see Table 4-13, and Table 4-15 above).

A dry weather survey was conducted along the Salem Sound shoreline in 2004 to create an inventory of observable stormwater pipe outfalls 12" or more in diameter. Two rounds of bacteria sampling occurred between October 5, and November 4, involving 8 observed outfalls in the Salem Harbor area (see Table 4-32 below). Fecal coliform bacteria levels ranged between <5- 110,000 cfu/100mL. Enterococci levels ranged between 10 – 650 cfu/100 mL (Horsley- Witten Group 2005). Shellfishing growing areas status: Prohibited (Figure 1-1).

Table 4-32. Summary of Fecal Coliform and Enterococci Data for Salem Harbor Segment MAMA93-54 [formerly 93-21] (Horsley- Witten Group, 2004).

Site Description	Min	Max	Geometric Mean	Number Samples
	cfu/100 mL			n
Nov 2004 stormwater pipe survey, MB-2-2, MB-2-4, MB-2-5,S-1-10, S-1-9, S2-1, S2-2, S2-4, (Horsley- Witten 2004)	<5 FC 10 E	110,000 FC 650 E	32 FC Not available	4 13
FC = fecal coliform E = enterococci				

Marblehead Harbor Segment MA93-22

This segment is a 0.56 mi^2 Class SA estuary. The MassDEP WQA defines the harbor as the waters inside of an imaginary line drawn from Fort Sewell to Marblehead Light. The community of Marblehead (MAR041047) has MS4 coverage under the NPDES program. MassDEP WQA identifies a vessel sewage pump-out facility at the Cliff St. boat yard in Marblehead (MassDEP 2000a). The effluent collected at this pump-out facility is transferred to the SESD Wastewater Treatment Facility for further processing.

A dry weather survey was conducted along the Salem Sound shoreline in 2004 (see Table 4-33 below) to create an inventory of observable stormwater pipe outfalls 12" or more in diameter. Two rounds of bacteria sampling occurred between October 5, and November 4, involving 3 observed outfalls in the Marblehead Harbor area. Two Fecal Coliform samples ranged between 31,000 - 41,000 cfu/100 mL. Enterococci levels ranged between 16- 4,800 cfu/100 mL (Horsley- Witten Group 2005). Shellfishing growing areas status: Prohibited (Figure 1-1).

Salem Sound Coastwatch sampled a number of stations in the area of this segment in 2004-5 for fecal coliform. Wet weather results in 2004 included at least several counts in excess of 6,400 cfu/100mL, up to a maximum of 21,000 cfu/100 mL, and in 2005, a maximum of 6,270 cfu/100mL. Dry weather results

2004-5 included several counts (particularly in 2005) over 6,900 cfu/100mL, with a maximum of 9,678 cfu/100mL (see Table 4-13, and Table 4-15 above) (SSCW 2004).

Table 4-33. Summary of Fecal Coliform and Enterococci Data for Marblehead Harbor MA93-22 (Horsley and Witten Group, 2004).

Site Description	Min	Max	Number Samples
	cfu/100 mL		
3 observed outfalls in the Marblehead Harbor, MB-1-15, MB-1-16, MB-1-18 (Horsley- Witten Group 2004)	31,000 FC 16 E	41,000 FC 4,800	2 6
FC = fecal coliform E = enterococci			

Salem Sound Segment MA93-55 & MA93-56 (formerly MA93-25)

Salem Sound has been delineated as two separate areas for assessment purposes. The combined area (6.01 mi^2) is a Class SA waterbody. Segment 93-56 is the southern portion of Salem sound defined as the waters landward of an imaginary line from Naugus Head, Marblehead to the northwest point of Bakers Island, Salem to Hospital Point, Beverly to Juniper Point, Salem (excluding Forest River) (formerly segment MA93-21 Salem Harbor and a portion of segment MA93-25 Salem Sound [waterbody code 93907]). Segment 93-55 is defined as the northern portion of Salem Sound, waters landward of and within imaginary lines from Chubb Point, Manchester to Gales Point , Manchester to the northwest point of Bakers Island, Salem to Hospital Point, Beverly (formerly reported as a portion of segment MA93-25). Segment 93-55 receives effluent from the Manchester By-The-Sea WWTP (MA0100871) (MassDEP 2000a). The communities of Manchester (MAR041207), Beverly (MAR041181), Danvers (MAR041188), Peabody (MAR041216), Salem (MAR041219), and Marblehead (MAR041047) have coverage under the MS4 NPDES Program (MassDEP 2002c)[5].

A dry weather survey was conducted along the Salem Sound shoreline in 2004 to create an inventory of observable stormwater pipe outfalls 12” or more in diameter. Two rounds of bacteria sampling occurred between October 5, and November 4, involving 3 observed outfalls in the Danvers River- Salem Sound area (see Table 4-34 below). One fecal coliform sample taken was 610 cfu/100mL. Enterococci levels ranged between 90- 640 cfu/100 mL (Horsley- Witten Group 2005). Shellfishing growing areas status: Prohibited (Figure 1-1).

[5] The delineation of these waterbodies in the North Coastal Watershed Assessment Report (2002) reported in the 2008 Integrated List was not consistent with DWM’s water quality standards. The delineations in this Table are consistent with the WQS and future Integrated List accounting. A WQS clarification will be made during the next revision to avoid confusion in the future. Likewise a correction will be made to the North Coastal assessment report during the next assessment cycle for the North Coastal watershed.

Table 4-34. Summary of Fecal Coliform and Enterococci Data for Salem Sound MA93-55, MA93-56 (Horsley- Witten Group, 2004).

Site Description	Min	Max	Number Samples
	cfu/100 mL		
2 Salem Sound area MB-1-2, MB-1-6 (Horsley-Witten Group 2004)	-- 90 E	600 FC 640 E	1 4
FC = fecal coliform E = enterococci			

Weekly testing for Enterococci bacteria during the 2002 to 2004 swimming season has been conducted at five beaches within the Salem Sound segment (MA DPH 2003, 2004, and 2005b and Salem Sound Coastwatch 2004). These beaches include:

West Beach, Beverly – No postings were reported during the summers of 2002 to 2004.

Mingo Beach, Beverly - There were three postings because of elevated Enterococci bacteria counts in 2002 (total 21 days) and one posting (total two days) in 2003.

Brackenbury Beach, Beverly - There was one posting reported because of elevated Enterococci bacteria counts in 2003 (total two days).

Grace Oliver Beach, Marblehead - There was one posting reported because of elevated Enterococci bacteria counts in 2004 (total two days).

Gas House Beach, Marblehead - There was one posting reported because of elevated Enterococci bacteria counts in 2004 (total 13 days).

Nahant Bay Segment MA93-24

Nahant Bay is a 5.1 mi^2 Class SA/CSO estuary. The MassDEP WQA defines Nahant Bay as the waters inside of an imaginary line drawn across Galloupes or Phillips Point, Swampscott, to East Point, Nahant. There is currently one individual NPDES permitted discharge into Nahant Bay, namely, the Lynn Water and Sewer Commission Facility Combined Sewer Overflow (CSO) #006, (part of permit MA0100552). Formerly, the Swampscott WWTP (MA0101907) discharged to the Bay, but in 1992 was tied into the Lynn Water and Sewer Commission Facility (MA0100552) (MassDEP 2000a). Lynn Water and Sewer Commission (LWSC) Outfall #006 (Sanderson Avenue) is a wet weather CSO that discharges into Stacy Brook. This culverted brook ultimately discharges to Kings Beach. Under the Second Modified Consent Decree (SMCD) entered in federal court (Civil Action # 76-2184-RGS), the Lynn Water & Sewer Commission is proceeding with sewer separation work, which will result in the elimination of outfall #006 as a CSO discharge point (Brander 2006b). Overflows form the #006 CSO were reported to occur 26 times each year with an average total annual discharge of 61 million gallons. The 006 discharge is anticipated to be eliminated by December 2009. Once the sewer separation work is complete, the Stacy Brook culvert will continue to discharge base flow and separated stormwater to the outfall on King's Beach (Brander 2006b). The communities of Swampscott (MAR041064), Lynn (MAR041044), and Nahant (MAR041051) currently have MS4 coverage under the NPDES program (MassDEP 2002c)

MassDEP conducted a special bacteria source tracking project survey involving four stations on Stacy Brook, on April 11, 2005 (see Table 4-35 below), in the Kings Beach, Swampscott area, adjacent to Kings Beach Road. Fecal coliform results ranged between 13 - 1,400 cfu/100 mL and E. coli results ranged between <6 - 1,200 cfu/100 mL. Enterococci results ranged between 72- 980 cfu/100 mL. Two of the three upstream tests were positive for human marker indicators. The town of Swampscott continues to operate a chlorination system during the swimming season to disinfect flows from Outfall 004 (e.g., the New Ocean Street Underdrain intermittent discharge from Stacey Brook to King's Beach). Outfall 004 is not currently permitted by MassDEP. The town will need to undertake a program to identify and remove any direct connections and proceed with any infrastructure improvements to keep the sewers from exfiltrating into the drain (Duerring 2006). Shellfishing growing areas status: Prohibited (Figure 1-1).

Table 4-35. Summary of Fecal Coliform and E. Coli (MassDEP) 2005, for Nahant Bay- MA93-24.

Site Description	Min	Max	Number Samples
	cfu/100 mL		
Four stations, including the Stacey Brook Outfall at King's Beach, and three other stations upstream (MassDEP 2005).	13 FC <6 EC	1,400 FC 1,200 EC	4 4
FC = fecal coliform EC = E. coli			

There are 7 public swimming areas within this segment area. Weekly testing for Enterococci bacteria during the 2002-2004 swimming season has been conducted at eight beaches within this segment. Including:

Eisman's Beach, Swampscott - There were no postings reported for the 2002-2004 sampling period.

Whales Beach, Swampscott - There were no postings reported for the 2002-2004 sampling period.

Fisherman's Beach, Swampscott - There was one posting reported because of elevated Enterococci bacteria counts in 2004 (total six days).

King's North Beach, Swampscott - There were no postings reported for the 2002-2004 sampling period.

King's DCR Beach, Lynn - There was one posting reported because of elevated Enterococci bacteria counts in 2003 (totaling six days) and two postings reported in 2004 (total two days). .

Nahant Beach, Nahant - There was one posting reported because of elevated Enterococci bacteria counts in 2002 (totaling one day) and one posting reported in 2003 (total one day).

Short Beach, Nahant - There were no postings reported for the 2002-2004 sampling period.

Saugus River System

The Saugus River system originates at the outlet of Lake Quannapowitt in Wakefield and eventually flows into the estuary downstream of the Saugus River Ironworks in Saugus. The River receives flow from four tributaries in its freshwater reach including Beaverdam Brook, Mill River, Hawks Brook and Bennett's Pond Brook. Shutes Brook discharges into the tidal Saugus River, which is joined by the Pines River. They flow into Lynn Harbor, which eventually discharges into Broad Sound.

The Saugus River Watershed Council collected samples from various locations along the Saugus River for analysis of E. coli bacteria in 2003 and 2004. Results from their 2003 sampling effort are shown in Table 4-31 (SRWC 2004). A map of sampling locations is provided in Figure 4-2.

Saugus River Segment MA93-34

This segment is a 3.1 mile Class B Public Water Supply. This segment of the Saugus River runs from the outlet of Lake Quannapowitt in Wakefield to a small impoundment where water is withdrawn to supply public water to the City of Lynn. There is currently one individual NPDES permitted non- contact cooling water discharge, New England Detroit Diesel, (formerly, Power Products, Inc. (MA0026247), to this segment of the Saugus River (MassDEP 2002c). The communities of Wakefield (MAR041065), and Saugus (MAR041059), currently have MS4 coverage under the NPDES program.

The MassDEP collected two fecal coliform samples and one E. coli sample from this segment of the Saugus River in the summer of 1997. The fecal coliform counts were 40 and 160 cfu/100 mL. The single E. coli count was <20 cfu/100 mL (MassDEP 2002a).

In 2002 MassDEP conducted fecal coliform sampling on five occasions between May and September at Station SR04a, (Vernon St./Main St. crossover in Wakefield/Lynnfield). Bacteria sample results ranged between 39 - 20,000 cfu/100 mL (fecal coliform), 20- 1,200 cfu/100mL (E. coli) and 29 and 16,000 cfu/100mL (Enterococci). The highest count was reported to be related to a recent storm event (MassDEP 2002c).

Table 4-36. Summary of Fecal Coliform, E. Coli and Enterococci Saugus River MA93-34 (Mass DEP 2002).

Site Description	Min	Max	Geometric Mean	Number Samples
	cfu/100 mL			
Station SR04a, at Vernon St./Main St. crossover in Wakefield/Lynnfield (MassDEP) 2002	39 FC 20 EC 29 E	20,000 FC 1,200 EC 16,000 E	617 FC Not available 311 E	5 4 5
FC = fecal coliform EC = E. coli E = enterococci				

The Saugus River Watershed Council did sampling along this segment (at sites SR2 and SR3) during 2003 and 2004 (see Table 4-37 for data and Figure 4-2 for sampling locations below). In 2003 E. coli bacteria sample results for these two locations ranged between 13 - 2,000 cfu/100 mL. In 2004 E. coli bacteria sample results for these two stations ranged between 12 - 260 cfu/100 mL.

It should be noted that the sites covered in Table 4-37 encompass all 4 Saugus River Segments: Saugus River MA 93-34 (Sites SR2, SR3); Saugus River MA93-35 (Sites SR4, SR5, SR6, SR7); Saugus River MA93-43 (Sites SR8; SR9,); Saugus River MA93-44 (SR10, SRT4, SRT6).

Table 4-37. Saugus River Watershed Council 2003-4 Water Quality (E. Coli) Monitoring Data (SRWC 2004, 2005).

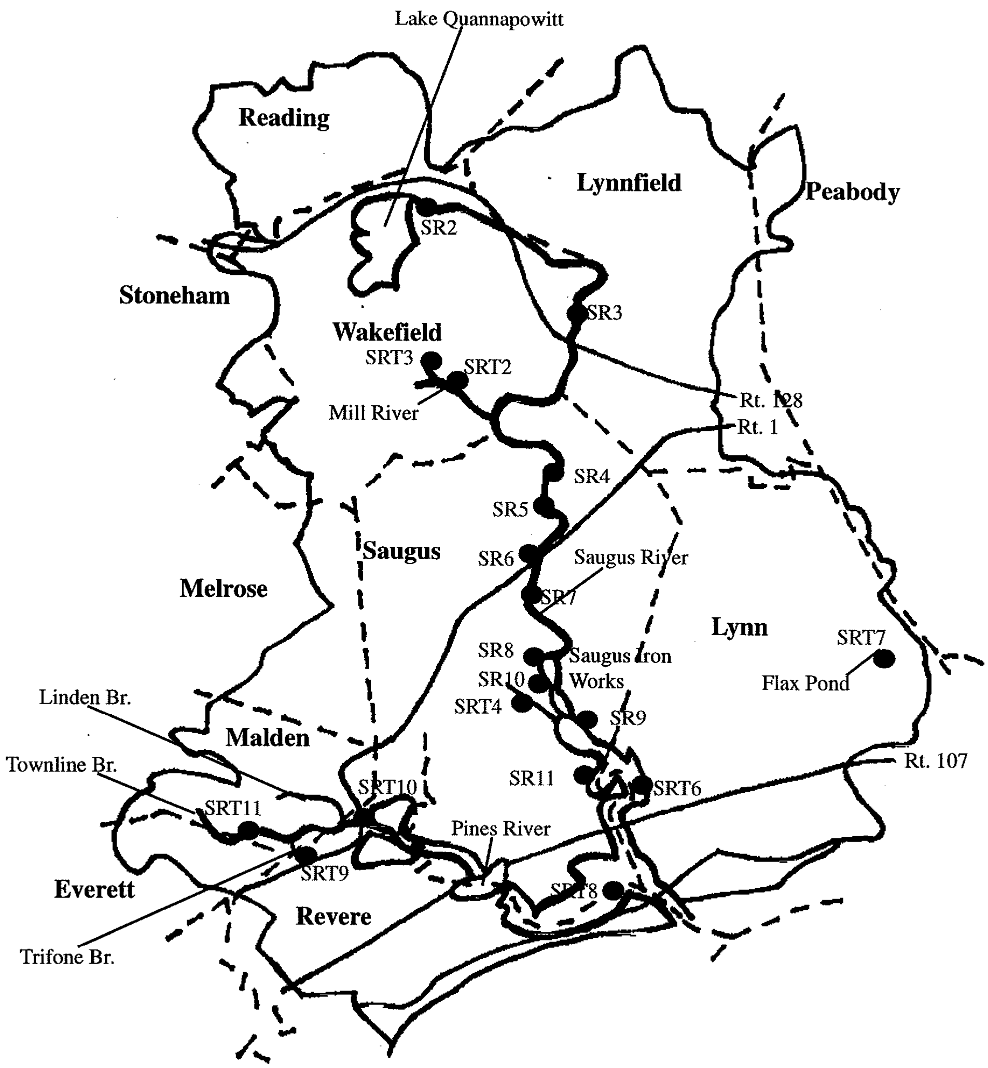
	Site #	E. coli Range (cfu/100 mL)	E. coli Geometric Mean (cfu/100 mL)
		Min ↔ Max	
2003 Water Quality Summary			
River @ L. Quannapowitt	SR 2	38 ↔ 2,000 (4)	146
Dam @ Colonial	SR 3	13 ↔ 46 (4)	26
Breakheart Bridge	SR 4	23 ↔ 129 (4)	86
Route 1	SR 6	27 ↔ 137(4)	105
Prankers Pond	SR 7	35 ↔ 350 (4)	147
Iron Works	SR 8	66 ↔ 282 (4)	162
Boston St.	SR10	39 ↔ 2,000 (4)	509
Mill River	SRT2	21 ↔ 170 (4)	91
Mill R. @ Town Br.	SRT3	111 ↔ 2,000 (4)	293
Shute Brook	SRT4	109 ↔ 2,000 (4)	368
Strawberry Br.	SRT6	0 ↔ 2,000 (4)	185
Pt. Of Pines	SRT8	3 ↔ 178 (4)	26
Trifone Brook (TLB)	SRT9	0 ↔ 2,000 (4)	2000
Town Line Br./Rte.1	SRT10	44 ↔ 63 (4)	56
Town Line Br./Cemetery	SRT11	271 ↔ 2,000 (4)	858
Flax Pond	SRT12	44 ↔ 222 (4)	65
2004 Water Quality Summary			
River @ L. Quannapowitt	SR 2	12 ↔ 260 (4)	44
Dam @ Colonial	SR 3	22 ↔ 110 (4)	40
Breakheart Bridge	SR 4	44 ↔ 296 (3)	136
Route 1	SR 6	56 ↔ 490 (4)	219
Prankers Pond	SR 7	70 ↔ 2,000 (4)	383
Iron Works	SR 8	114 ↔ 2,000(4)	435
Boston St.	SR10	114 ↔ 1,430 (4)	281
Mill River	SRT2	98 ↔ 2,000 (4)	514
Mill R. @ Town Br.	SRT3	134 ↔ 2,000 (4)	558
Shute Brook	SRT4	207 ↔ 2,000 (4)	634
Strawberry Br.	SRT6	225 ↔ 2,000(4)	597
Pt. Of Pines	SRT8	11 ↔ 103(4)	34
Trifone Brook (TLB)	SRT9	215 ↔ 2,000 (4)	1,022

	Site #	E. coli Range (cfu/100 mL)	E. coli Geometric Mean (cfu/100 mL)
Town Line Br./Rte.1	SRT10	50 ↔ 1,810 (4)	229
TLB @ Cemeteries	SRT11	54 ↔ 2,000 (3)	301
Flax Pond	SR 12	36 ↔ 59 (3)	43

NS – not sampled. 2003 samples collected on 6/30, 7/29, 8/27, 10/23. 2004 samples collected on 4/28, 5/26, 7/29, 9/19.

Figure 4-2. Saugus River Watershed Council Water Quality Monitoring Sites

Saugus River Watershed Council
Water Quality Monitoring Sites



SR2 - Lake Quannapowitt Outflow, Wakefield
SR3 - Dam at Sheraton Colonial, Wakefield
SR4 - River at Water Street, Wakefield
SR5 - Breakheart/Camp Nihan Bridge, Saugus
SR6 - Route 1 @ Dunkin Donuts, Saugus
SR7 - Prankers Pond, Saugus
SR8 - Saugus Iron Works, Saugus
SR9 - Old Railroad Bridge/Hamilton Street, Saugus
SR10 - Boston Street Bridge, Lynn
SR11 - Ballard Street, Saugus

SRT2 - Mill River @ Farm & Water Street, Wakefield
SRT3 - Mill River @ Town Brook
SRT4 - Shute Brook @ Winter Street Cemetery, Saugus
SRT6 - Strawberry Brook @ Summer Street, Lynn
SRT7 - Flax Pond, Lynn
SRT8 - Point of Pines, Revere
SRT9 - Trifone Brook, Revere
SRT10 - Town Line Brook @ Route 1, Revere
SRT11 - Town Line Brook @ Cemeteries, Malden

Beaverdam Brook Segment MA93-30

This segment is a 1.5 mile Class B waterbody. Beaver Dam Brook originates just east of Main Street in Lynnfield and flows into the Saugus River just north of the Wakefield/Lynnfield town line. MassDEP WQA lists Lynnfield Center Water District (MassDEP 2000a) as the only individual NPDES permit holder for the segment. The community of Lynnfield (MAR041045) currently has MS4 coverage under the NPDES program (MassDEP 2002c).

The MassDEP collected a total of seven fecal coliform and five E. coli samples from two locations on this segment of Beaverdam Brook in 1997 and 1998. Fecal coliform values ranged from <20 to 2,000 cfu/100 mL with two dry weather sample results of 1,600 and 2,000 cfu/100 mL. E. coli values ranged from <20 to 800 cfu/100 mL (MassDEP 2002a). In 2002 Mass DEP conducted field surveys in Beaverdom Brook. Bacteria results ranged between 10 – 580 cfu/100 mL (fecal coliform), 13 -1 50 cfu/100/mL (E. coli), and 45 to 560 cfu/100 mL (Enterococci).

Table 4-38. Summary of Fecal Coliform, E. coli and enteroccoci data for Beaverdam Brook MA93-30 (MassDEP 2002).

Site Description	Min	Max	Geometric Mean	Number Samples
	cfu/100 mL			
Stations W0450, CR03 (MassDEP 2002)	10 FC 13 EC 45 E	580 FC 150 EC 560 E	81 FC Not available 333 E	5 4 5
FC = fecal coliform EC = E. coli E = enterococci				

Saugus River Segment MA 93-35

This segment of the Saugus River is listed in the MassDEP WQA as a 5.4 mile Class B waterbody. One of the MassDEP WQA recommendations is, however, that this segment be described as a Class B, Warm Water Fishery since this segment is not tidally influenced. The MassDEP WQA states that this segment begins in wetlands in Reading and Wakefield, but recommendations that the segment begins at the canal which discharges into Hawkes Pond. The segment does extend to Saugus Iron Works. The community of Saugus (MAR041059) currently has MS4 coverage under the NPDES program (MassDEP 2002c). Camp Nihan (at Pecham Pond) in Saugus is the only public swimming area within this segment. Between the 2002 and 2004 swimming seasons there has been only one posting (in 2002) at this he beach (MA DPH 2003, 2004, and 2005b).

MassDEP collected 25 fecal coliform samples at four locations (including one pipe discharge) within this segment in 1997 and 1998. A total of 17 E. coli samples were also collected. Fecal coliform bacteria values ranged from <20 to 2,800 cfu/100 mL. E. coli bacteria values ranged from <20 to 1,300 cfu/100 mL (MassDEP 2002a).

In 2002 MassDEP conducted sampling on five occasions (a total of 13 samples) between May and September 2002 at two stations (see Table 4-39 below). Results ranged between 210 - 17,000cfu/100 mL (Fecal coliform), 140 – 410 cfu/100 mL (E. coli), and 20 – 24,000 cfu/100 mL (Enterococci) (MassDEP 2002c).

Table 4-39. Summary of Fecal Coliform, E. coli and enteroccoci the Saugus River MA93-35 (MassDEP 2002).

Site Description	Min	Max	Geometric Mean	Number Samples
	cfu/100 mL			
Station SR01B and W0883 (MassDEP 2002).	210 FC 140 EC 20 E	17,000 FC 410 EC 24,000 E	808 FC 236 EC 572 E	8 5 8
FC = fecal coliform EC = E. coli E = enterococci				

The Saugus River Watershed Council conducted sampling along this segment between 2003 - 2004 (see Table 4-37 above for data and Figure 4-2 for sampling locations). Three sites were sampled for E. coli in 2003: SR 4, SR 6, SR 7, with E coli sample results ranging between 23 - 350 cfu/100 mL for the three locations. During 2004, E coli sample results ranged between 44- >2,000 cfu/100 mL for the same three locations.

Mill River Segment MA93-31

The Mill River is a 2.0 mile Class B waterbody. The River originates just south of Salem Street in Wakefield and flows to its confluence with the Saugus River also in Wakefield. The MassDEP WQA currently lists two NPDES individual permitted discharges that include the Wakefield Corporation (MA250965) (formerly Wakefield Bearing Corporation), a non- contact cooling water permit, and the Crystal Lake Water Treatment Plant (MA0105004) (MassDEP 2002c). The community of Wakefield (MAR041065) currently has MS4 coverage under the NPDES program (MassDEP 2002c).

Three Mill River stations were sampled for fecal coliform and E. coli by the MassDEP in 1997 (see Table 4-40 below). Two piped discharges were also sampled once during 1997. Fecal coliform in the river samples (8 samples) ranged from 40 to 600 cfu/100 mL, and 1,300 and 1,500 cfu/100 mL for the two pipe discharge samples. E. coli values ranged from 20 to 200 cfu/100 mL in the river samples (6 samples), and 320 and 480 cfu/100 mL for the two pipe discharge samples (MassDEP 2002a)

Table 4-40. Summary of Fecal Coliform and E. coli Mill River MA93-31 (MassDEP 1997-1998).

Site Description	Min	Max	Number Samples
	cfu/100 mL		
Three locations in the Mill River (MassDEP 1997-1998)	40 FC 20 EC	600 FC 200 EC	8 6
2 piped discharges (DEP 1997- 1998)	1,300 FC 320 EC	1,500 FC 480 EC	2 2
FC = fecal coliform, EC = E. coli			

The Saugus River Watershed Council conducted sampling along this segment between 2003 and 2004 (see Table 4-37 above for data, and Figure 4-2 for sampling locations). Two sites were sampled for E. coli: SRT 2, and SRT 3, with sample results ranging between 21- 170 cfu/100 mL, at SRT 2, and 111-

>2,000 cfu/100 mL at SRT 3 in 2003. In 2004, at SRT 2, sample results ranged between 98- >2,000 cfu/100 mL, and at SRT 3, the range was between 134- >2,000 cfu/100 mL.

Hawkes Brook Segment MA93-32

This segment of Hawkes Brook is a 2.6 mile Class A, Public Water Supply, Outstanding Resource Water. It originates on the southwestern side of Bow Ridge at the municipal border between Lynn and Lynnfield and discharges into Hawkes Pond. The community of Lynnfield (MAR041045) currently has MS4 coverage under the NPDES program (MassDEP 2002c).

The MassDEP collected fecal coliform and E. coli samples from one location in this segment of Hawkes Brook during 1997 (see Table 4-41 below). Fecal coliform levels ranged between 460 to 2,000 cfu/100 mL (4 samples). Three samples collected during dry weather conditions all contained more than 400 cfu/100 mL (including the highest reading of 2,000 cfu/100 mL) (MassDEP 2002a). E. coli samples ranged from 120 to 700 cfu/100 mL (3 samples).

Table 4-41. Summary of Fecal Coliform and E. coli for Hawkes Brook MA93-32 (MassDEP 1997).

Site Description	Min	Max	Number Samples
	cfu/100 mL		
one location in Hawkes Brook (MassDEP 1997)	460 FC 120 EC	2,000 FC 700 EC	4 3
FC = fecal coliform EC = E. coli			

Hawkes Brook Segment MA93-33

This segment of Hawks Brook is a 1.1 mile Class B waterbody. It flows from the outlet of Hawkes Pond to its confluence with the Saugus River. The community of Lynnfield (MAR041045) currently has MS4 coverage under the NPDES program (MassDEP 2002c).

In 1997, MassDEP collected water samples for bacterial analysis six times from one location for fecal coliform and four times for E. coli (see Table 4-42 below). Fecal coliform levels ranged from <20 to 2,400 cfu/100 mL. Three samples collected during dry weather conditions all contained more than 400 cfu/100 mL (including the highest reading of 2,400 cfu/100 mL). E. coli samples ranged from <20 to 1,000 cfu/100 mL (MassDEP 2002a).

Table 4-42. Summary of Fecal Coliform and E. coli for Hawkes Brook MA93-33 (Mass DEP 1997).

Site Description	Min	Max	Number Samples
	cfu/100 mL		
one location (station HB01, Spring St., North Saugus) (MassDEP 1997)	<20 FC <20 EC	2,400 FC 1,000 EC	6 4
FC = fecal coliform, EC = E. coli			

Bennetts Pond Brook Segment MA93-48

This segment is a 2.4 mile Class B tributary that runs from its headwaters east of Lynn Fells Parkway (in Bellevue Golf Course), Melrose to confluence with Saugus River, Saugus. The communities of Melrose (MAR041050), and Saugus (MAR041059) currently have MS4 coverage under the NPDES program (MassDEP 2002c).

Sampling was conducted by MassDEP staff in Bennetts Pond Brook near the mall entrance east of Forest Street in Saugus (W0878) as part of the 2002 North Coastal Drainage Area water quality surveys (See Table 4-43 below). Bacteria counts ranged from 220 to 9,400 cfu/100 mL (fecal coliform), 20 – 1,500 cfu/100mL (E. coli), and 39 – 6,600 cfu/100mL (Enterococci). The highest count was reported to represent a local storm event (MassDEP 2002c).

Table 4-43. Summary of Fecal Coliform, E. coli and enteroccoci data for Bennetts Pond Brook Segment MA93-48 (MassDEP 2002).

Site Description	Min	Max	Geometric Mean	Number Samples
	cfu/100 mL			
one location near the mall entrance east of Forest Street in Saugus (W0878 (MassDEP 2002)	220 FC 10 EC 39 E	9,400 FC 1,500 EC 9,600 E	1,341 FC 245 EC 870 E	7 6 7
FC = fecal coliform, EC = E. coli, E = enterococci				

Shute Brook Segment MA93-49

This is a Class SA segment, 0.01 m^2 in area, located approximately 350 feet downstream from Central Street, Saugus to the confluence with the Saugus River, Saugus. The community of Saugus (MAR041059) currently has MS4 coverage under the NPDES program (MassDEP 2002c).

Bacteria sampling was conducted by MassDEP staff upstream from this segment of Shute Brook near Central Street in Saugus (W0877) as part of the 2002 North Coastal Drainage Area water quality surveys (See Table 4-44 below). The bacteria counts ranged from 440 to 28,000 cfu/100 mL (fecal coliform), <20 – 2,200 cfu/100mL (E. coli), 78 – 32,000 cfu/100mL (Enteroccoci) (MassDEP 2002c). The highest fecal coliform bacteria count was reported to represent the influence of a local storm event. Shellfishing growing areas status: Prohibited (Figure 1-1).

Table 4-44. Summary of Fecal Coliform, E.coli and enteroccoci data for Shute Brook Segment MA93-49 (MassDEP 2002).

Site Description	Min	Max	Geometric Mean	Number Samples
	cfu/100 mL			
one location near Central Street in Saugus (W0877) (MassDEP 2002)	440 FC <20 EC 78 E	28,000 FC 2,200 EC 32,000 E	2,991 FC Not available 1,439	5 4 5
FC = fecal coliform, EC = E. coli, E = enterococci				

Shute Brook Segment MA93-50

This segment is a Class B tributary, 0.89 miles in length, which runs from the confluence of Fiske Brook, Saugus to approximately 350 feet downstream from Central Street, Saugus. The community of Saugus (MAR041059) currently has MS4 coverage under the NPDES program (MassDEP 2002c).

Bacteria sampling was conducted by DWM staff at one station within this segment between May and September, 2007. Preliminary results are summarized in Table 4-45 below[6].

Table 4-45. Summary of MassDEP E coli Data for Shute Brook MA 93-50 (MassDEP 2007).

Site Description	Min	Max	Geometric Mean	Number Samples
	cfu/100 mL			
Station 0877 (MassDEP 2007).	280 EC	11,000 EC	2,431 EC	6
EC = E. coli				

Saugus River Segment MA93-43

This segment is a 0.04 mi^2 Class SB estuary. This segment of the Saugus River starts at the Saugus Iron Works, Bridge Street, Saugus, and runs to Lincoln Avenue/Boston Street, Saugus/Lynn. This segment was formerly part of Segment MA 93-14. The community of Saugus (MAR041059) currently has MS4 coverage under the NPDES program (MassDEP 2002c).

The Saugus River Watershed Council sampled three times each during summer 2003, and summer 2004 at SR 8 (see Table 4-46 below for data, and Figure 4-2 for sampling locations). In 2003, E. coli levels ranged between 66 - 282 cfu/100 mL. In 2004, E coli levels ranged between 114- 2,000 cfu/100mL.

Table 4-46. Summary of E. coli for Saugus River MA93-43 (SWRC 2003, 2004).

Site Description	Min	Max	Number Samples
	cfu/100 mL		
SR-8, at the Saugus Iron Works (SRWC 2003)	66 EC	282 EC	4
SR-8, at the Saugus Iron Works, 2004 (SRWC 2004)	114 EC	2,000 EC	4
EC = E. coli			

The MassDEP DWM 2002 North Coastal Assessment Report indicates that the Primary and Secondary Contact Recreational and Aesthetics uses were not assessed, but were identified with an Alert Status because of the Town of Saugus's SSO (Sanitary Sewer Overflow) discharge to the river during significant wet weather events (MassDEP 2002c). DMF shellfishing status as of September 2009 indicated that Area N26.0, which comprises this segment area, is prohibited.

[6] Provisional data.

Saugus River Segment MA93-44

This segment is a 0.36 mi^2 Class SB/CSO, Outstanding Resource Water, estuary. This segment of the Saugus River starts at Lincoln Avenue/Boston Street, Saugus/Lynn and eventually flows into Lynn Harbor. This segment was formerly part of Segment MA 93-14. From Boston Street to the mouth of the estuary, this segment is designated as an Outstanding Resource Water because it is part of the Rumney Marshes Areas of Critical Environmental Concern. The MassDEP WQA lists three individual NPDES permitted dischargers to this segment of the Saugus River (MassDEP 2002c). The Lynn Water and Sewer Commission (MA0100552) has authorization for a wet weather CSO discharge (Outfall #003). The other two dischargers include Refuse Energy Systems Company (now Wheelabrator Saugus JV) (MA028193), and General Electric Company (MA0003095). Discharges from these two companies include non-contact cooling water, contact cooling water, stream condensate, floor drainage, boiler blowdown, boiler filter backwash, ion exchange regeneration and backwash, flash tank blowdown, oil coolers, cooling tower blowdown, engine test cells wash waters and stormwater (MassDEP 2002c). The communities of Lynn (MAR041044), and Saugus (MAR041059), currently have MS4 coverage under the NPDES program.

The Lynn Water and Sewer Commission (LWSC), (MA0100552), is under a court order (Civil Action No. 76-2184-RGS) to mitigate their CSOs, including CSO discharges from #003. It is estimated that Outfall #003 results in 27 events each year, discharging a total of approximately 8 million gallons of CSO flow. LWSC submitted a Supplemental CSO Facilities Plan (SFP) to MassDEP and EPA for review in October 2004, The recommendations in the SFP included additional CSO abatement actions at the WWTP and the collection system, which will eliminate CSO discharges at outfall #003 during a “typical” year, with average precipitation (Brander 2006b).

The Town of Saugus has a wastewater pumping station next to the Saugus River on Lincoln Rd (behind Spuds restaurant) (Brander 2006a). MassDEP/NERO has issued the town an Administrative Consent Order (ACO) due to chronic sewer system overflows at this location. The entire Saugus sewer system conveys flows to this point, and during significant wet weather events, the flows reaching the station have been beyond the capacity of the pumping facilities, which are limited under an Inter-municipal Agreement (IMA) with the LWSC, who receives and treats the waste. MassDEP's ACO requires the town to aggressively identify and remove infiltration and inflow from the sewer system, and establish a "sewer bank" to ensure that any new connections to the system do not exacerbate the overflow problem (Brander 2006a).

Investigative sampling was conducted by MassDEP NERO on 22 October, 1997 during dry weather conditions at a Summer St./ Strawberry Brook outfall in Saugus. The MassDEP found greater than 2,000,000 cfu/100 mL fecal coliform in water collected at that outfall. The Saugus River Watershed Council reported frequent excessive bacterial counts at this outfall in both wet and dry conditions (MassDEP 2002a).

In 2002 MassDEP conducted fecal coliform sampling on five occasions between May and September at Station SR00 (summarized in Table 4-47 below). Sample results (total of 5 samples) ranged between 10-330cfu/100 mL (fecal coliform), <6- 220 cfu/100mL (E. coli), and 3 and 84 cfu/100mL (Enterococci) (MassDEP 2002c).

The Saugus River Watershed Council conducted sampling (see Table 4-37 above for data, and Figure 4-2 for sampling locations) along this segment between 2003 and 2004 at SR 10, SRT 4, and SRT 6. During

2003, fecal coliform results at the three stations ranged between 39- 2,000 cfu/100mL, and during 2004, the results ranged between 0- 2,000 cfu/100mL. (SRWC 2004). Shellfishing growing areas status: Prohibited (Figure 1-1).

Table 4-47. Summary of Fecal Coliform, E coli, and enteroccoci for Saugus River MA93-44 (MassDEP 2002).

Site Description	Min	Max	Geometric Mean	Number Samples
	cfu/100 mL			
Station SR00, at approximately 800' upstream off Route 107 crossover in Saugus (MassDEP 2002)	10 FC <6 EC 3 E	330 FC 220 EC 84 E	88 FC Not available 12 E	5 4 5
FC = fecal coliform EC = E. coli E = enterococci				

Unnamed Tributary ("Town Line Brook") (Segment MA93-51)

This is a Class SA tributary, 0.02 m^2 in area, locally known as 'Town Line Brook', which runs from Route 99, Malden to the confluence with the Pines River, Revere. The communities of Malden (MAR041046), and Revere (MAR041057), currently have MS4 coverage under the NPDES program.

Bacteria sampling was conducted by MassDEP staff in the Unnamed Tributary, or commonly known as "Town Line Brook", (which discharges to the Pines River), at Station TL01, near the northern end of Beth Israel Cemetery in Malden (W0880) as part of the 2002 North Coastal Drainage Area water quality surveys (See Table 4-48 below). Bacteria counts ranged between 59 - 8,400 cfu/100 mL (fecal coliform, 210 – 6,400 cfu/100mL (E. coli), and 39 – 800 cfu/100/mL (Enterococci) (MassDEP 2002c). DMF does not manage this waterbody as an active shellfishing growing areas in accordance with the requirements of National Shellfish Sanitation Program (NSSP).

Table 4-48. Summary of Fecal Coliform, E coli Data, and enteroccoci data for Unnamed Tributary Segment MA93-51 (MassDEP 2002).

Site Description	Min	Max	Geometric Mean	Number Samples
	cfu/100 mL			
one location near the northern end of Beth Israel Cemetery in Malden (Station TL01-W0880) (MassDEP 2002)	59 FC 210 EC 39 E	8,400 FC 6,400 EC 800 E	907 1,260 260	7 5 7
FC = Fecal coliform, EC - E. Coli, E= enterococci				

Pines River Segment MA93-15

This segment is a 0.58 mi^2 Class SB estuary and is also designated an Outstanding Resource Water because it is included in the Rumney Marshes Areas of Critical Environmental Concern. The segment runs from the Route 1 Bridge in Revere/Saugus to the mouth of the Saugus River. Currently there is only one individual NPDES permitted discharge listed within this segment: Refuse Energy Systems Company

(RESCO) (MA0028193) (MassDEP 2002c). The communities of Saugus (MAR041059), and Revere (MAR041057), currently have MS4 coverage under the NPDES program.

MassDEP conducted fecal coliform sampling on five occasions (see Table 4- 49 below) on Station TL01, on Unnamed Tributary, or Town Line Brook (which discharges directly into the Pines River), between May and September, 2002. Bacteria sample results ranged between 78 - 8,400 cfu/100mL (fecal coliform), 210 – 6,400 cfu/100mL (E. coli), and 39 – 800 cfu/100mL (Enterococci). The highest reading was reported to follow dry weather (MassDEP 2002c).

Table 4-49. Summary of Fecal Coliform, E coli Data, and enteroccoci data for Pines River MA93-15 (MassDEP 2002).

Site Description	Min	Max	Geometric Mean	Number Samples
	cfu/100 mL			
Station TL01,unnanmed tributary to Pines River, locally known as Town Line Brook, north of Fuller St., Everett (MassDEP 2002)	78 FC 210 EC 39 E	8,400 FC 6,400 EC 800 E	907 FC 1,260 EC 260 E	7 5 7
FC = fecal coliform, EC = E. coli, E = enterococci				

The Saugus River Watershed Council carried out extensive sampling along this segment and its tributaries between 2003 - 2004 (see Table 4-37 above for data, and Figure 4-2 for sampling locations). Four sites were sampled for E. coli at SRT 11, SRT 10, SRT 9, and SRT 8. During 2003, fecal coliform bacteria levels for these four stations ranged between 0- 2,000 cfu/100mL, and in 2004, results ranged between 11- 2,000 cfu/100mL. Shellfishing growing areas status: Prohibited (Figure 1-1).

Lynn Harbor (Inner) Segment MA93-52

This segment is a 1.6 mi^2 Class SB/CSO estuary. The MassDEP WQA defines this segment as the waters inside an imaginary line drawn across Bass Point, Nahant, to the eastern edge of Point of Pines, Revere excluding the Saugus River. The MassDEP WQA lists four outfalls from the Lynn Water and Sewer Commission discharging to Lynn Harbor; although, one may actually discharge to Broad Sound (MassDEP 2002c). Three of these discharges are wet weather CSO outfalls.

NPDES Discharges include: MA0100552--The Lynn Water and Sewer Commission (LWSC) Outfall #001. The Lynn Water & Sewer Commission is currently authorized (MA0100552 issued in May 2000) to discharge an average monthly flow of 25.8 MGD to the Lynn Outer Harbor. When the influent flows exceed 75 MGD, the permittee is authorized to discharge combined primary and secondary treated effluent to the Lynn Inner Harbor through Outfall 002 and to the Lynn Outer Harbor through Outfall 001. The facility is also permitted to discharge wet weather combined sewer overflows via four additional outfalls into the Lynn Harbor (Inner) Harbor.

The Lynn Water & Sewer Commission (LWSC), DEP, and EPA agreed to terms on a Second Modified Consent Decree (SMCD), which was executed on June 29, 2001. The SMCD included requirements for sewer separation work which would result in elimination of three of the Commission's four CSO discharges: 006, which discharges to King's Beach, and 004, 005 which discharge to Lynn Harbor. The fourth CSO outfall, 003, discharges to the Saugus River via the Little River. The SMCD required the Commission to proceed with sewer separation work and Inflow/ Infiltration (I/I) work in the 003 system, and conduct follow up monitoring to determine if further actions are needed to eliminate this outfall. The SMCD required outfall 006 to be eliminated by December 31, 2003, 005 to be eliminated by December 31, 2006, and 006 to be eliminated by December 31, 2009. During implementation of the sewer separation work to achieve this outcome, it was discovered that over 900 acres of the city thought to be served by separate sewer and drain systems were in fact combined systems, and that the ongoing design for the SMCD sewer separation work would fail to achieve the intended benefits. The Commission has since developed and submitted an October 2004 Supplemental CSO Facilities Plan (SFP). The recommendations from that plan are to proceed with $55 million in I/I projects, sewer separation projects, and CSO storage facilities. This would be in addition to the $80 million spent to date by the Commission on CSO abatement actions.

LWSC currently has two wet weather CSO outfalls that discharge into Lynn Harbor, outfalls #004—Market Street Overflow and #005 Broad Street Overflow. Lynn is under the latest court order (Civil Action No. 76-2184-RGS) to mitigate their CSOs, including CSO discharges from outfalls #004 and #005 (Brander 2006b). Dry weather discharges are prohibited. The Outfall #004 on average is active 31 events each year, discharging approximately 77 million gallons of CSO flow, while Outfall #005 on average is active 15 events per year, discharging approximately 22 million gallons of CSO flow (Brander 2006b). In October 2004, LWSC submitted a Supplemental CSO Facilities Plan (SFP) to MassDEP and EPA. The recommendations in the SFP include additional CSO abatement actions at the WWTP and in the collection system that will reduce CSO discharges at outfalls #004 and #005 to 4 events during a "typical" year, with average precipitation. MassDEP and EPA are reviewing the plan to determine if this represents the highest feasible level of CSO control, as required by the Clean Water Act, and MA Water Quality Standards (Brander 2006b).

The communities of Saugus (MAR041059), Revere (MAR041057), Wakefield (MAR041065), Lynn (MAR041044), Melrose (MAR041050), and Malden (MAR041046) currently have MS4 coverage under the NPDES program.

There is one beach, Black Rock Beach, along the shoreline of Lynn Harbor in Nahant. Weekly Enterococci bacteria testing was conducted during the summer swimming season between 2002 and 2004 and there were no postings (MA DPH 2003, 2004, and 2005b).

Investigative fecal coliform bacteria sampling was conducted by MassDEP NERO for two CSOs (see Table 4-50 below) on October 22, 1997 during dry weather conditions, and August 26, 1997 during wet weather conditions. Dry weather sample results (2 samples) were 14,000 and > 10,000,000 cfu/100 mL. The LWSC NPDES permit specifically states that dry weather discharges from CSOs are prohibited. Wet weather sample results (2 samples) were 94,000 and 110,000 cfu/100 mL (MassDEP 2000a).

Table 4-50. Summary of Fecal Coliform (MassDEP) in 1997 for the Lynn Harbor MA93-52.

Site Description	Min	Max	Number Samples
	cfu/100 mL		
Two CSO's in dry weather (MassDEP 1997)	14,000 FC	>10,000,000 FC	2
Two CSO's in wet weather (MassDEP 1997)	94,000 FC	110,000 FC	2
FC = fecal coliform, EC = E. coli			

The DMF has done periodic monitoring for fecal coliform bacteria involving 11 stations both in the Inner and Outer Lynn Harbor segments. The data are summarized in Table 4-51 below. Shellfishing growing areas status: Prohibited (Figure 1-1).

Table 4-51. Summary of DMF Fecal Coliform Data 2005- 2010 for Lynn Harbor (Inner and Outer) MA93-52, MA93-53.

Site Description	Min	Max	Geometric Mean	Number Samples
	cfu/100 mL			
ambient stations throughout both segments 10/2005 - 9/2010	2 FC	320 FC	30 FC	74
FC = fecal coliform				

Lynn Harbor (Outer) Segment MA93-53

This segment is a 6.6 mi^2 Class SB/CSO estuary. The MassDEP WQA defines this segment as the waters landward of an imaginary line drawn from Bailey's Hill, Nahant to eastern point of Winthrop Highlands, Winthrop to the seaward edge of Lynn Inner Harbor (an imaginary line drawn from Black Rock Point, Nahant to the eastern edge of Point of Pines, Revere). NPDES permits (point source and MS4s) and issues associated with CSO's are described under segment 93-52 (Inner Harbor). The DMF monitoring for fecal coliform bacteria is summarized in Table 4-51 above.

Weekly testing for Enterococci bacteria during the 2002 to 2004 swimming season has been conducted at three beaches along the shoreline of Lynn Outer Harbor. These beaches include:

Revere Beach, Revere - There was one posting reported in both 2003 and 2004 for one day each because of elevated Enterococci bacteria counts (total two days).
Short Beach, Revere/Wintrop - The beach was posted twice in 2003 because of elevated Enterococci bacteria counts (total two days).
Halford Beach, Winthrop – There were no postings in 2003 and 2004 at this beach.

The DMF shellfish status for areas N26.0 and N26.2, which comprise this segment area, are prohibited.

5.0 Potential Sources

The North Coastal watershed has 43 segments, located throughout the watershed, that are listed as pathogen impaired requiring a TMDL. These segments represent 100% of the estuary area and 91% of the river miles assessed. Sources of indicator bacteria in the North Coastal watershed are many and varied. A significant amount of work has been done in the last decade to improve the water quality in the North Coastal watershed.

Largely through the efforts of the MassDEP, DMF, local governments, and the volunteers of numerous potential local conservation groups such as Salem Sound Coastwatch and the Saugus River Watershed Council, numerous point and non-point sources of indicator bacteria have been identified. Table 5-1 summarizes the river segments impaired due to measured indicator bacteria densities and identifies some of the suspected and known sources identified in the WQA or by other organizations. Some suspected and known dry weather sources include:

- leaking sewer pipes,
- stormwater drainage systems (illicit connections of sanitary sewers to storm drains),
- failing septic systems,
- recreational activities,
- wildlife including birds, and
- discharges of inadequately treated boat waste.

Some suspected and known wet weather sources include:

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

It is difficult to provide accurate quantitative estimates of indicator bacteria contributions from the various sources in the North Coastal watershed because many of the sources are diffuse and intermittent, and extremely difficult to monitor or accurately model. Therefore, a general level of quantification according to source category is provided (e.g., see Tables 5-2 and 5-3). This approach is suitable for the TMDL analysis because it indicates the magnitude of the sources and illustrates the need for controlling them. Additionally, many of the sources (failing septic systems, leaking sewer pipes, sanitary sewer overflows, and illicit sanitary sewer connections) are prohibited, because they indicate a potential health risk and, therefore, must be eliminated.

Table 5-1. Some of the Potential Sources of Bacteria in Pathogen Impaired Segments in the North Coastal Watershed.

Segment	Potential Sources
Essex Bay System	
Alewife Brook MA93-45	Failing septic systems, storm drains
Alewife Brook MA93-46	Failing septic systems, storm drains
Essex River MA93-11	Failing septic systems, storm drains
Essex Bay MA93-16	Failing septic systems, storm drains
Annisquam River System	
Mill River MA93-28	Failing septic systems, Riverside Avenue Pumping Station Bypass, storm drains
Annisquam River MA93-12	Failing septic systems, Gloucester Pumping Station Bypass, storm drains, tributaries
Rockport Harbor MA93-57	Rockport WWTP and Cape Ann lighthouse treated sanitary waste discharges, failing septic systems
Gloucester Harbor MA93-18	Failing septic systems, City of Gloucester WWTP, CSOs, sewage pumping station bypasses, storm drains, and marine sediments
Salem Sound System	
Causeway Brook MA93-47	Possible illegal sewer connections
Cat Brook MA93-29	Possible illegal sewer connections
Manchester Harbor MA93-19	Surface waters discharging to the harbor
Bass River MA93-08	CSO (eliminated in 1997)
Frost Fish Brook MA93-36	Unknown
Porter River MA93-04	CSO (eliminated in 1997)
Crane Brook MA93-02	Unknown
Crane River MA93-41	Unknown
Waters River MA93-01	Unknown
Goldthwait Brook MA93-05	Unknown
Proctor Brook MA93-39	Unknown
North River MA93-42	Upstream fecal coliform levels
Danvers River MA-93-09	CSOs
Beverly Harbor MA93-20	Surface waters discharging to the harbor
Proctor Brook MA93-40	Unknown
Salem Harbor MA-93-54	South Essex Sewerage District, Surface waters discharging to the harbor
Marblehead Harbor MA93-22	Unknown
Salem Sound MA93-55 & MA93-56	Surface waters discharging to the sound and WWTP effluent
Nahant Bay MA93-24	CSOs, untreated sewage from an underdrain
Saugus River System	
Saugus River MA93-34	Unknown
Beaverdam Brook MA93-30	WWTP
Saugus River MA93-35	Tributaries
Mill River MA93-31	Two discharge pipes (source unspecified)
Hawkes Brook MA93-32	Unknown

Segment	Potential Sources
Hawkes Brook MA93-33	CSO
Bennetts Pond Brook MA93-48	Unknown
Shute Brook MA93-49	Unknown
Shute Brook MA93-50	Unknown
Saugus River MA93-43	MS4- Stormwater
Saugus River MA93-44	CSO, WWTP, tributaries
Unnamed Tributary MA93-51	Unknown
Pines River MA93-15	Unknown
Lynn Harbor MA93-52	CSO
Lynn Harbor MA93-53	CSO

Potential sources obtained from MassDEP 2000 and CZM 2000.

Sanitary Waste

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

Illicit sewer connections into storm drains result in direct discharges of sewage via the storm drainage system outfalls. The existence of illicit sewer connections to storm drains is well documented in many urban drainage systems, particularly older systems that may have once been combined. The EPA, MWRA, the Boston Water and Sewer Commission (BWSC) and many communities throughout the Commonwealth have been active in the identification and mitigation of these sources. It is probable that numerous illicit sewer connections exist in storm drainage systems serving the older developed portions of the North Coastal watershed.

Monitoring of storm drain outfalls during dry weather is needed to document the presence or absence of sewage in the drainage systems. Approximately 80.0% of the North Coastal watershed is classified as Urban Areas by the United States Census Bureau and is therefore subject to the Stormwater Phase II Final Rule that requires the development and implementation of an illicit discharge detection and elimination plan. See Section 8.0 of this TMDL for information regarding illicit discharge detection guidance.

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

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

Another potential source of pathogens is the discharge of sewage from vessels with onboard toilets. These vessels are required to have a marine sanitation device (MSD) to either store or treat sewage. When MSDs are operated or maintained incorrectly they have the potential to discharge untreated or inadequately treated sewage. For example, some MSDs are simply tanks designed to hold sewage until it can be pumped out at a shore-based pump-out facility or discharged into the water more than 3 miles from shore. Uneducated boaters may discharge untreated sewage from these devices into near-shore waters. In addition, when MSDs designed to treat sewage are improperly maintained or operated they may malfunction and discharge inadequately treated sewage. Finally, even properly operating MSDs may discharge sewage in concentrations higher than allowed in ambient water for shellfishing or primary and secondary contact recreational activities. Vessels are most likely to contribute to bacterial impairment in situations where large numbers of vessels congregate in enclosed environments with low tidal flushing. Many marinas and popular anchorages are located in such environments.

Wildlife and Pet Waste

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

Household pets such as cats and dogs can be a substantial source of bacteria – as much as 23,000,000 colonies/gram, according to the Center for Watershed Protection (1999). A rule of thumb estimate for the number of dogs is ~1 dog per 10 people producing an estimated 0.5 pound of feces per dog per day. Based on an estimated population in the North Coastal watershed of 500,000 people (EOEA 2003), this translates into 25,000 lbs/day of animal feces. Uncollected pet waste is then flushed from the parks, beaches and yards where pets are walked and transported into nearby waterways during wet-weather.

Stormwater

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

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

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

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

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

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

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

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

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

6.0 Prioritization and Known Sources

The following section provides a summary of North Coastal Watershed, Bacteria Impaired Waters, by Sub- Basin.

Essex Bay System - In the Essex Bay System, both Essex River Segments are impaired. The segments are located within parts of the towns of Essex, Ipswich, and Gloucester. Failing septic systems and overland stormwater flows are the principal causes of continued bacteria impairments. The town of Essex has entered into a consent agreement with MassDEP to address the discharge of pollutants from mainly failing septic systems into the town's storm drainage facilities and ultimately into coastal waters. Water quality improvements are expected to result from the removal of failing septic systems and the subsequent connection of a substantial number of the homes/businesses into the Gloucester sewage collection and wastewater treatment facility.

Annisquam River System - Both the Mill and Annisquam Rivers are impaired in the Annisquam River Sub- Basin as well as Rockport and Gloucester Harbors. Pump station (CSO) bypasses exist (city of Gloucester) on both the Mill and Annisquam Rivers. Rockport Harbor has permitted discharges for treated sanitary wastes adjacent to the harbor, as well as a sewage pump-out facility within the harbor area. The town of Rockport is under an administrative order (#835) that restricts the number of new connections to the sewer system and requires that permissions to connect be obtained through the Board of Health. The town is also under an administrative consent order to remove infiltration/inflow (I/I). Gloucester Harbor has 40 minor discharges, a major wastewater treatment plant discharge into the outer harbor (which may affect estuary areas through tidal influences), four Combined Sewer Overflow (CSO) discharges to the harbor, and seventeen major storm drains discharging directly to the harbor. The City of Gloucester, under a joint Federal/State Judgment, has aggressively tackled on-site septic system problems in the North Gloucester area through implementation of a wastewater management plan, with the help of State Revolving Fund (SRF) monies.

The City, DEP, and EPA entered into a Consent Decree on September 2, 2005 that established a schedule for completing the sewer separation work. The City submitted a Final Combined Sewer Overflow Long-Term Control Plan in June 2005. The recommended plan includes $14.6 million in system improvements, largely consisting of sewer separation projects. This work is expected to dramatically reduce the frequency and volume of CSO discharges, reducing discharge events from 53 to 2, and reducing annual volume from 25 million gallons to 0.44 million gallons. This will result in improved water quality at Pavilion Beach and Gloucester's Inner Harbor. The work will proceed under a number of separate construction contracts, and is expected to be complete by June 2012.

Salem Sound System - The Salem Sound System is comprised of five sub- basin drainage systems: Manchester; Beverly; Salem; Salem and Marblehead Harbors; and Nahant Bay.

Manchester Harbor Sub- Basin - In the Manchester Harbor Sub- Basin, Causeway Brook flows into Cat Brook, and this flows into Manchester Harbor. All three reaches are impaired for pathogens. High pathogen counts occur in these tributaries following rain events. Also, certain storm drains discharging directly into the harbor have, on occasion, had high bacteria counts. The town of Manchester is under an administrative consent order (#844) which restricts the number of new connections to the sewer system unless approval is given by the Board of Health. Also, this consent order included I/I removal requirements. The town's wastewater treatment plant was upgraded from primary treatment to secondary in 1998, however, effluents might still affect the estuary harbor area due to tidal influences.

Beverly Harbor Sub-Basin - A complex of four tributary/river systems that are bacteria impaired eventually connect with Beverly Harbor/Salem Sound: Bass River/ Danvers River; Beaver Brook/Crane Brook/Crane River (2 segments); Waters River/Danvers River; Goldthwait Brook/Proctor Brook/North River. This entire sub- region has been identified in various land-use studies as an area with particularly extensive impervious surfaces (up to 30% or greater) created by dense housing developments, commercial buildings, roads, and parking lots. Stormwater runoff from these areas has moderate to high bacteria loadings, which affects the integrity of swimming and shellfishing areas in the estuary and harbor areas. Prime bacteria sources in the stormwater appear to be from failing septic systems, pet and animal waste, and bird (geese) waste, etc. Numerous stormdrains discharge directly into the harbor area. Bacteria sampling has demonstrated high bacteria levels, particularly following wet weather events. The major wastewater treatment facility, SESD, discharges into the outer part of Beverly Harbor, but bacteria treatment before discharge should prevent those problems at the point of discharge.

Salem Harbor, and Marblehead Harbor Areas - The Forest River drains directly into the Salem Harbor segment (both are bacteria impacted). Salem Sound Coastwatch bacteria sampling throughout both harbor areas, at shoreline locations, has demonstrated particularly high levels following storm events. Once again, stormwater conveyances emptying directly into the tidal estuary/harbor areas are the source of much of this contamination.

The Nahant Bay Impacted Area – Swampscott (part of Lynn) and Nahant Island circle this embayment. This area has two NPDES permits, which include a city of Lynn Water and Sewer Commission wet weather CSO (LWSC 0utfall # 006) and the Swampscott WWTP discharge.

The Saugus River System - The Saugus River System (bacteria impacted portions) drains into Lynn Harbor, and consists of two Saugus River mainstem segments, and one Saugus River Estuary segment. Upstream, there are four (impacted) connecting tributaries to the Saugus mainstem segments: Mill River; Beaverdam Brook; and two Hawkes Brook Segments. Separate from the Saugus River System, the Pines River (also impacted) drains into the Saugus River Estuary/Lynn Harbor Area from the southwest (Revere-Saugus border). Once again, stormwater runoff is a key factor in adding bacteria loadings in these segments, as well as to the harbor/estuary areas. The city of Saugus is under a MassDEP consent order to remove I/I, so as to prevent Sewer Overflows (particularly during wet weather) into the Saugus River. Also, the city of Lynn has four CSO's, and is under a joint Federal/ State judgment to eliminate all CSO's and to address contaminated stormwater. The Saugus River Watershed Association is conducting bacteria monitoring to attempt to develop a data-base for long term trend analysis.

Pollution associated with urbanization and industrial land uses has historically stressed the Saugus River watershed. Over the past two decades, much has been accomplished to improve water quality in the Saugus River. An upgraded wastewater treatment plant in Lynn has significantly reduced direct contributions of sewage to the Saugus River. Despite progress, the River continues to be affected by sewage discharges, stormwater pollution, urban runoff, illegal dumping and other water quality problems. During major rainstorms, untreated wastewater is discharged into the Saugus River from the Lincoln Avenue pumping station in Saugus and via Combined Sewer Overflows near Strawberry Brook in Lynn.

Water quality conditions in the watershed have also been historically impacted by the withdrawal of millions of gallons of water per day at the Lynn Dam located at the border of Lynnfield and Wakefield. The Saugus River provides approximately 88% of the water used to fill Lynn's Reservoir system. Water is diverted from the Saugus River to Hawkes Brook and eventually to the ponds that make up Lynn's Reservoir system. A diversion dam located along the Saugus River adjacent to the Sheraton Colonial in Wakefield is used to control the amount of water diverted directly from the Saugus River.

The sites with the highest levels of bacterial pollution in 2004 were Trifone Brook in Revere (a tributary to the Town Line Brook), Shute Brook in Saugus, Mill River @ Town Brook in Wakefield, and the confluence of Strawberry Brook and Saugus River in Lynn. Bacteria levels at these sites were extremely high at times, with many samples exhibiting bacteria colonies that were too numerous to count (at least 2,000 *E. Coli*). The sources of pollution are unknown but likely include illegal connections and/or faulty sewer and storm drainage systems.

The Saugus River Watershed Council (SRWC) is working with the cities of Revere, Malden, Everett, and Melrose to address water quality, flooding, and public access in the Town Line Brook watershed. This effort has included several storm drain sampling projects to pinpoint areas of highest pollution, pet waste education, cleanups of illegal debris and implementation of stormwater management projects to reduce stormwater pollution. Restoring water quality in this portion of the watershed is needed to address public health issues, improve water quality and help to restore shellfish beds in Rumney Marsh.

In 2005, the Town of Saugus entered into a Consent Order with the Department of Environmental Protection (DEP) to end long-time direct sewage discharges from the Lincoln Avenue Pumping Station into the Saugus River during major rainstorms. Under the Consent Order, the Town is required to resolve this significant environmental problem by implementing major upgrades to its stormwater and sewer infrastructure over the next several years

The Lynn Water & Sewer Commission (LWSC), DEP, and EPA agreed to terms on a Second Modified Consent Decree (SMCD), which was executed on June 29, 2001. The SMCD included requirements for sewer separation work which would result in elimination of three of the Commission's four CSO discharges: 006, which discharges to King's Beach, and 004, 005 which discharge to Lynn Harbor. The fourth CSO outfall, 003, discharges to the Saugus River via the Little River. The SMCD required the Commission to proceed with sewer separation work and I/I work in the 003 system, and conduct follow up monitoring to determine if further actions are needed to eliminate this outfall.

The SMCD required outfall 006 to be eliminated by December 31, 2003, 005 to be eliminated by December 31, 2006, and 006 to be eliminated by December 31, 2009. During implementation of the sewer separation work to achieve this outcome, it was discovered that over 900 acres of the city thought to be served by separate sewer and drain systems were in fact combined systems, and that the ongoing design for the SMCD sewer separation work would fail to achieve the intended benefits. The Commission has since developed and submitted an October 2004 Supplemental CSO Facilities Plan (SFP). The recommendations from that plan are to proceed with $55 million in I/I projects, sewer separation projects, and CSO storage facilities. This would be in addition to the $80 million spent to date by the Commission on CSO abatement actions.

DEP and EPA are continuing to review the recommendations in the SFP, and discussions have been focused on identifying and proceeding with projects to eliminate CSO discharges to King's Beach. There has been a Draft CSO 006 Sewer Service Area Regulator Evaluation Study submitted as a result of these ongoing discussions, and I/I projects and regulator modifications are now proceeding with the goal of eliminating the 006 discharge.

In an effort to provide guidance for setting bacterial implementation priorities within the North Coastal Watershed, a summary table is provided. Table 6-1 below provides a prioritized list of pathogen-impaired segments that will require additional bacterial source tracking work and implementation of structural and non-structural Best Management Practices (BMPs). Since limited source information and data are available in each impaired segment a simple scheme was used to prioritize segments based on fecal coliform concentrations. High priority was assigned to those segments where either dry or wet weather concentrations (end of pipe or ambient) were equal to or greater than 10,000 cfu/100 mL. Medium priority was assigned to segments where concentrations ranged from 1,000 to 9,999 cfu/100 mL . Low priority was assigned to segments where concentrations were observed less than 1,000 cfu/100 mL. MassDEP believes the higher concentrations are indicative of the potential presence or raw sewage and therefore they pose a greater risk to the public. It should be noted that in all cases, waters exceeding the water quality standards identified in Table ES- 2 are considered impaired.

Also, prioritization was adjusted upward based on proximity of waters, within the segment, to sensitive areas such as Outstanding Resource Waters (ORW's), or designated uses that require higher water quality standards than Class B, such as public water supply intakes, public swimming areas, or shellfish areas. Best professional judgment was used in determining this upward adjustment. Generally speaking, waters that were determined to be lower priority based on the numeric range identified above were elevated up one level of priority if that segment were adjacent to or immediately upstream of a sensitive use. An asterisk * in the priority column of the specific segment would indicate this situation. In many cases the DMF sampling results that were used to develop Table 6-1 do not differentiate whether the sampling was conducted during wet or dry weather.

MassDEP believes that segments ranked as high priority in Table 6-1 are indicative of the potential presence of raw sewage and therefore they pose a greater risk to the public. Elevated dry weather bacteria concentrations could be the result of illicit sewer connections or failing septic systems. As a result, the first priority should be given to bacteria source tracking activities in those segments where sampling activities show elevated levels of bacteria during dry weather. Identification and remediation of dry weather bacteria sources is usually more straightforward and successful than tracking and eliminating wet weather sources. If illicit bacteria sources are found and eliminated it should result in a dramatic reduction of bacteria concentration in the segment in both dry and wet-weather. Segments that remain impaired during wet weather should be evaluated for stormwater BMP implementation opportunities starting with less costly non-structural practices first (such as street sweeping, and/or managerial approaches using local regulatory controls), and if necessary, more expensive structural measures. Structural stormwater BMP implementation may require additional study to identify cost efficient and effective technology prior to implementation.

Table 6-1. Prioritized List of North Coastal Watershed Pathogen Impaired Segments .

Segment ID	Segment Name	Segment Type, Class	Size[1]	Segment Description	Priority "Dry"	Priority "Wet"
Essex Bay System						
MA93-45	Alewife Brook, B	River	1.4	Headwaters, outlet Chebacco Lake, Essex to Landing Road, Essex.	Medium	High
MA93-46	Alewife Brook,	Estuary	0.01	Landing Road, Essex to confluence	Medium*	High*

Segment ID	Segment Name	Segment Type, Class	Size[1]	Segment Description	Priority "Dry"	Priority "Wet"
	SA			with Essex River, Essex.	shellfishing	shellfishing
MA93-11	Essex River, SA	Estuary	0.5	Source east of Southern Avenue to mouth at Essex Bay, Essex.	Medium* (possible illicit discharges) ORW, shellfishing	High* (from Alewife Bk trib) ORW, shellfishing
MA93-16	Essex Bay, SA	Estuary	1.0	Essex/Ipswich/Gloucester	Insufficient Data, public swimming, shellfishing	Insufficient Data, public swimming, shellfishing
Annisquam River System						
MA93-28	Mill River, SA	Estuary	0.1	Outlet Mill Pond, Gloucester to confluence with Annisquam River, Gloucester.	Medium* shellfishing	Medium* Sewer pump stations shellfishing
MA93-12	Annisquam River, SA	Estuary	0.82	The waters from the Gloucester Harbor side of the Route 127 bridge, Gloucester to Ipswich Bay at an imaginary line drawn from Bald Rocks to Wigwam Point, Gloucester.	Insufficient Data shellfishing	Insufficient Data 2 Sewer pump stations shellfishing
MA-93-57 (formerly MA93-17)	Rockport Harbor, SB	Estuary	0.35	Waters landward of an imaginary line from Gully Point, Rockport to Granite Pier, Rockport (including Back Harbor and a portion of Sandy Bay) (includes area formerly reported as segment MA93-17)	Insufficient Data	Insufficient Data
MA93-18	Gloucester Harbor, SB	Estuary	2.3	The waters landward of an imaginary line drawn between Mussel Point and the tip of the Dog Bar Breakwater, Gloucester excluding the Annisquam River.	Medium* public swimming, 3 sewer pump stations, CSOs, shellfishing in adjoining waterbody	High* public swimming, 3 sewer pump stations, CSOs, shellfishing in adjoining waterbody
Salem Sound System						
MA93-47	Causeway Brook, B	River	1.1	Headwaters, outlet Dexter Pond, Manchester to confluence with Cat Brook, Manchester	Medium	High
MA93-29	Cat Brook, B	River	1.7	Headwaters north of Route 128 Manchester/Essex/Gloucester to confluence Manchester Harbor, Manchester.	Medium	High (one reading 10,000cfu)
MA93-19	Manchester Harbor, SB	Estuary	0.33	The waters landward of an imaginary line drawn between Gales Point and Chubb Point, Manchester excluding Cat Brook.	Medium (possible illicit discharges)	Medium

Segment ID	Segment Name	Segment Type, Class	Size[1]	Segment Description	Priority "Dry"	Priority "Wet"
MA93-08	Bass River, SA	Estuary	0.12	Outlet of Lower Shoe Pond north of Route 62 to confluence with Danvers River, Beverley.	High* (possible illicit discharges)	High* (wet weather maximums)
MA93-36	Frost Fish Brook, B	River	1.0	Cabot Road, Danvers to Porter River confluence at Route 62.	Medium (possible illicit discharges)	Medium
MA93-04	Porter River, SA	Estuary	0.13	Confluence with Frost Fish Brook at Route 62 to confluence with Danvers River, Danvers.	High (possible illicit discharges)	Medium*
MA93-02	Crane Brook, B	River	1.8	Headwaters east of route 95, to inlet Mill Pond, Danvers.	Medium (possible illicit discharges)	Medium (wet weather highs, 2002 survey)
MA93-41	Crane River, SA	Estuary	0.07	Outlet pump house sluiceway at Purchase Street, Danvers to confluence Danvers River, Danvers.	Insufficient Data,	Insufficient Data,
MA93-01	Waters River, SA	Estuary	0.09	Headwaters west of Route 128, Peabody/Danvers, to confluence with Danvers River, Danvers.	Medium*	Medium*
MA93-05	Goldthwait Brook, B	River	3.3	Outlet Cedar Pond, Peabody to confluence with Proctor Brook, Peabody.	Low	Medium
MA93-39	Proctor Brook, B	River	2.9	Outlet of small pond in wetland north of Downing Road, Peabody to Grove/Goodhue Street bridge, Salem (formerly part of 93-05).	Medium	Medium
MA93-42	North River, SA	Estuary	0.15	Downstream of Route 114 bridge (Proctor Brook becomes North River at this bridge), Salem to confluence with Danvers River, Salem (formerly part of MA93-06).	Insufficient Data,	Insufficient Data,
MA93-09	Danvers River, SA	Estuary	0.53	Confluence with Porter, Crane and Waters rivers, Danvers to mouth at Beverly Harbor, Beverly/Salem.	Medium*	Medium*
MA93-20	Beverly Harbor, SB	Estuary	1.02	From the mouth of the Danvers River, Salem/Beverly to an imaginary line from Juniper Point, Salem to Hospital Point, Beverly.	Medium* (possible illicit discharges) public swimming,	Medium* public swimming,
MA93-40	Proctor Brook, SA	Estuary	0.01	Grove/ Goodhue Street bridge, Salem to Route 114 culvert, Salem (formerly part of MA93-06)	Medium	Medium
MA93-54 (formerly MA93-21)	Salem Harbor, SB	Estuary	4.91	Waters landward of an imaginary line from Naugus Head, Marblehead to the northwest point of Bakers Island, Salem to Hospital Point, Beverly to Juniper Point, Salem (excluding Forest River)	High* (possible illicit discharges) public swimming,	Medium* public swimming

Segment ID	Segment Name	Segment Type, Class	Size[1]	Segment Description	Priority "Dry"	Priority "Wet"
				(formerly segment MA93-21 Salem Harbor and a portion of segment MA93-25 Salem Sound [waterbody code 93907])		
MA93-22	Marblehead Harbor, SA	Estuary	0.56	The waters landward of an imaginary line drawn northwesterly from the northern tip of Marblehead Neck to Fort Sewall, Marblehead.	High* (possible illicit discharges)	Medium*
MA93-55 (formery MA93-25)	Salem Sound, SA	Estuary	3.46	Northern portion of Salem Sound, waters landward of and within imaginary lines from Chubb Point, Manchester to Gales Point , Manchester to the northwest point of Bakers Island, Salem to Hospital Point, Beverly (formerly reported as a portion of segment MA93-25)	Medium* public swimming,	Medium* public swimming,
MA93-56 (formerly MA93-25)	Salem Sound, SA	Estuary	2.55	Southern portion of Salem Sound, waters landward of and within imaginary lines from Fort Sewall, Marblehead to the Marblehead Lighthouse on Marblehead Neck, Marblehead to the northwest point of Bakers Island, Salem to Naugus Head, Marblehead (formerly reported as a portion of segment MA93-25)	Medium* public swimming,	Medium* public swimming,
MA93-24	Nahant Bay, SA	Estuary	5.1	The waters landward of an imaginary line drawn between Galloupes Point, Swampscott and East Point, Nahant.	Medium* public swimming, CSO	High* public swimming, CSO
Saugus River System						
MA93-34	Saugus River, B	River	3.1	Headwaters, outlet of Lake Quannapowitt, Wakefield (thru Reedy Meadow) to Lynn Water & Sewer Commission diversion canal, Wakefield/Lynnfield (canal diverts to Hawks Pond) (formerly part of segment MA93-13).	Medium	High
MA93-30	Beaverdam Brook, B	River	1.5	Headwaters west of Main Street, Lynnfield to confluence with Saugus River, Lynnfield.	Medium	Low
MA93-35	Saugus River, B	River	5.4	From the Lynn Water & Sewer Commission diversion canal, Wakefield/Lynnfield to Saugus Iron Works, Bridge Street, Saugus (formerly part of segment MA93-13).	Medium* public swimming	High* public swimming

Segment ID	Segment Name	Segment Type, Class	Size[1]	Segment Description	Priority "Dry"	Priority "Wet"
MA93-31	Mill River, B	River	2.0	From headwaters in wetlands north of Salem Street in Wakefield to confluence with Saugus River, Wakefield.	Medium	Medium
MA93-32	Hawkes Brook, A	River	2.6	Headwaters at the Lynn/Lynnfield border to the outlet of Hawkes Pond in North Saugus.	High* (possible illicit discharges) ORW	Medium* ORW
MA93-33	Hawkes Brook, B	River	1.1	Outlet of Hawkes Pond, North Saugus to confluence with Saugus River, Saugus.	Medium (possible illicit discharges)	Low
MA93-48	Bennetts Pond Brook, B	River	2.4	Headwaters east of Lynn Fells Parkway (in Bellevue Golf Course), Melrose to confluence with Saugus River, Saugus.	Medium	Medium
MA93-49	Shute Brook, SA	Estuary	0.01	Approximately 350 feet downstream from Central St., Saugus to the confluence with the Saugus River, Saugus.	Medium*	High*
MA93-50	Shute Brook, B	River	0.89	From the confluence with Fiske Brook, Saugus to approximately 350 feet downstream from Central St., Saugus.	Medium	High
MA93-43	Saugus River, SB	Estuary	0.04	Saugus Iron Works, Bridge Street , Saugus, to Lincoln Avenue/Boston Street, Saugus/Lynn (formerly part of segment (MA93-14).	Insufficient Data	Insufficient Data
MA93-44	Saugus River, SB	Estuary	0.36	Lincoln Avenue/Boston Street, Saugus/Lynn to mouth (east of Route 1A) at Lynn Harbor, Lynne/Revere (formerly part of 93-14).	Medium* ORW, CSOs	High* ORW, CSOs
MA93-51	Unnamed Tributary, SA	Estuary	0.02	Unnamed tributary locally known as "Town Line Brook" from Route 99, Malden to the confluence with the Pines River, Revere.	Medium*	High*
MA93-15	Pines River, SB	Estuary	0.58	Headwaters east of Route 1, Revere/Saugus to confluence with the Saugus River, Saugus/Revere.	High* (possible illicit discharges) ORW,	Medium* ORW
MA93-52	Lynn Harbor, SB	Estuary	1.6	The "inner" portion of Lynn Harbor; the waters landward of an imaginary line from Black Rock Point, Nahant to the eastern edge of Point of Pines, Revere excluding the Saugus River (formerly part of 93-23)..	High* (possible illicit discharges) CSOs	High* CSOs

Segment ID	Segment Name	Segment Type, Class	Size[1]	Segment Description	Priority "Dry"	Priority "Wet"
MA93-53	Lynn Harbor, SB	Estuary	6.6	The "outer" portion of Lynn Harbor; the waters landward of an imaginary line drawn from Baileys Hill, Nahant to the eastern point of Winthrop Highlands, Winthrop to the seaward edge of the "inner" portion of Lynn Harbor (at an imaginary line drawn from Black Rock Point, Nahant to the eastern edge of Point of Pines, Revere) (formerly part of segment 93-23).	High* (effects from the inner harbor) CSOs	High* (effects from the inner harbor) CSOs

[1] Units = Miles for river segments and square miles for estuaries

Along with the information in the earlier paragraphs in this section on principal sources of pollution, it should be stressed that there were a total of 13 segments having suspected illicit connection dry weather flow problems (identified in Table 6-1 above). These segments include: MA93-11 Essex River (estuary); MA93-19 Manchester Harbor (estuary); MA93-08 Bass River; MA93-36 Frost Fish Brook; MA93-04 Porter River (estuary); MA93-02 Crane Brook; MA93-20 Beverly Harbor (estuary); MA93-21 Salem Harbor (estuary); MA93-22 Marblehead Harbor (estuary); MA93-32 Hawkes Brook; MA93-33 Hawkes Brook; MA93-15 Pines River (estuary); MA93-23 Lynn Harbor (estuary). The communities within these segments need to address these problems through more follow-up monitoring, with rectification efforts undertaken with those responsible for these illegal inputs into the stormwater conveyances.

7.0 Pathogen TMDL Development

Section 303 (d) of the Federal Clean Water Act (CWA) requires states to identify waters that do not meet the water quality standards on a list of impaired waterbodies. The 2008 Integrated List identifies a total of 43 segments within the North Coastal Watershed for use impairment caused by excessive indicator bacteria concentrations.

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

TMDL = WLAs + LAs + Margin of Safety (MOS)

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

LA = Load Allocation is the portion of the receiving water's loading capacity that is allocated to existing and future non-point sources of pollution.

MOS = Margin of safety, either explicitly or implicitly.

This TMDL was established from an alternative standards-based approach, which is based on indicator bacteria concentrations, but considers the terms of the above equation. This approach is more in line with the way bacteria pollution is regulated (i.e., according to concentrations standards), however, the standard loading approach is provided as well.

7.1 General Approach: Development of TMDL Targets

For this TMDL the MassDEP developed two types of daily TMDL targets[7]. First, MassDEP set Daily concentration TMDL targets for all potential pathogen sources by category (i.e., storm water, NPDES, etc) and surface water classification. Expressing a loading capacity for bacteria in terms of

[7] Percent reduction was not used in this TMDL because it was not possible to uniformly calculate percent reduction due to the variety of indicators and data format inconsistencies.

concentrations set equal to the Commonwealth's adopted criteria, as provided in Table 7-1, provides the clearest and most understandable expression of water quality goals to the public and to groups that conduct water quality monitoring. MassDEP recommends that the concentration targets be used as the primary guide for implementation (See Section 7.2).

Second, MassDEP estimated the total maximum daily load for each river or stream segment as a function of flow (15 of 43 North coastal segments). Expressing the loading capacity for bacteria in terms of loadings (e.g., numbers of organisms per day, cfu/day), although valid as a TMDL, is more difficult for the public to understand because the "allowable" loading number varies with flow over the course of the day and season. Also, the loading numbers are very large (i.e. billions or trillions of bacteria per day) and therefore difficult to interpret as they do not relate directly to the State Water Quality Standards or public health criteria.

For embayments, however, total maximum daily pathogen loads are typically calculated based on long-term average runoff volumes. Because of runoff morphology in the North Coastal watershed, for the purposes of this report, the loading calculations for all 28 of the estuary segments were estimated by using; 1) the concentration allowed by the Massachusetts Water Quality Standards and 2) the estimated volume of runoff entering the embayment from each contributing watershed (See Section 7.3. for detailed methodology).

It is important to note that MassDEP realizes that an iterative approach to achieving compliance with this pathogen TMDL is warranted, given the vast potential number of bacteria sources, and the difficulty of identifying and removing some sources (e.g., stormwater). While the stated goal in the TMDL is to meet the water quality standard at the point of discharge it also attempts to be clear that MassDEP's expectation is that adaptive management is needed for implementation of stormwater control measures that includes prioritization of outfalls and the application of BMPs. MassDEP believes this is approach is consistent with current EPA guidance and regulations as stated in a November 22, 2002 EPA memo from Robert Wayland (see Appendix B).

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

To ensure attainment with water quality standards throughout the waterbody, MassDEP emphasizes the simplest and most readily understood way of meeting the TMDL is to have a goal of bacteria sources not exceeding the WQS criteria at the point of discharge. This is also an implicit conservative approach with respect to the MOS.

Sources of indicator bacteria in the North Coastal Watershed are varied; however data indicate that most of the bacteria sources are likely stormwater related. Sections 4, 5 and 6 of this document discuss in more detail the types of sources identified as well as their prioritization for implementation. Point sources within the North Coastal Watershed include five major wastewater treatment plants (WWTPs); Gloucester WWTP (MA0100625), including 5 CSOs and 3 pumping stations; Rockport WWTP MA0100145); Manchester WWTP (MA0100871); South Essex Sewerage District (SESD) WWTP (MA0100501); Lynn Water and Sewer Commission (LWSC) WWTP (MA0100552), including 1 CSO. Other NPDES-permitted wastewater discharges, include: process, non-contact cooling water, power plant cooling, or other industrial waste waters. In addition, there are numerous stormwater discharges from storm drainage systems, of which many are covered under the EPA Phase II Stormwater Permit MS4

Program, throughout the watershed in the communities of: Essex, Ipswich, Gloucester, Rockport, Manchester, Beverly, Danvers, Peabody, Salem, Marblehead, Swampscott, Lynn, Nahant, Wakefield, Saugus, Lynnfield, Melrose, Malden, and Revere.

NPDES wastewater discharge WLAs for WWTPs are set at the water quality standards. All piped discharges are, by definition, point sources regardless of whether they are currently subject to the requirements of NPDES permits. Therefore a WLA set equal to the WQS criteria will be assigned to the portion of the stormwater that discharges to surface waters via storm drains. For any illicit sources including illicit discharges to stormwater systems and sewer system overflows (SSO's) the goal is complete elimination (100% reduction). The specific goal for controlling combined sewer overflows (CSO's) is meeting water quality standards through implementation of approved Long-Term Control Plans. It is recommended that these concentration targets be used to guide implementation. The goal to attain WQS at the point of discharge is environmentally protective, and offers a practical means to identify and evaluate the effectiveness of control measures. In addition, this approach establishes clear objectives that can be easily understood by the public and others responsible for monitoring activities. Success of control efforts and subsequent conformance with TMDL will be determined by documenting that a sufficient number of bacteria samples from receiving water meet the appropriate indicator criteria (WQS) for the water body.

Table 7-1 presents the TMDL indicator bacteria WLAs and LAs for the various source categories as daily concentration targets for the North Coastal Watershed. WLAs (to address point sources of pollution) and LAs (to address non-point sources of pollution) are presented by applying both the former (fecal coliform) and recently revised (E. coli and enterococcus) WQS. The full version of the WQS can be accessed at: http://www.mass.gov/dep/service/regulations/314cmr04.pdf

Table 7-1. Waste Load Allocations (WLAs) and Load Allocations (LAs) as Daily Concentrations (cfu/ 100 ml).

Surface Water Classification	Pathogen Source	Waste Load Allocation Indicator Bacteria (cfu/100 mL)[1]	Load Allocation Indicator Bacteria (cfu/100 mL)[1]
A, B, SA, SB (prohibited)	Illicit discharges to storm drains	0	
	Leaking sanitary sewer lines	0	Not Applicable
	Failing septic systems	Not Applicable	0
A (Includes filtered water supply) & B	Any regulated discharge-including stormwater runoff[4] subject to Phase I or II NPDES permits, NPDES wastewater treatment plant discharges [7,9], and combined sewer overflows[6].	Either; E. coli <=geometric mean[5] 126 colonies per 100 mL; single sample <=235 colonies per 100 mL; or b) Enterococci geometric mean[5] <= 33 colonies per 100 mL and single sample <= 61 colonies per 100 mL	Not Applicable

Surface Water Classification	Pathogen Source	Waste Load Allocation Indicator Bacteria (cfu/100 mL)[1]	Load Allocation Indicator Bacteria (cfu/100 mL)[1]
	Nonpoint source stormwater runoff[4]	Not Applicable	Either E. coli <=geometric mean[5] 126 colonies per 100 mL; single sample <=235 colonies per 100 mL; or Enterococci geometric mean[5]<= 33 colonies per 100 mL and single sample <= 61 colonies per 100 mL
SA (Approved for shellfishing)	Any regulated discharge - including stormwater runoff[4] subject to Phase I or II NPDES permits, NPDES wastewater treatment plant discharges[7,9], and combined sewer overflows[6].	Fecal Coliform <= geometric mean, MPN, of 14 organisms per 100 mL nor shall 10% of the samples be >=28 organisms per 100 mL	Not Applicable
	Nonpoint Source Stormwater Runoff[4]	Not Applicable	Fecal Coliform <= geometric mean, MPN, of 14 organisms per 100 mL nor shall 10% of the samples be >=28 organisms per 100 mL
SA & SB[10] (Beaches[8] and non-designated shellfish areas)	Any regulated discharge - including stormwater runoff[4] subject to Phase I or II NPDES permits, NPDES wastewater treatment plant discharges[7,9], and combined sewer overflows[6].	Enterococci - geometric mean[5] <= 35 colonies per 100 mL and single sample <= 104 colonies per 100 mL	Not Applicable
	Nonpoint Source Stormwater Runoff[4]	Not Applicable	Enterococci -geometric mean[5] <= 35 colonies per 100 mL and single sample <= 104 colonies per 100 mL
SB (Approved for shellfishing w/depuration)	Any regulated discharge - including stormwater runoff[4] subject to Phase I or II NPDES permits, NPDES wastewater treatment plant discharges[7,9], and combined sewer overflows[6].	Fecal Coliform <= median or geometric mean, MPN, of 88 organisms per 100 mL nor shall 10% of the samples be >=260 organisms per 100 mL	Not Applicable
	Nonpoint Source Stormwater Runoff[4]	Not Applicable	Fecal Coliform <= median or geometric mean, MPN, of 88 organisms per 100 mL nor shall 10% of the samples be >=260 organisms per 100 mL

[1] Waste Load Allocation (WLA) and Load Allocation (LA) refer to fecal coliform densities unless specified in table.
[2] In all samples taken during any 6 month period
[3] In 90% of the samples taken in any six month period;
[4] The expectation for WLAs and LAs for stormwater discharges is that they will be achieved through the implementation of BMPs and other controls.

[5] Geometric mean of the 5 most recent samples is used at bathing beaches. For all other waters and during the non-bathing season the geometric mean of all samples taken within the most recent six months, typically based on a minimum of five samples.
[6] Or other applicable water quality standards for CSO's
[7] Or shall be consistent with the Waste Water Treatment Plant (WWTP) National Pollutant Discharge Elimination System (NPDES) permit.
[8] Massachusetts Department of Public Health regulations (105 CMR Section 445)
[9] Seasonal disinfection may be allowed by the Department on a case-by-case basis.
[10] Segments designated as CSO have a long term control plan in place.

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

It is recommended that these concentration targets be used to guide implementation. The stated goal to attain WQS at the point of discharge is conservative and environmentally protective, and offers a practical means to identify and evaluate the effectiveness of control measures. In addition, this approach establishes clear objectives that can be easily understood by the public and others responsible for monitoring activities. Success of the control efforts and subsequent conformance with the TMDL can be determined by documenting that a sufficient number of valid bacteria samples from a segment meet the appropriate bacteria indicator criterion for the segment's water quality classification. Compliance will be measured by concentrations measured in the receiving water.

Potential Sources of Bacteria Contamination

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

7.3 TMDL Expressed as Daily Load (CFU/Day)

The following section describes the approach for deriving allowable daily bacteria loads for the North Coastal watershed

7.3.1 Rivers

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

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

Bacteria also can be discussed in terms of concentrations and loads. However, the common way of expressing concentrations of bacteria is in terms of numbers rather than weight (although one could use weight). Bacteria standards for water are written in terms of concentrations, and while the method of determining the concentrations can be by direct count or estimated through the outcome of some reaction, it is numbers that are judged to be in a given volume of water. Once again, the load is determined by the concentration multiplied by the volume of water. As can be seen, changes in concentration and/or changes in flow result in changes in the loads. Also, maximum loads can increase and if flow increases in proportion, the concentration will remain the same. For instance, if the total number of bacteria entering a section of stream doubles, but the flow also doubles, the concentration remains the same. This means that as flow increases, allowable load can increase so that concentration remains constant (or lower if dilution occurs) while continuing to meet the water quality criterion. In its simplest application, this is the concept of the flow duration curve approach. At each given flow, the maximum load that can enter and still meet the concentration criterion is set. If the numbers of bacteria entering are higher than this allowable number, then a reduction is needed. As a practical matter, determining the flow at each sampling point is resource intensive, expensive and generally is not done. Given this, however, some estimates of flow can be derived from USGS gages in the watershed or in nearby similar watersheds if there is no gage in the impaired stream.

The pollutant loading that a waterbody can safely assimilate is expressed as either mass-per-time, toxicity or some other appropriate measure (40 CFR § 130.2)1. Typically, TMDLs are expressed as total maximum daily loads. Expressing stormwater pathogen TMDLs in terms of daily loads is difficult to interpret given the very high numbers of indicator bacteria and the magnitude of the allowable load is dependent on flow conditions and, therefore, will vary as flow rates change. For example, a very high load of indicator bacteria is allowable if the volume of water that transports indicator bacteria is also high. Conversely, a relatively low load of indicator bacteria may exceed the water quality standard if flow rates are low. Given the intermittent nature of stormwater related discharges, MassDEP believes it is appropriate to express stormwater-dominated indicator bacteria TMDLs proportional to flow for flows greater than 7Q10. This approach is appropriate for stormwater TMDLs because of the intermittent nature of stormwater discharges. However, the WLAs for continuous discharges are not set based on the receiving water's proportional flow, but rather, are based on the criteria multiplied by the permitted effluent flow (applying the appropriate conversion factor). Because the water quality standard is also expressed in terms of the concentration of organisms per 100 mL, the acceptable in-stream daily load or TMDL is the product of that flow and the criterion.

In recognition that bacteria loads from stormwater are flow dependent, the total TMDL can be calculated as a function of flow, and allocated to different source categories, as shown in the following equation:

$$\textbf{TMDL} = \textbf{WQS} \times \textbf{Q}_T = \textbf{WLA} + \textbf{LA} + \textbf{MOS} + \textbf{NB}$$

Where:
WLA = allowable load for point source categories (including piped stormwater)
LA = allowable load for nonpoint source categories
Q_T = stream flow on any given day when >7Q10
MOS = margin of safety
NB = natural background conditions
WQS = Massachusetts Water Quality Standard criterion

7.3.2 Embayment's

For the North Coastal embayment's, the allowable loading was estimated using the same methodology employed in the Buzzards Bay Pathogen TMDL (Mass DEP 2009). Most embayment's in the North Coastal watershed are fed by a surface water feature such as a river or stream. The landuse, associated with the North Coastal embayment subwatesheds, is comprised largely of urbanized areas (see Figure 2-1) which represent greater than 50% of the landuse in the watershed. Several urban areas like Saugus, Lynn, Swampscott, Beverly, Marblehead Salem, and Gloucester operate large sewer and/or stormwater systems and have vast amounts of impervious cover. As a result, the method for estimating allowable loading for the 28 North Coastal embayments was calculated by multiplying the concentration allowed by the Massachusetts Water Quality Standards by the estimated volume of runoff entering from each contributing watershed. Runoff estimates for the region were extracted from historical precipitation and runoff records maintained by the USGS and the Massachusetts Department of Conservation and Recreation (DCR). DCR precipitation records from 1915-2007 for the North Coastal Area of Massachusetts show an average precipitation for the region of 45.7 inches per year (3.8 ft/year) (DCR 2010 http://www.mass.gov/dcr/watersupply/rainfall/). USGS maintains a gage network throughout the state of Massachusetts. Runoff records take into account water that is lost to evapotranspiration or infiltration processes. The average runoff for the state of Massachusetts is 2.0 feet per year based on a period of record form 1905-2007 (personal communication David Wilcock, USGS 2008). The estimated volume of runoff entering from each contributing watershed was conservatively estimated by assuming that all precipitation to impervious areas runs directly off into a local waterway (average runoff value of 45.7 inches per year or 3.8 feet). In pervious areas a conservative estimate of 24 inches per year (2.0

feet) was used which represents the 50 percentile of runoff values observed at USGS gages in New England (Hydrologic Unit 1) based on long-term records(1905-2007).

These runoff values were multiplied by the contributing watershed acreage and the most stringent water quality standard for each segment to calculate the allowable load or total number of bacteria per year (cfu/year). The daily TMDL was then calculated by dividing the allowable annual load by the number of days, on average, that it rains. Since it rains once every three to four days the annual load was divided by 105 days per year with rainfall to calculate the daily load. Precipitation data were based on information interpreted from the National Oceanic and Atmospheric Administration (NOAA) at http://cdo.ncdc.noaa.gov/ancsum/ACS.

The 105 days per year of rainfall represents an average of the total number of days of precipitation >0.01 inch. It is assumed that precipitation less than 0.01 inch either adsorbs into the ground or evaporates and therefore does not runoff. Finally, the total daily load allocation was then split into wasteload and load allocations based on the ratio of impervious to pervious land within each watershed.

7.3.3 Water Quality Criteria

The water quality criteria used to develop the TMDL was based on the most stringent designated use identified in the Massachusetts Water Quality Standards. In the case of the North Coastal watershed the most sensitive use is shellfishing. A summary of the relevant water quality criteria that apply to the North Coastal watershed are summarized in Table 7-2.

Table 7-2. Water Quality Targets for North Coastal Watershed.

Waterbody Use	Shellfishing Criterion (apply in approved areas)		Primary Contact Recreation Criterion			
	Fecal coliform (cfu/100LmL)		E. coli (cfu/100mL)		Enteroccoci (cfu/100mL)	
Waterbody Class	**Geometric Mean**	**10% of samples not to exceed**	**Geometric Mean**	**Single Sample Maximum [d]**	**Geometric Mean**	**Single Sample Maximum [d]**
A (filtered Public Water Supply)	None	None	126 [a]	235 [a]	33[b]	61[b]
B	None	None	126 [a]	235 [a]	33[b]	61[b]
SA	14 [c]	28 [c]	None	None	35 [b]	104 [b]
SB	88 [c]	260 [c]	None	None	35 [b]	104 [b]

[a] e.coli is the indicator, [b] enterococci is the indicator, [c] Fecal coliform is the indicator, [d] Used for decision of beach closure when limited data is available, 25% of samples not to exceed.

MassDEP is basing the TMDL on the recently (1/07) revised Massachusetts Water Quality Standards for the indicator organisms (*E. coli* and enterococci). The full version of the revised standards can be found at: http://mass.gov/dep/water/laws/regulati.htm#wqual

Primary contact recreation criteria apply to all fresh water systems and will pertain for all river segments in the North Coastal watershed. For marine segments shellfishing criteria are the most stringent and will be applied to all marine segments that are actively managed by DMF for shellfishing in accordance with the requirement of the NSSF. Two impaired waterbodies are not managed as active shellfishing areas by

DMF (MA93-51 and MA93-40) and the primary contact recreation standard will be applied to these water bodies for the purposes of the TMDL. With the exception of the Essex Bay System and the Annisquam River System, most of the waterbodies in the North Coastal watershed have been prohibited to commercial shellfishing for most of the last century.[8] It is unclear as of the date of this report whether these prohibitions are due to water quality, health risk (dense population, number of WWTP outfalls, mooring fields, marinas), or insufficient data to make a determination.

7.3.4 Calculating the TMDL as Daily Loads (Colonies/Day)

MassDEP believes it is appropriate to express indicator bacteria TMDLs proportional to flow. Because the water quality standard is also expressed in terms of the concentration of organisms per 100 mL, the acceptable in-stream daily load or TMDL is the product of that flow and the water quality standard criterion, which is the same approach used for any pollutant with a numerical criterion. In the case of embayments, contributing watershed runoff is the flow that is being used to determine the maximum daily load.

The TMDL is calculated based on flow or volume and the concentration of the applicable Massachusetts water quality standard criterion for bacteria in the river. Once the flow or volume is estimated, the total maximum daily load of bacteria in numbers per day is derived by multiplying the estimated flow or runoff volume by the water quality standard criterion for the indicator bacteria. The actual allowable load of bacteria in fresh water systems where the primary contact recreation standard applies, in numbers of bacteria per day, varies with flow at or above 7Q10 in each segment (as presented in Figure 7-1a [when e.coli is the indicator] and Figure 7-1b [when enterococci is the indicator]). This approach sets a target for reducing the loads so that water quality criteria for indicator bacteria are met at all flows equal to or greater than 7Q10.

Example calculations for determining the TMDL are provided as follows:

<u>For Rivers:</u> The TMDL associated each 1.0 cubic foot per second of flow to meet a water quality standard of 126 cfu/100 ml (E.coli, Class A or B,) or 33 cfu/100 mL (enteroccoci Class A or B,) is derived as follows:

River Segment (E. coli, Class A or B) TMDL= (0.02832 m^3/sec) x (86,400 sec/day) x (1,000 liters/m^3) x (1,000 ml/liter) x (126 cfu/100ml) = 3.08×10^9 cfu/day.
River Segment (enteroccoci, Class A or B) TMDL= (0.02832 m^3/sec) x (86,400 sec/day) x (1,000 liters/m^3) x (1,000 ml/liter) x (33 cfu/100ml) = 8.07×10^8 cfu/day.

For River segments the TMDL is proportioned between the WLA and LA by multiplying the daily load by the percent impervious cover for the WLA, and by multiplying the daily load by the percent pervious cover for the contributing watershed for the LA. Table 7-3 summarizes the TMDL for the fresh water segments in the North coastal Watershed.

---

[8] Belding, 1930. The soft Shell Clam Fishing of Massachusetts Marine Fisheries, Series No 1. Mass Div of Marine Fisheries, MassDMF, 1997.

Figure 7-1a: TMDL: E. coli Rivers

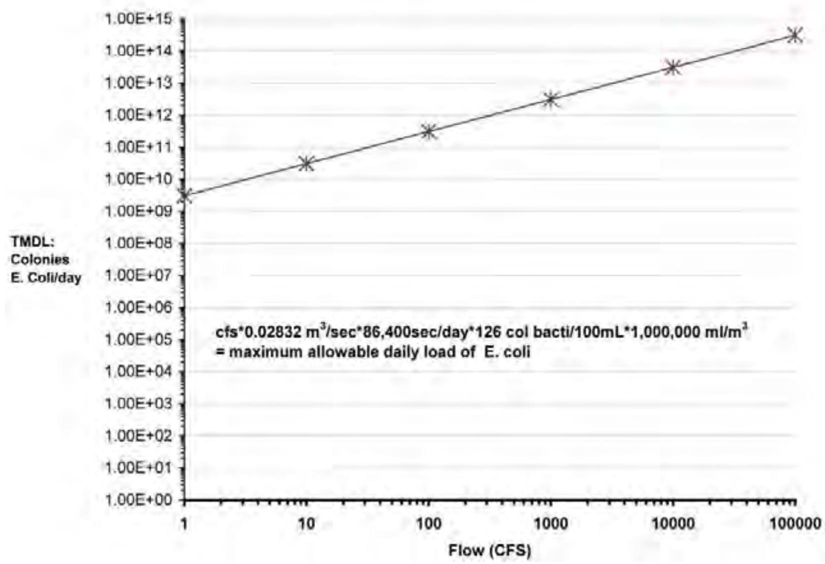


Figure 7-1b:TMDL: Entercoccus Rivers

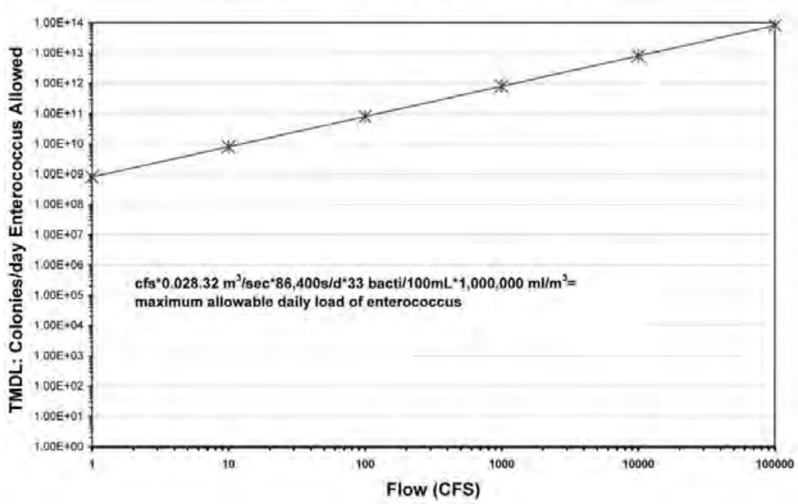


Table 7-3: WLA and LA TMDL By River Segment for the North Coastal Watershed (E. coli indicator in CFU/Day).

	TMDL Allocation[1]	FLOW, cfs					
Segment[2], Waterbody WQS Classification	WLA LA	1	10	100	1,000	10,000	100,000
Essex Bay System							
MA93-45, Alewife Brook, B	5.2%	1.61E+08	1.61E+09	1.61E+10	1.61E+11	1.61E+12	1.61E+13
	94.8%	2.93E+09	2.93E+10	2.93E+11	2.93E+12	2.93E+13	2.93E+14
Annisquam River System							
no river segments							
Salem Sound System							
MA93-47, Causeway Brook, B	17.0%	5.25E+08	5.25E+09	5.25E+10	5.25E+11	5.25E+12	5.25E+13
	83.0%	2.56E+09	2.56E+10	2.56E+11	2.56E+12	2.56E+13	2.56E+14
MA 93-29, Cat Brook, B	17.0%	5.25E+08	5.25E+09	5.25E+10	5.25E+11	5.25E+12	5.25E+13
	83.0%	2.56E+09	2.56E+10	2.56E+11	2.56E+12	2.56E+13	2.56E+14
MA93-36, Frost Fish Brook, B	17.9%	5.53E+08	5.53E+09	5.53E+10	5.53E+11	5.53E+12	5.53E+13
	82.1%	2.53E+09	2.53E+10	2.53E+11	2.53E+12	2.53E+13	2.53E+14
MA93-02, Crane Brook, B	27.5%	8.49E+08	8.49E+09	8.49E+10	8.49E+11	8.49E+12	8.49E+13
	72.5%	2.24E+09	2.24E+10	2.24E+11	2.24E+12	2.24E+13	2.24E+14
MA93-05, Goldthwait	31.5%	9.72E+08	9.72E+09	9.72E+10	9.72E+11	9.72E+12	9.72E+13
Brook, B	68.5%	2.11E+09	2.11E+10	2.11E+11	2.11E+12	2.11E+13	2.11E+14
MA93-39, Proctor Brook, B	27.6%	8.52E+08	8.52E+09	8.52E+10	8.52E+11	8.52E+12	8.52E+13
	72.4%	2.23E+09	2.23E+10	2.23E+11	2.23E+12	2.23E+13	2.23E+14
Saugus River System							
MA93-34 Saugus River, B	19.4%	5.99E+08	5.99E+09	5.99E+10	5.99E+11	5.99E+12	5.99E+13
	80.6%	2.49E+09	2.49E+10	2.49E+11	2.49E+12	2.49E+13	2.49E+14
MA93-30, Beaver Dam	12.5%	3.86E+08	3.86E+09	3.86E+10	3.86E+11	3.86E+12	3.86E+13
Brook, B	87.5%	2.70E+09	2.70E+10	2.70E+11	2.70E+12	2.70E+13	2.70E+14
MA93-35 Saugus River, B	16.5%	5.09E+08	5.09E+09	5.09E+10	5.09E+11	5.09E+12	5.09E+13
	83.5%	2.58E+09	2.58E+10	2.58E+11	2.58E+12	2.58E+13	2.58E+14
MA93-31, Mill River, B	17.7%	5.46E+08	5.46E+09	5.46E+10	5.46E+11	5.46E+12	5.46E+13
	82.3%	2.54E+09	2.54E+10	2.54E+11	2.54E+12	2.54E+13	2.54E+14
MA93-32, Hawkes Brook, A	17.3%	5.34E+08	5.34E+09	5.34E+10	5.34E+11	5.34E+12	5.34E+13
	82.7%	2.55E+09	2.55E+10	2.55E+11	2.55E+12	2.55E+13	2.55E+14
MA93-33, Hawkes Brook, B	20.1%	6.20E+08	6.20E+09	6.20E+10	6.20E+11	6.20E+12	6.20E+13
	79.9%	2.47E+09	2.47E+10	2.47E+11	2.47E+12	2.47E+13	2.47E+14
MA93-48, Bennetts Pond	20.1%	6.20E+08	6.20E+09	6.20E+10	6.20E+11	6.20E+12	6.20E+13
Brook, B	79.9%	2.47E+09	2.47E+10	2.47E+11	2.47E+12	2.47E+13	2.47E+14
MA93-50, Shute Brook, B	20.3%	6.27E+08	6.27E+09	6.27E+10	6.27E+11	6.27E+12	6.27E+13
	79.7%	2.46E+09	2.46E+10	2.46E+11	2.46E+12	2.46E+13	2.46E+14

[1] TMDL allocation: % surface area of segment watershed for WLA (impervious) and LA (pervious), respectively

[2] All Class A and B segments based on 126 E. coli/100ml water quality standard

For Embayment's

For embayment's the size of the watershed contributing to the flow must be accounted for. The following equation illustrates the calculation that applies to the estuarine segments.

Embayment TMDL = (1 acre) x (43,560 ft^2/acre) x ((2.0 ft (% pervious area) + 3.8 ft (% impervious area)/105 days)) x (7.48 gallons/ft^3) x (3.78 liters/gallon) x (Applicable WQ Standard cfu/100 ml) x (1000 ml/l)

Similar to the River TMDL calculation the embayment TMDL is proportion between the WLA and LA by multiplying the daily load by the percent impervious for the WLA, and by multiplying the daily load by the percent pervious for the contributing watershed for the LA. Table 7-4 summarizes the TMDL for the marine segments in the North coastal Watershed.

7.3.5 – Wasteload Allocations (WLAs) and Load Allocations (LAs)

There are several WWTPs and other NPDES-permitted wastewater discharges within the watershed. NPDES wastewater discharge WLAs are set at the WQS. In addition, there are numerous storm water discharges from storm drainage systems throughout the watershed. All piped discharges are, by definition, point sources regardless of whether they are currently subject to the requirements of NPDES permits. Therefore, a WLA set equal to the WQS will be assigned to the portion of the storm water that discharges to surface waters via storm drains.

WLAs and LAs are identified for all known source categories including both dry and wet weather sources for Class SA, SB, A, B segments within the North Coastal watershed. Establishing WLAs and LAs that only address dry weather indicator bacteria sources would not ensure attainment of standards because of the significant contribution of wet weather indicator bacteria sources to WQS exceedances. Illicit sewer connections and deteriorating sewers leaking to storm drainage systems represent the primary dry weather point sources of indicator bacteria, while failing septic systems and possibly leaking sewer lines represent the non-point sources. Wet weather point sources include discharges from storm water drainage systems (including MS4s) and sanitary sewer overflows (SSOs). Wet weather non-point sources primarily include diffuse storm water runoff.

7.3.6 Stormwater Contribution

Part of the stormwater contribution originates from point sources and is included in the waste load allocation, and part comes from non-point sources and is included in the load allocation of the TMDL. The fraction of the runoff load attributed to the waste load allocation is estimated from the fraction of the watershed that has impervious cover because storm water from impervious cover is more likely to be diverted, collected and conveyed to the receiving water by storm water collection systems than non-impervious areas. The fraction of the TMDL associated with the wasteload allocation was estimated, using MassGIS and the algorithm within it to estimate the extent of impervious surface. The wasteload allocation was then defined by multiplying the TMDL for each segment by the percent of imperviousness in each watershed. Likewise the load allocation was estimated using the percent pervious cover in each watershed. MassDEP believes this approach is conservative because it assumes that all runoff from

Table 7-4: WLA and LA TMDL By Embayment for the North Coastal Watershed (CFU/Day).

Segment[2], Waterbody WQS Classification	TMDL Allocation[1] WLA LA	WQS/Indicator (cfu/100mL)	Waterwshed size (Acres)	TMDL (cfu/day)	WLA	LA
Essex Bay System						
MA93-46, Alewife Brook, SA	5.2% 94.8%	F. coliform 14	1,923	6.29E+11	3.27E+10	5.97E+11
MA93-11, Essex River, SA	5.2% 94.8%	F. coliform 14	4,676	1.53E+12	7.96E+10	1.45E+12
MA93-16, Essex Bay, SA	4.3% 95.7%	F. coliform 14	9,499	3.14E+12	1.35E+11	3.00E+12
Annisquam River System						
MA93-28, Mill River, SA	17.1% 82.9%	F. coliform 14	236	6.77E+10	1.16E+10	5.61E+10
MA93-12, Annisquam River, SA	11.0% 89.0%	F. coliform 14	3,454	1.06E+12	1.17E+11	9.46E+11
MA93-57, Rockport Harbor, SB (formerly 93-17)	2.0% 98.0%	F. coliform 88	127	2.70E+11	5.40E+09	2.64E+11
MA93-18 Gloucester Harbor, SB	19.1% 80.9%	Fecal Coliform 88	2,757	4.86E+12	9.27E+11	3.93E+12
Salem Sound System						
MA93-19, Manchester Harbor, SB	8.4% 91.6%	Fecal Coliform 88	3,211	6.39E+12	5.36E+11	5.85E+12
MA93-08, Bass River, SA	29.5% 70.5%	Fecal Coliform 14	2,076	5.09E+11	1.50E+11	3.59E+11
MA93-04, Porter River, SA	23.0% 77.0%	Fecal Coliform 14	2,153	5.75E+11	1.32E+11	4.43E+11
MA93-41 Crane River, SA	26.5% 73.5%	Fecal Coliform 14	3,462	8.83E+11	2.34E+11	6.49E+11
MA93-01, Waters River, SA	42.1% 57.9%	Fecal Coliform 14	307	6.21E+10	2.61E+10	3.60E+10
MA93-42, North River, SA	28.6% 71.4%	Fecal Coliform 14	5,803	1.44E+12	4.12E+11	1.03E+12
MA93-09, Danvers River, SA	27.6% 72.4%	Fecal Coliform 14	16,454	4.14E+12	1.14E+12	2.99E+12
MA93-20, Beverly Harbor, SB	27.2% 72.8%	Fecal Coliform 88	19,078	3.03E+13	8.24E+12	2.21E+13
MA93-40, Proctor, SA (no shellfishing)[3]	27.6% 72.4%	Enterococci 35	3,295	2.07E+12	5.72E+11	1.50E+12
MA93-54, Salem Harbor, SB (MA93-21-08)	24.8% 75.2%	Fecal Coliform 88	4,384	7.19E+12	1.78E+12	5.41E+12
MA93-22, Marblehead Harbor, SA	27.6% 72.4%	Fecal Coliform 14	742	1.87E+11	5.15E+10	1.35E+11
MA93-55 Salem Sound, SA (MA93-25-08)	23.3% 76.7%	Fecal Coliform 14	30,221	8.04E+12	1.87E+12	6.16E+12
MA93-56, Salem Sound, SA (MA-93-25-08)	23.3% 76.7%	Fecal Coliform 14	30,221	8.04E+12	1.87E+12	6.16E+12
MA93-24, Nahant Bay, SA	29.2% 70.8%	Fecal Coliform 14	3,306	8.13E+11	2.37E+11	5.76E+11

Table 7-4: WLA and LA TMDL By Embayment for the North Coastal Watershed (CFU/Day) (Continued).

	TMDL Allocation[1]					
Segment[2], Waterbody WQS Classification	WLA LA	WQS/Indicator (cfu/100mL)	Waterwshed size (Acres)	TMDL (cfu/day)	WLA	LA
TMDL Allocation[1]						
Segment[2], Waterbody WQS Classification	WLA LA	WQS/Indicator (cfu/100mL)	Waterwshed size (Acres)	TMDL (cfu/day)	WLA	LA
Saugus River System						
MA93-49, Shute Brook, SA	20.3%	Fecal Coliform	1,837	5.07E+11	1.03E+11	4.04E+11
	79.7%	14				
MA93-43, Saugus River, SB	20.3%	Fecal Coliform	19,786	3.43E+13	6.97E+12	2.74E+13
	79.7%	88				
MA93-44, Saugus River, SB	20.3%	Fecal Coliform	20,017	3.47E+13	7.05E+12	2.77E+13
	79.7%	88				
MA93-51, Unnamed Tributary, SA	27.2%	Enterococci	871	2.20E+11	5.99E+10	1.60E+11
(no shellfishing)[3]	72.8%	35				
MA93-15, Pines River, SB	27.2%	Fecal Coliform	6,014	9.55E+12	2.60E+12	6.96E+12
	72.8%	88				
MA93-52, Lynn Harbor, SB	5.2%	Fecal Coliform	33,358	6.86E+13	3.57E+12	6.50E+13
	94.8%	88				
MA93-53, Lynn Harbor, SB	5.2%	Fecal Coliform	33,358	6.86E+13	3.57E+12	6.50E+13
	94.8%	88				

[1] TMDL allocation: % surface area of segment watershed ~~for WLA (impervious)~~ and LA (pervious), respectively

[2] Class SA calculations based on 14 fecal coliform/100ml, Class SB calculations based on 88 fecal coliform/100ml.

[3] Primary contact recreation standard applied to waterbodies that are not actively managed by DMF for shellfishing.

impervious areas actually makes it to the waterbody segment in question, which may or may not always be the case.

Land use information from MassGIS was used to estimate the extent of impervious surface for each impaired segment. For example land use associated with the Saugus River segment MA93-35 (B) at the USGS gage at the Saugus Ironworks is estimated to have 16.5% impervious land surface and 83.5% pervious. Thus, 16.5% of the acceptable bacteria load at a given flow is assigned as waste load allocation while 83.5% of the total load represents the load allocation. In this Class B segment (applicable E. coli standard is 126 cfu/100 ml) for which the average daily flow on the Saugus River at the USGS Gage, (Saugus MA) is 31.2 cfs, the allowable bacteria load for that day and location or segment is 9.6 x10^{10} E. coli /day (from Figure 7-1). Therefore, for that flow in the Saugus River at the USGS Gage at the Saugus

Ironworks, the waste load allocation is 1.6×10^{10} bacteria per day[9] (i.e., (0.165) x (9.6×10^{10} bacteria/day) and the load allocation is 8.0×10^{10} bacteria per day (i.e., (0.835) x (9.6×10^{10} bacteria/day).

Also as previously indicated, the allowable stormwater load for bacteria varies with receiving water flow. In order to calculate the allowable daily load (TMDL), flow must be taken into account. To estimate the flow for an ungaged location or segment, flows at a gage in the watershed or nearby watershed can be prorated based on drainage area. The USGS also has a web-based application at water.usgs.gov/osw/streamstats/ungaged.html for Massachusetts that incorporates ungaged flow estimations.

Using this procedure, as well as the procedures explained in sections 7.3.4 and 7.3.5, the wasteload allocations and load allocations for each river segment were calculated for varying flow regimes and are provided in Table 7-2a below while the wasteload allocations and load allocations for each marine segment based on contributing acreage are provided in Table 7-2b.

7.4 Application of the TMDL To Unimpaired or Currently Unassessed Segments

This TMDL applies to the 43 pathogen impaired segments of the North Coastal Watershed that are currently listed on the 2008 CWA § 303(d) list of impaired waters. MassDEP recommends however, that the information contained in this TMDL guide management activities for all other waters throughout the watershed to help maintain and protect existing water quality. For these non-impaired waters, Massachusetts is proposing “pollution prevention TMDLs” consistent with CWA § 303(d)(3).

The analyses conducted for the pathogen-impaired segments in this TMDL would apply to the non-impaired segments, since the sources and their characteristics are equivalent. The concentration waste load and/or load allocation for each source and designated use would be the same as specified herein. Therefore, the pollution prevention TMDLs would have identical waste load and load allocations based on the sources present and the designated use of the water body segment (see Table 7.1). Any discharge would need to be consistent with the applicable waste load allocations, as well as the antidegradation provision of the Massachusetts Water Quality Standards.

This North Coastal Watershed TMDL may, in appropriate circumstances, also apply to segments that are listed for pathogen impairment in subsequent Massachusetts CWA § 303(d) Integrated List of Waters. For such segments, this TMDL may apply if, after listing the waters for pathogen impairment and taking into account all relevant comments submitted on the CWA § 303(d) list, the Commonwealth determines with EPA approval of the CWA § 303(d) list that this TMDL should apply to future pathogen impaired segments. Any new construction that complies with state stormwater standards and permits is presumed to comply with antidegradation requirements of the state water quality standards.

7.5 Margin of Safety

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

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

7.6 Seasonal Variability

In addition to a Margin of Safety, TMDLs must also account for seasonal variability. Pathogen sources to North Coastal Watershed waters arise from a mixture of continuous and wet-weather driven sources, and there may be no single critical condition that is protective for all other conditions. This TMDL has set WLAs and LAs for all known and suspected source categories equal to the Massachusetts WQS independent of seasonal and climatic conditions. This will ensure the attainment of water quality standards regardless of seasonal and climatic conditions. Controls that are necessary will be in place throughout the year, protecting water quality at all times.

8.0 Implementation Plan

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

Elevated dry weather bacteria concentrations could be the result of illicit sewer connections, leaking sewer pipes, sanitary sewer overflows, or failing septic systems. These sources are illegal and must be eliminated, so first priority overall should be given to bacteria source tracking activities to investigate potential illicit bacteria sources in segments impaired by bacteria during dry weather. Tracking and remediation of dry weather bacteria sources is usually more straightforward and successful than tracking and eliminating wet weather sources. If illicit bacteria sources are found and eliminated it should result in a dramatic reduction of bacteria concentration in the segment in both dry and wet weather. A comprehensive program is needed to ensure illicit sources are identified and that appropriate actions will be taken to eliminate them. Guidance on eliminating illicit sources can be found in the following references: A Center for Watershed Protection Manual entitled*: Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments* which can be downloaded at: http://www.cwp.org/documents/cat_view/78-other-center-publications.html

Practical guidance for municipalities is provided in a New England Interstate Water Pollution Control Commission publication entitled Illicit Discharge Detection and Elimination Manual, A Handbook for Municipalities available at: http://www.neiwpcc.org/iddemanual.asp. (CWP 2004, NEIWPCC 2003).

Storm water runoff represents another potential major source of pathogens in the North Coastal watershed, and the current level of control is inadequate for standards to be attained in several segments. Improving storm water runoff quality is essential for restoring water quality and recreational uses. It may not be cost effective or even possible to track and identify all wet weather sources of bacteria, therefore segments impaired during wet weather should be evaluated for stormwater BMP implementation opportunities starting with intensive application of less costly non-structural practices (such as street sweeping, and/or managerial strategies using local controls). Periodic monitoring to evaluate the success of these practices should be performed and, depending on the degree of success of the non-structural storm water BMPs, more expensive structural controls may become necessary to meet water quality standards. This adaptive management approach to controlling stormwater contamination is the most practical and cost effective strategy to reduce pathogen loadings as well as loadings of other storm water pollutants (e.g., nutrients and sediments) contributing to use impairment in the North Coastal watershed.

Controls on several types of pathogen sources will be required as part of the comprehensive control strategy. Many of the sources in the North Coastal watershed including sewer connections to drainage systems, leaking sewer pipes, sanitary sewer overflows, and failing septic systems, are prohibited and must be eliminated. Individual sources must be first identified in the field before they can be abated. Pinpointing sources typically requires extensive monitoring of the receiving waters and/or tributary stormwater drainage systems during both dry and wet weather conditions. A comprehensive program is needed to ensure illicit sources are identified and that appropriate actions will be taken to eliminate them. The MassDEP, Saugus River Watershed Council (SRWC), Salem Sound Coastwatch (SSCW), DMF, EPA and communities within the North Coastal watershed have been successful in carrying out such monitoring, identifying sources, and in some cases, mobilizing the responsible municipality and other entities to begin to take corrective actions.

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

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

Table 8-1. Tasks.

Task	Organization
Writing TMDL	MassDEP
TMDL public meeting	MassDEP
Response to public comment	MassDEP
Organization, contacts with volunteer groups	MassDEP/Local watershed conservation groups
Development of comprehensive stormwater management programs particularly in close proximity to each embayment including identification and implementation of BMPs	North Coastal Watershed Communities
Illicit discharge detection and elimination (where applicable)	North Coastal Watershed Communities and local watershed conservation groups
Leaking sewer pipes and sanitary sewer overflows	North Coastal Watershed Communities
CSO management	North Coastal Watershed Communities
Inspection and upgrade of on-site sewage disposal systems as needed	Homeowners, North Coastal Watershed Communities (Boards of Health)
Organize implementation; work with stakeholders and local officials to identify remedial measures and potential funding sources	MassDEP, North Coastal Watershed Communities, local watershed conservation groups, and Massachusetts Bays National Estuary Program.
Organize and implement education and outreach program	North Coastal Watershed Communities and Massachusetts Bays National Estuary Program.
Write grant and loan funding proposals	North Coastal Watershed Communities, local watershed conservation groups, and

Task	Organization
	Massachusetts Bays National Estuary Program.
Inclusion of TMDL recommendations in Executive Office of Energy and Environmental Affairs (EOEEA) Watershed Action Plan	EOEEA
Surface Water Monitoring	MassDEP, North Coastal Watershed Communities, and local watershed conservation groups
Provide periodic status reports on implementation of remedial activities	MassDEP, North Coastal Watershed Communities, and local watershed conservation groups

8.1 Summary of Activities within the North Coastal Watershed

The North Coastal Watersheds Team has prepared a Five-Year Action Plan (Action Plan) to "serve as the strategic environmental planning document for the North Coastal Watersheds (NCW) Team. It is intended to provide a long-term vision for the watershed and to describe a set of overall goals and objectives. The Action Plan was developed in conjunction with representatives of a wide array of public watershed interests, via input at public meetings, on a website (www.NorthCoastal.net), through newspaper articles, and through videotaping at public events." (EOEA 2004). The implementation strategy of this pathogen TMDL is consistent with the Action Plan. The goals of the NCW [North Coastal Watershed] team and the Action Plan are:

1. Open Space: Foster Sustainable Development (people-oriented).
2. Habitat: Conserve habitat and wildlife (nature-oriented).
3. Water Quality: Improve water quality and water-related human health.
4. Water Quantity: Better water management / flood control.
5. Recreation: Foster recreational use of natural resources and economic growth related to recreation.
6. Outreach: Local capacity building, outreach, and education." (EOEA 2004)

Implementation of measures to meet North Coastal Watershed TMDL targets will proceed at the local level. Formerly, EOEEA's Massachusetts Watershed Initiative would have overseen the implementation of the Action Plan. With the dissolution of that Initiative, implementation will be accomplished in a more decentralized manner – primarily via local watershed groups, with some oversight and input from EOEEA and other Watershed Team representatives. (EOEA 2004). This approach is particularly appropriate for the North Coastal watershed as it consists not of a single river basin, but of many drainage sub-basins, each with their own particular conditions and problems. The MassDEP will work with local governments, the North Coastal watersheds Team plus local watershed and conservation organizations (such as Friends of Lynn Woods, Salem Sound Coastwatch, Saugus River Watershed Council, Eight Towns and the Bay, Chebacco Lake Association, Friends of Lake Quannapowitt, Wenham Lake Watershed Association, Massachusetts Audubon Society North Shore Chapter), MWRA, Massachusetts Bays National Estuary Program, USEPA, CZM – North Shore Regional Office and other team partners to make every reasonable effort to assure implementation of this TMDL

Please see the Action Plan available for download from the worldwide web at http://www.mass.gov/envir/water/publications.htm for more details on specific proposals and accomplishments to date.

In addition, the DEP, CZM, and EPA have sponsored various program (MWI, 319, 104(b)(3), 604(b), CPR (Coastal Pollution Remediation- CZM) grant projects related to controlling bacteria throughout the basin over the past decade.

With respect to the Mass. Watershed Initiative Grants program: (1) "Comprehensive Data Assessment in Selected Subwatersheds of the North Coastal Watershed"- a $49,992 project grant to Salem Sound 2000, which reviewed and compiled water quality and other information in four subwatersheds in the North Coastal drainage area and identify data gaps. The information was to be used in developing required Total Maximum Daily Loads (TMDL's) in each subwatershed, and informing/ educating municipalities and their respective departments and personnel as to general concepts/ solutions to nonpoint source pollution problems in communities within the four subwatersheds; (2) "Treating and Eliminating Untreated Sewage Discharges"- a $60,000 project award to URS Grenier Woodward Clyde, which developed and implemented a program to target and eliminate illicit sewer connections in selected subwatersheds in the basin, which consisted of a developed QAPP, actual dry weather outfall sampling, and a plan for removals; (3) "North Coastal Watershed Setting Priorities at the Sub-Watershed Level"- an $18,010 project to Salem Sound 2000, to piggyback the Comprehensive Data Assessment project, to hold a series of forums in the North River, Saugus River, Gloucester Harbor, and Smallpox Brook subwatersheds to present and prioritize the findings of the Comprehensive Data Assessment project; (4) "Technical Assistance for Stormwater Phase II Compliance"- a $47,305 project award to Vanasse Hangen Brustlin, Inc., to provide technical assistance to municipalities: to assist Lynn, Peabody, and Malden in assessing their status relative to stormwater Phase II regulations to assist Danvers, Gloucester, Marblehead, Salem, Saugus, Swampscott, Lynnfield, Melrose, Wakefield, Reading, and Revere on their Phase II planning.

With respect to the MassDEP 319 Grant program: (1) "A Demonstration Program to Mitigate Storm Drain Pollution Impacting shellfishing Beds", a $124,647 project to develop an innovative system called "StormTreat Systems",(one in Gloucester and one in Harwich) to treat stormwater before it enter shellfish beds by running it through a series of settling chambers, including an end chamber which is constructed wetland; (2) "Watershed Education Teaching (WET) Program", a $40,466 project which (a) introduces nonpoint source pollution into the science curriculum of schools located in the Charles River and North Coastal Basins who chose to enter into the WET program, and (b) integrates aspects of the Mass. Bays Comprehensive Conservation Management Plan into the same schools through an educators guide developed as part of the project; (3) " Demonstration of Innovative Stormwater Management Retrofit Systems"- a $175,370 project awarded to Center for Urban Watershed Renewal, which demonstrated retrofitting existing urbanized landscapes with BMP's to improve infiltration rates, filtering mechanisms, and water quality by installing a volume dependent stormwater retention planter, a vegetated infiltration system, and a vegetated roof at two sites on the North River in Salem.

With respect to the MassDEP 104(b)(3), and CZM Coastal Remediation Grants program: (1) a $61,700 project, ancillary to Bacteria related pollution, to apply a Wetlands Ecological Assessment method to elected sites in the basin by selecting wetlands adversely affected by stormwater pollution and initiating wetland mitigation efforts; (2) "Salem Sound Nutrient Monitoring"- a $14,584 Grant, ancillary to Bacteria related pollution, to conduct marine and fresh water life systems, and to conduct water quality monitoring in the Salem Sound area.; (3) "Wetlands Health Assessment Toolbox" a $34,110 project, ancillary to bacteria related pollution, to develop a wetlands health assessment toolbox which will look at wetland quality impacts resulting from new development/ changing land- uses.

With respect to the MassDEP 604(b) Grant program, project #02-01, "Shoreline Survey of Salem Sound", a $49,600 project to conduct an assessment (to update an earlier 1993 survey to measure effect of construction and sewer line repairs) via a series of surveys (stressing bacteria monitoring) of dry weather outfalls that are near shellfish beds and public swimming areas in harbor and estuarine areas stretching from Manchester Harbor to Salem Harbor/ Salem Sound.

On March 18, 2009, the U.S. Environmental Protection Agency (EPA) approved the state's proposal to designate the coastal waters of Revere, Saugus, Lynn, Nahant, and Swampscott as a vessel No Discharge Area (NDA). This ban on discharge of all boat sewage would also apply to the state waters of the Saugus and Pines Rivers. The designation is in response to the EOEEA nomination for NDA status, which was prepared by CZM, working closely with the five communities and Safer Waters in Massachusetts, an advocate for clean water across Massachusetts Bay. "Congratulations to everyone who helped make this NDA a reality, ensuring that the upcoming boating season will bring cleaner waters to the lower North Shore," said CZM Director Deerin Babb-Brott. "We are now one step closer to Governor Patrick's goal of declaring all of Massachusetts state waters as no discharge for boat sewage." (CZM 2009)

To assist local communities in their efforts to reduce bacterial contamination, The MassDEP implemented, over the past several years, a bacterial source tracking program. The primary goal was to implement bacteria source tracking in targeted, high- priority polluted areas (303(d) impaired list), where it is believed implementation solutions may result in improved water quality. This report, particularly in Section 4.0 Problem Assessment, has outlined past available bacteria related data, and there are at least several segments where the past data indicates high bacteria counts that would benefit from some source tracking efforts by this newly instated program. In particular, areas that should be considered for this sort of work are in the vicinity of beaches in the North Coastal Watershed that have had high counts in the recent past, such as Stramski Beach in Marblehead, Rice Beach in Beverly, Sandy Beach in Danvers, Juniper Beach in Salem, and Bennetts Brook in Manchester. Additionally, any of the "Priority Wet &/or Priority Dry" columns which were ranked "High" in Tables ES-1 and 6-1 would be prime candidates for possible bacteria source tracking work.

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

Study and Rehabilitation of Closed Coastal Shellfishing Beds

Shellfishing beds along most of the North Coastal watershed coast have been closed, but clamming on the beaches was once an integral part of those communities. While not confined to the North Coastal watershed, the Massachusetts Bays Comprehensive Conservation & Management Plan (MBP 2003) lists the following initiatives intended to protect and enhance shellfishing and the progress of these initiatives:

Conducted three Sanitary Survey Training Sessions annually-one each on the North Shore, Metro Boston/South Shore, and North Coastal Watershed-to educate local shellfish constables and health officers on the proper technique for identifying and evaluating pathogen inputs into shellfish harvesting areas (progress: full). Local partner: Division of Marine Fisheries

Developed and administer a local shellfishing Management Grants Program to help communities finance the development and implementation of affective local shellfish management plans (progress: substantial). Local partner: Division of Marine Fisheries

Continue and expand the shellfishing Bed Restoration Program to restore and protect shellfish beds impacted by non-point source pollution (progress: moderate). Local partner: shellfishing Bed Restoration Program

Through the shellfishing Clean Water Initiative, complete an Interagency Agreement defining agency roles and contributions to protect shellfish resources from pollution sources (progress: new). Local partner: Office of Coastal Zone Management.

8.2 Illicit Sewer Connections, Failing Infrastructure and CSOs

Elimination of illicit sewer connections, repairing failing infrastructure and controlling impacts associated with CSOs are of extreme importance. Several municipalities have already implemented programs, have programs in place, or are planning programs to eliminate sewage discharge from CSOs and/or illicit septic system connection to stormwater drains. For example:

Gloucester submitted a Final Combined Sewer Overflow Long- Term Control Plan in June 2005. This includes $ 14.6 million in system improvements (mainly sewer separation projects) which will substantially reduce CSO discharges events from 53 to 2 annually, and volumes from 25 million gallons to 0.44 million gallons annually. A Consent Decree (between the City, EPA, and DEP) in September 2005 set up a schedule to complete all the work by June 12, 2012.

Essex has entered into Consent Judgment to address the discharge of pollutants from the town's storm drainage facilities into Essex Coastal Waters. A source of these pollutants has been identified as failing septic systems that are directly or indirectly tied into the storm drainage system (EOEA 2004).

The Lynn Water & Sewer Commission (LWSC), DEP and EPA have agreed to a Second Modified Consent Decree (SMCD) in June 2001 (superseding a prior Consent Judgment) to eliminate all four CSOs (two discharges into Lynn Harbor, one to Kings Beach, and one into the Saugus River). This work is to be completed by December 31, 2009, costing $ 55 million dollars. A Supplemental CSO Facilities Plan includes an additional $ 55 million in I/I and sewer separation work which must complement the main SMCD work.

Peabody has conducted a comprehensive inventory of the City’s existing stormwater facilities. As a result of this effort, three residential septic systems were disconnected from the storm sewer. Peabody is committed to repairing sewer/storm drain cross-connections as they are discovered (Peabody 2002).

Implementation of the Stormwater Phase II Final Rule requires that municipalities detect and eliminate sewage discharges to storm sewer systems including illicit sewer connections (USEPA 2000).

Implementation of this rule will thus help communities achieve bacteria TMDLs. In 2001, the North Coastal Watersheds Team contracted with an engineering consultant to conduct a series of workshops and provide technical assistance to 15 watershed municipalities for their implementation of NPDES Stormwater Phase II compliance. MassDEP Phase II coordinators have been provided with all of the materials developed and presented by engineering consultant in their series of workshops on Technical Assistance for NPDES Stormwater Phase II Compliance. "These materials and follow up assistance should allow MassDEP to better serve the North Coastal watershed communities with timely and up to date assistance consistent with their needs and progress towards meeting Phase II compliance." (EOEA 2004).

Elimination of illicit sewer connections and repairing failing infrastructure are of extreme importance. EPA's Phase II rule specifies an MS4 community must develop, implement, and enforce a storm water management program that is designed to reduce the discharge of pollutants to the maximum extent practicable, protect water quality, and satisfy the applicable water quality requirements of the Clean Water Act. Illicit discharge detection and elimination (IDDE) is one of the six minimum control measures that must be included in the storm water management program. The other control measures are:

- Public education and outreach on storm water impacts
- Public involvement and participation
- Construction site storm water runoff control
- Post-construction storm water management in new development and redevelopment
- Pollution prevention and good housekeeping for municipal operations

As part of their applications for Phase II permit coverage, MS4 communities must identify the best management practices they will use to comply with each of these six minimum control measures and the measurable goals they have set for each measure.

In general, a comprehensive IDDE Program must contain the following four elements:

1) Develop (if not already completed) a storm sewer system map showing the location of all outfalls, and the names and location of all waters of the United States that receive discharges from those outfalls.

2) Develop and promulgate municipal regulations that require the municipality to comply with Phase II regulations including prohibition of illicit discharges and appropriate enforcement mechanisms.

3) Develop and implement a plan to detect and address illicit discharges, including illegal dumping, to the system. EPA recommends that the plan include the following four components: locating priority areas; tracing the source of an illicit discharge; removing the source of an illicit discharge; and program evaluation and assessment.

4) Inform public employees, businesses, and the general public of hazards associated with illegal discharges and improper disposal of waste. IDDE outreach can be integrated into the broader stormwater outreach program for the community. Fulfilling the outreach requirement for IDDE helps the MS4 community to comply with this mandatory element of the stormwater program.

Communities that are not covered under the Phase II rule (i.e., not designated as MS4 communities) are encouraged to implement a program for detecting and eliminating sewage discharges to storm sewer systems including illicit sewer connections. Implementation of the Phase II rule (USEPA 2000), whether voluntarily or mandated will help communities achieve bacteria TMDLs.

Guidance for implementing an illicit discharge detection and elimination program is available from several documents. EPA New England developed a specific plan for the Lower Charles River (USEPA 2004a) to identify and eliminate illicit discharges (both dry and wet weather) to their separate storm sewer systems. Although originally prepared for the Charles River watershed it may be applicable to other watersheds throughout the Commonwealth, however, it represents just one of the approved methodologies available. More generic guidance is provided in a document prepared for EPA by the Center for Watershed Protection and the University of Alabama entitled Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments which can be downloaded from:http://www.cwp.org/documents/search_result.html .

In addition, practical guidance for municipalities is provided in a New England Interstate Water Pollution Control Commission publication entitled Illicit Discharge Detection and Elimination Manual, A Handbook for Municipalities available at: http://www.neiwpcc.org/iddemanual.asp. Implementation of the protocol outlined in these guidance documents satisfies the Illicit Discharge Detection and Elimination requirement of the NPDES program.

A list of the municipalities in Massachusetts regulated by the Phase II Rule, as well as the Notices of intent for each municipality can be viewed: http:/www.epa.gov/region01/npdes/stormwater/ma.html.

8.3 Stormwater Runoff

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

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

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

The NPDES permit does not, however, establish numeric effluent limitations for stormwater discharges. Maximum extent practicable (MEP) is the statutory standard that establishes the level of pollutant reductions that regulated municipalities must achieve. The MEP standard is a narrative effluent limitation that is satisfied through implementation of SWMPs and achievement of measurable goals.

Non-point source discharges are generally characterized as sheet flow runoff and are not categorically regulated under the NPDES program and can be difficult to manage. However, some of the same principles for mitigating point source impacts may be applicable. Individual municipalities not regulated under the Phase I or II should implement the exact same six minimum control measures minimizing stormwater contamination. In addition, the North Coastal Watersheds Five-Year Action Plan lists the following recommendations to decrease the occurrence of stormwater acting as a non-point source of pathogens (EOEA 2004):

Address pet waste as a water quality issue. People are generally unaware of the connection between pet waste and water quality as well. A brochure on this subject can be found at http://www.mass.gov/dep/water/resources/petwaste.htm.

Reduce public geese feeding, especially along lakes where both geese and people congregate. Goose waste is a major source of bacterial runoff.

Provide technical and funding assistance for the implementation of municipal stormwater plans and ensure that consent judgments are completed in a timely manner. Efforts should be prioritized within the four targeted watersheds of the Saugus River, Salem Sound, Gloucester Harbor, and Smallpox Brook.

Encourage communities and watershed groups to take advantage of the U.S. Department of Agriculture's Natural Resources Conservation Service interest in working with communities to identify sources of stormwater contamination, and evaluate remedial options. They can meet with communities to determine goals and problems, conduct watershed site visits, help them set priorities, carry out demonstration projects, and help prepare applications for funding through various grant programs (EOEA 2004).

Educate communities to consider permit and development strategies that address stormwater runoff – implementing BMPs that reduce runoff, beneficial stormwater recharge, buffer zones, and Low Impact Development (LID) in general.

Under a 2002- 2003 grant from the Executive Office of Energy and Environmental Affairs (EOEEA, formerly EOEA) to the Department of Environmental Protection's Massachusetts Watershed Initiative (MWI) Program, the Vanasse Hangen Brustlin, Inc. (VHB) project team provided technical assistance to 15 communities within the North Coastal Region to begin their efforts towards the development of a Plan to achieve compliance with EPA's NPDES Stormwater Phase II Regulations. The 15 communities included in the project are Gloucester, Beverly, Marblehead, Danvers, Salem, Peabody, Swampscott, Lynn, Lynnfield, Melrose, Reading, Wakefield, Saugus, Malden and Revere. A letter was sent to each of these communities inviting them to participate in the Phase II technical assistance workshops to be completed by VHB.

VHBs efforts focused on assessing the existing Stormwater Management efforts in the communities and assisting the towns in prioritizing their planning and coordination tasks to facilitate the development of their compliance plans. Assistance included the following: (1) a binder included a variety of training and resource materials; (2) VHB conducted initial workshops for representatives from the communities to provide baseline education relative to the Phase II program and its requirements; (3) VHB prepared Powerpoint presentations highlighting the key elements of the overall NPDES Phase II Stormwater Regulations as well as individual presentations for each of the six minimum measures required under the regulations; (4) VHB developed and distributed a Stormwater Management questionnaire (both in hard copy and on a CD) to each community during the initial workshops and asked them to fill it out prior to the second training session; (5) VHB developed three matrices to assist the municipalities in organizing what programs they currently have in place that fulfill some, or part, of the six minimum requirements; (6) VHB conducted follow-up training workshops to discuss the findings of the Stormwater Questionnaires with the individual towns; (7) VHB inventoried each of the 15 communities' status with respect to GIS mapping of stormwater systems; (8) VHB refined the original matrices developed during the training sessions to be expanded and more useful as a standalone process without in-depth coaching. The five step process, formalized into a plan for the community was comprised of: (A) Town regulations review; (B) Questionnaire of current practices; (C) Assessment of current practices; (D) Expanded or new recommended practices; (E) The Five Year Plan. Three of the project communities; Gloucester, Salem and Wakefield responded to the offer for additional technical assistance. Two meetings were held with Gloucester, one with Salem, and 3 were held with Wakefield.

Stormwater Phase II Annual Reports from the various communities were last received in May 2008. Indications are that substantial progress is being made, particularly with certain communities, on those aspects of the six point plan requirements that would address bacteria pollution. A brief review is made herein on various communities in the watershed and their progress:

Beverly- Public education on stormwater efforts is included in Consumer Confidence Reports mailed out to all residents annually. The Stormwater Management Plan was advertised by the high school ecology club at the annual Landmark Shore Country Day Celebration. The City posts bacteria beach testing results on its website. Dog waste disposal procedures are included in annual notices to all dog owners, as well as waste disposal sign postings in public parks. A SWMP review is done via TV coverage once annually at the City Council meetings. A stormwater advisory committee meets 1- 2 times per year. The stormwater collection system with all major outfalls has been mapped on GIS. All outfalls were inspected by the end of 2006, and as of January 2008, a number of dry weather outfalls had been sampled, with data result reporting coordinated between Salem Sound and the town's consultant, Horsley-Whitten. The City's Stormwater Ordinance on illicit connections was adopted by the City Council in April, 2008. One to two percent of all dry weather outfalls are being sampled each year. A plan has been developed to target illicit connections and remove them. An inventory of sensitive receptor areas has been developed as part of housekeeping practices. Street sweeping is carried out on all roads once per year, and twice per year on major arteries. The town has set a goal of cleaning all catch basins once per.

Danvers- Public education on stormwater efforts includes a stormwater newsletter with updated information on relevant town regulations ("What's in the Works") sent to all residents each year between 2003 and 2008. Fact sheets on dog waste disposal are sent out in annual dog license renewal reminders to residents. The town's website posts information on stormwater. There is an annual progress update on implementation of the town's stormwater management plan once per year at the selectman's meeting. A stormwater advisory committee meets twice yearly. A number of dry weather outfalls were sampled in 2004, but none were sampled in 2005-6. The stormwater conveyance/ outfall system has been mapped in GIS, and is available to the public. One illicit connection was removed in 2005 (at 117 Liberty St.), and after a DEP NON was issued 7/2007, an outfall problem at Glen Ave. was fixed. The sewer connection by-law is being enforced by conducting inspections. A total of 92 new connections were approved in 2007. With housekeeping, an inventory of sensitive receptors has been created. Street sweeping is done once annually, and up to 1,200 catch basins are cleaned annually (covering 1/3rd of the town).

Essex- A major sewering project in a large part of Essex was completed in 2006 along with the tie in of many septic systems (that were failing) into these sewer lines. These sewer lines convey sanitary waste to the Gloucester WWTP facility. The town completed assessments of all septic systems and owners were sent notices to alert them to the capability of connecting with the newly installed sewer lines. Most illicit connections into stormwater lines have also been stopped by the process of blockage of any non- permitted drain lines. These actions should result in significant improvements in bacteria related water quality conditions in the future. Also, several outfall locations are being repaired. Along with these actions, a much stricter illicit connection by-law has been passed. Housekeeping include street sweeping and catch basin cleaning in the fall of each year. During 2006-2007 a new catch basin inspection and follow-up repair program was initiated, with a total of six catch basins replaced or repaired during each of these two years.

Gloucester- Stormwater outreach has occurred in schools along with the posting of educational literature in various town department bulletin boards and at the town library. An Adopt-a-Stream program was developed in 2005, with the intent of conducting pond and stream cleanups, and monitoring. Cleanup and water quality monitoring, through the Gloucester High School Environmental Club "Generation Conservation" Program, and the Eight Towns & the Bay Organization, has occurred during 2006-2008. Efforts focused on the Mill Pond/River areas. A stormwater steering committee was formed in 2004, which meets quarterly. All city departments are actively engaged in investigating illicit discharges, particularly on city lands. Much of the MS4 stormwater conveyances have been inspected by TV camera, and many have been cleaned. A consultant was hired in 2005-2006 to conduct a special $150,000 project to map all conveyances, outfalls, and manholes on GIS. As a follow-up to this effort, a consultant helped the City during 2007 to inspect 520 manholes, conduct building inspections on 1,140 residences or commercial establishments, and conduct 370 dye- tests. As a result, 17 illicit connections were discovered and eliminated. A septic system inspection/ monitoring program, with noncompliance enforcement efforts is part of the overall stormwater effort. Housekeeping includes street sweeping once per year on all roads, as well as bi-weekly on certain main arteries. A catch basin cleaning program commenced in 2003, and this effort has been enhanced with the addition of two new street (vacuum) sweeper trucks. In 2007, 750 catch basins were cleaned and efforts were initiated to begun to repair or replace up to 10 catch basins per year.

Lynn- The stormwater pollution control program is directed by the Lynn Water and Sewer Commission, which is currently under a Second Modified Consent Decree to eliminate all its four CSO's by 2020. An $80 million supplemental facilities plan will construct new sewer/stormwater (separate) systems and storage conduits/flow control structures, as well as facilitate infiltration/ inflow removal. The city reports that this effort comprises the major portion of its Phase II activities. National Water Main Cleaning Company was hired in 2007 and 2008 to embark on video inspection, illicit connection detection, as well as storm line cleaning. Housekeeping efforts include street sweeping of all streets 3 times per year, and catch basin cleaning once per year. In 2007, an overall effort began to repair damaged catch basins, as well as clearing and cleaning all stormwater conduits by water jetting, snaking, and root eradication procedures. Citizen efforts including stormwater public education, stenciling, stormwater forums, startup of watershed committees, and training for employees began in 2007. The appendix section of the 2007 town annual report lists 62 various stormwater rules and regulations, as well as a section on applicable stormwater detention basin BMPs and procedures for their upkeep.

Lynnfield- Stormwater related information is broadcast on the local cable channel, as well as regularly mentioned in the town website. A stormwater brochure has been developed and placed in major town offices, as well as in the town library. A stormwater advisory committee meets twice a year. As of the

2007 report, the town engineering department was making progress in verifying and mapping all stormwater conveyances and outfalls. An illicit connection detection and elimination draft plan and by- law was put together in 2007, with formal adoption expected during 2008 at town meeting. Housekeeping activities include annual street sweeping, and the annual cleaning of 1,500- 2,100 catch basins.

Malden- Public outreach and education efforts include an explanation of the city's stormwater management plan on the town website. There is an active pet waste management program, which includes a tracking effort to control violators. The stormwater management committee often discusses the progress of pet waste control efforts at its meetings. Two pet waste stations have been established near Fellsmere Pond. Malden Access Cable TV broadcasts information on stormwater programs. The Beebe School curriculum (e.g. English, and other subjects) has mini- modules on stormwater concepts. An active stormwater management plan review committee meets bi- monthly, and reports annually on its work progress at town meeting. A consultant was hired to map the stormdrain system, verify outfall locations, and identify and control illicit connections. A draft ordinance on control of illegal discharges to municipal stormwater lines was drafted, considered for adoption in 2007. During 2006 - 2008 an outfall monitoring effort was conducted to find illicit connections into the Malden River, Spot Pond Brook, Town Line Brook, and on portions of DCR properties. The illicit connection detection program is well integrated with the routine catch basin and conveyance inspection program. Between 2004 - 2007, there were 2 sewer rehabilitation projects awarded (grant # 2004 S-1, and 2007 S-1), totaling $2.5 million, to remove 1.1 million MGD of infiltration/ inflow (I/I) from the sewer system. In 2007 - 2008, regular housekeeping efforts were carried out on a regular basis throughout the year involving street sweeping and basin cleaning activities.

Manchester- Stormwater public education efforts include the preparation of stormwater information flyers and their distribution through one mailing to all residents. Stream team debris cleaning occurred in December of 2004 and 2005 on Sawmill Brook and Causeway Brook. Stakeholders, consisting of stream teams, have discussed water quality issues and concerns with the Conservation Commission at their meetings. GIS mapping of all stormdrain was completed as of September, 2007. Illicit connection detection and control policy regulations were developed in 2008. In 2008, 45 property owners were informed that they need to repair their septic systems.

Marblehead- Stormwater literature is distributed one day per year at an information booth at a local farm stand. Stormwater related brochures are available in the town library. Pet waste barrels were added to all the public parks in 2003. All stormwater outfalls and their receiving waters have been mapped. A draft stormwater illicit connection by- law was drafted. Two dry weather outfall sampling runs were conducted in 2006. During 2007, dry weather outfall testing (with TV inspections) occurred on Stramsky Way to attempt to find illicit connections. Future efforts of illicit connection detection will include TV video inspections of as much of the stormwater system as possible, with detection of unauthorized connections, and follow-up removals. The sewer department has persuaded 5 private developers (projects) to put in stormwater treatment systems as part of their construction projects. Housekeeping includes street sweeping twice per year, and starting in 2007, up to 2000 catch basins were cleaned each year.

Melrose- Public education efforts on stormwater include: stormwater pollution control related information sent out once annually in water/sewer bills; distribution of stormwater brochures throughout the city; producing a stormwater page on the town website; manning a stormwater information booth at the city 'Victorian' annual fair; placing pet waste signs in all public parks and athletic fields; broadcast once per year on the town cable station of the EPA program, "Reining in the Storm, One Building at a Time"; and participating in an Ell Pond annual cleanup. During 2007, a debris cleanup occurred on Swains Pond. The Ell Pond Restoration Committee is planning more aggressive cleanup and protection efforts in 2008 (e.g., the identification and removal of illicit connections). The city's stormwater management plan progress is discussed annually at a (televised) alderman's meeting. The engineering department has mapped the stormwater collection system and outfalls on GIS. There are plans in the works to identify and remove all non- stormwater discharges going into stormwater conveyances. There are a number of illicit discharges that have been already removed from stormwater systems. An illicit connection by-law has been drafted, and it specifically includes inspection of new construction for proper sewer connections, as well as inspections of established buildings. Housekeeping includes street sweeping of all streets in the spring, plus twice weekly in commercial districts. As of 2007, 75% of all catch basins were cleaned annually.

Peabody- A stormwater brochure has been developed and mailed out to all residents. Stormwater information is found on the town's website, and there are stormwater related news spots on the local cable channel. Signs have been posted in public parks and recreation areas about proper procedures for animal waste disposal. There has been some town effort to coordinate pollution related cleanup efforts on the North River. Friends of Peabody's Lakes meets monthly to coordinate activities to improve water quality on Peabody's waterways. The GIS stormwater mapping effort (90% complete) has identified 8,000 drain structures as of April 2008. The illicit connection detection program is discovering illicit discharges and eliminating them (e.g., an illicit connection to the stormwater lines discovered at 11 Connally Terrace). As of 2008, all streets are being swept once per year, and 75% of catch basins are cleaned each year.

Revere- Public education includes a partnership between the town, the school department, and the Saugus River Watershed Council (SRWC) to develop a website, various stormwater related brochures, and visit many of the schools to present stormwater related informational programs. SRWC has led the formation of watershed committees for the Revere parts of the Mystic River, Saugus River, and Belle Isle Marsh. SRWC also led a cleanup effort in Town-Line Brook, as well as volunteer monitoring efforts on Town-Line Brook, Sales Creek, and Belle Isle Marsh. In 2006, illicit connection and detection efforts included completion of storm drain maps on GIS, a cross- connection inspection effort by the Building Department and plumbing inspector, and storm drain inspection efforts by the DPW Sewer/Drain crew. As of 2007, the town has an RFP in place for engineering services to increase illicit connection and detection inspection efforts. Housekeeping included pet waste disposal brochures are being developed and distributed. A more active street sweeping and catch basin cleaning effort was implemented in 2006.

Salem- Stormwater public education efforts include an interface between the Salem Sound Coast Watch (SSCW) and the community. The organization provides a website where the town can post stormwater related information and data that has been collected (by the BOH on beaches). The SSCW sponsors beach cleanups (including an annual coast beach sweep cleanup), volunteer WQ monitoring, and it publishes the results every two weeks on its website. A 'No Discharge Zone' application for Salem Harbor was filed with the State in January, 2007, and it was formally approved in April, 2009. The town conducts dry weather flow visual surveys of outfalls each year including weekly sampling at 18 locations between June 22 and August 10 each year. During Summer 2007, the SSCW Clean Beaches and Streams Program conducted volunteer monitoring efforts throughout the area. There has been a complete review of existing ordinances related to stormwater, with portions added on non-stormwater discharges to stormwater conveyances. In 2005 - 2006, the town sponsored a special BMP study of Juniper Beach to mitigate nonpoint source pollution and illicit connections to the beach area. A duckbill tide gate was constructed on a Juniper Beach outfall to alleviate pathogen pollution. In 2007 - 2008, a proactive illicit connection detection program within the MS4 areas commenced. Documentation indicates that a number of illicit connections were found and corrected. Housekeeping consists of street sweeping and catch basin cleaning "as needed".

Saugus- Public education on stormwater public outreach included a flyer from the Consumer Confidence Report on stormwater that was mailed to all residents in 2006. Other educational efforts include: pet waste signs posted in public parks; annual review of town stormwater management plan progress at a televised selectmen's meeting; staffing a table with stormwater literature at the annual Founder's Day; and providing in-kind services for the annual Saugus River cleanup. All stormwater outfalls were mapped by in GIS by 2007. 2007 also marked the beginning of an aggressive illicit connection detection effort which found a number of illicit connections that have since been corrected. A plan was instituted to remove non-stormwater discharges from stormwater lines, but, as of 2007, few have been actually found. A draft by-law to control illegal discharges to the MS4 stormwater system was in the process of being reviewed by the town's attorney in 2008. Street sweeping is done on all streets twice per year, and 50% of all catch basins are cleaned each year. Housekeeping activities also identified a list of sensitive receptors for priority attention (including Saugus R., Rumney Marsh, Lynn Reservoir).

Swampscott- Stormwater public education outreach efforts consist of the display of stormwater posters in the town hall, library, and schools. Stormwater announcements periodically appear on the local cable channel. As of 2008, there had been significant efforts with illicit connection detection efforts undertaken: mapping of all conveyances and outfalls; storm drain outfall inspections and testing, which found 24 significant outfalls (including dry weather flows) to coastal waters; smoke and dye testing of 41,150 linear feet of storm lines in 2004, as well as TV inspections of 15,000 linear feet the same year; two rounds of dry weather outfall sampling each year; and annual inspections of a number of sewer manholes. Dry weather outfall monitoring occurred in beach areas during 2006 and 2007. A stormwater by-law, including regulations on illicit connections was developed by town officials in 2006, and was expected to be enacted in 2007 or 2008. Housekeeping includes identifying and mapping sensitive areas for future priority efforts, street sweeping twice per year, and catch basin cleaning of 100% of the basins each year.

Wakefield- Stormwater public education accomplishments include: materials, brochures, and press releases placed on a stormwater related page in the town's website; town cable TV stormwater related ads, programs, and permit information; a fact sheet display in the town public library; and signage regarding proper disposal of pet waste placed in all public parks. All Phase II MS4 areas, including major outfalls, have been mapped. Criteria for illicit detection controls have been incorporated into existing town by- laws. In 2007, an illicit connection summary report was produced, with outfall maps showing suspect locations, and evaluations made as to possible impacts to receiving waters. A study was completed in 2006 comparing neighboring town's by-laws on stormwater controls (including illicit connection criteria). From this study, a town by-law on stormwater was developed in 2007 and approved in town meeting in April, 2008. The by-law contains regulations governing connections that are allowed, versus those that are prohibited. Housekeeping efforts have included an identification of sensitive areas, and a prioritization of street sweeping and catch basin cleaning activities within these sensitive areas. The Town 2007 and 2008 Annual Reports have a detailed list of 269 reference sources for any interested citizens on stormwater pollution controls and BMPs in the appendix section of those reports.

8.4 Failing Septic Systems

Septic system bacteria contributions to the North Coastal watershed may be reduced in the future through septic system maintenance and/or replacement. Additionally, the implementation of Title 5, which requires inspection of private sewage disposal systems before property ownership may be transferred, building expansions, or changes in use of properties, will aid in the discovery of poorly operating or failing systems. Because systems which fail must be repaired or upgraded, it is expected that the bacteria load from septic systems will be significantly reduced in the future. Regulatory and educational materials for septic system installation, maintenance and alternative technologies are provided by the MassDEP on the worldwide web at: http://www.mass.gov/dep/water/wastewater/septicsy.htm. In addition, the North Coastal Watersheds Five-Year Action Plan recommends innovative use of the State Revolving Fund for septic improvement and publicizing the income tax credit for septic improvement to increase its use (EOEA 2004).

Individual municipalities have also taken steps to eliminate failing on-site septic systems as a source of pathogens to the watershed. In 2001, the town of Rockport received a Determination of Insignificance from the Massachusetts Water Resources Commission for the interbasin transfer of wastewater from the Long Beach section of Rockport to the city of Gloucester's wastewater treatment system. This transfer would eliminate a long-standing pollution problem attributed to poor individual subsurface disposal facilities. Gloucester has aggressively worked to manage its on-site septic systems. City sewers have been installed in West Gloucester to replace on-site septic systems and a plan developed to identify areas for further sewering (EOEA 2004). The town of Essex has eliminated a great number of failing septic systems altogether, through a sewer construction program and recent tie-in with the Gloucester WWTP.

8.5 Wastewater Treatment Plants

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

Information presented in MassDEP's *North Coastal Watershed 1997/1998 Water Quality Assessment Report* and the *North Coastal Watersheds Five-Year Action Plan* indicate that considerable progress has been made in eliminating wastewater treatment plant discharges as a source of human pathogens to the watershed. The *North Coastal Watersheds Five-Year Action Plan* also recommends the development and implementation of plans to:

- provide technical and financial support to municipalities to improve compliance with all wastewater regulations, permits, consent orders, etc., and,
- provide technical support to help insure that all POTWs required to have a Local Limits program have one with a robust set of limits that address all water quality issues in their receiving waters and an enforcement program that insures compliance with all applicable limits (EOEA 2004).

8.6 Recreational Waters Use Management

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

- petitioning the State for the designation of a No Discharge Area (NDA),
- supporting installation of pump-out facilities for boat sewage (wastes collected are then transported and properly disposed of at a nearby WWTP),
- educating boat owners on the proper operation and maintenance of marine sanitation devices (MSDs), and
- encouraging marina owners to provide clean and safe onshore restrooms and pump-out facilities.

NDAs are designated by the Commonwealth of Massachusetts and approved by the EPA to provide protection by Federal Law prohibiting the release of raw or treated sewage from vessels into navigable waters of the U.S. The law is enforced by the Massachusetts Environmental Police. Massachusetts State Representative Bill Strauss has introduced legislation that would clearly define the role of harbormasters and other coastal police officers in enforcing NDAs and would allow them to collect up to $2000 for violations in NDAs (CZM 2009).

8.7 Funding/Community Resources

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

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

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

9.0 Monitoring Plan

The long term monitoring plan for the North Coastal watershed includes several components:

- continue with the current monitoring of the North Coastal watershed (local watershed conservation organizations, local governments, DFM),
- continue with MassDEP watershed five-year cycle monitoring (bacteria will be a priority in the next round of monitoring and assessment for the segments covered in this report),
- monitor areas within the watershed where data are lacking or absent to determine if the waterbody meets the use criteria,
- monitor areas where BMPs and other control strategies have been implemented, or discharges have been removed to assess the effectiveness of the modification or elimination,
- assemble data collected by each monitoring entity to formulate a concise report where the basin is assessed as a whole and an evaluation of BMPs can be made, and
- add/remove/modify BMPs as needed based on monitoring results.

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

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

10.0 Reasonable Assurances

Reasonable assurances that the TMDL will be implemented include both application and enforcement of current regulations, availability of financial incentives including low or no-interest loans to communities for wastewater treatment facilities through the State Revolving Fund (SRF), and the various local, state and federal programs for pollution control. In addition, when developing the TMDL no point sources were assigned a less stringent WLA based on reductions from nonpoint sources. Storm water NPDES permit coverage is designed to address discharges from municipal owned storm water drainage systems. Enforcement of regulations controlling non-point discharges includes local enforcement of the state Wetlands Protection Act and Rivers Protection Act, Title 5 regulations for septic systems and various local regulations including zoning regulations. Financial incentives include Federal monies available under the CWA Section 319 NPS program and the CWA Section 604b and 104b programs, which are provided as part of the Performance Partnership Agreement between MassDEP and the EPA. Additional financial incentives include state income tax credits for Title 5 upgrades, and low interest loans for Title 5 septic system upgrades through municipalities participating in this portion of the state revolving fund program. State monies are also available through the Massachusetts Office of Coastal Zone Management's Coastal Pollutant Remediation, Coastal Nonpoint Source Pollution Control, and Coastal Monitoring grant programs. The primary goal of all three programs is to improve coastal water quality by reducing or eliminating nonpoint sources of pollution. A brief summary of many of MassDEP's tools and regulatory programs to address common bacterial sources is presented below.

Overarching Tools

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

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

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

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

ADDITIONAL TOOLS TO ADDRESS COMBINED SEWER OVERFLOWS (CSO'S)

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

All permits for a CSO discharge must comply with Massachusetts Surface Water Quality Standards at 314 CMR 4.00. The water quality standards establish goals for waters of the Commonwealth, and provide the basis for water quality-based effluent limitations in NPDES permits. Any discharge, including CSO discharges, is allowed only if it meets the criteria and the antidegradation standard for the receiving segment. EPA's 1994 CSO Control Policy revised some features of its 1989 version to provide greater flexibility by allowing a minimal number of overflows, which are compatible with the water quality goals of the Clean Water Act. MassDEP's 1995 regulatory revisions correspondingly decreased reliance on partial use designation as the sole regulatory vehicle to support CSO abatement plans[10].

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

---

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

As untreated CSOs cause violations of water quality standards, and thus are in violation of NPDES permits, all of the state's CSO permittees are under enforcement orders to either eliminate the CSO or plan, design, and construct CSO abatement facilities. Each long-term control plan must identify and achieve the highest feasible level of control. The process also requires the permittee to comply with any approved TMDL. Presently, there are twenty–four (24) CSO communities in the Commonwealth.

Additional Tools to Address Failed Septic Systems

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

Additional Tools to Address Stormwater

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

Federal Phase 1 & 2 Stormwater Regulations: Existing stormwater discharges are regulated under the federal and state Phase 1 and Phase II stormwater program. In MA there are two Phase 1 communities, Boston and Worcester. Both communities have been issued individual permits to address stormwater discharges. Communities in the North Coastal Watershed that are included under Phase II include: Beverly, Danvers, Essex, Gloucester, Lynn, Lynnfield, Malden, Manchester, Marblehead, Melrose, Peabody, Revere, Salem, Saugus, Swampscott, and Wakefield. Phase II is intended to further reduce adverse impacts to water quality and aquatic habitat by instituting use controls on the unregulated sources of stormwater discharges that have the greatest likelihood of causing continued environmental degradation including those from municipal separate storm sewer systems (MS4s) and discharges from construction activity.

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

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

FINANCIAL TOOLS

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

In addition, the state is partnering with the Natural Resource Conservation Service (NRCS) to provide implementation incentives through the national Farm Bill. As a result of this effort, NRCS now prioritizes its Environmental Quality Incentive Program (EQIP) funds based on MassDEP's list of impaired waters. The program also provides high priority points to those projects designed to address TMDL recommendations. Over the past several years EQIP funds have been used throughout the Commonwealth to address water quality goals through the application of structural and non-structural BMPs.

MA, in conjunction with EPA, also provides a grant program to implement nonpoint source BMPs that address water quality goals. The section 319 funding provided by EPA is used to apply needed implementation measures and provide high priority points for projects that are designed to address 303d listed waters and to implement TMDLs.

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

Finally, it should be noted that the approach and process outlined for implementing this TMDL has been previously demonstrated with documented success. A previous TMDL, which utilized this approach was developed and approved by EPA for the Neponset River Watershed. The recommendations outlined in that TMDL were similar to the current proposal. Since the time of approval, MassDEP worked closely with a local watershed group (Neponset River Watershed Association) to develop a 319 project to implement the recommendations of the TMDL. The total project cost was approximately $472,000 of which $283,000 was provided through federal 319 funds and the additional 40% provided by the watershed association and two local communities.

Other examples include the Little Harbor in Cohasset and the Shawsheen River. Similar TMDLs were developed in these areas. In Little Harbor, the TMDL was used as the primary tool to obtain local approval and funding to design and install sewers around Little Harbor and other additional areas of Town impacted by sewerage contamination. Presently, the Town is seeking additional state funding to construct the sewers. In the Shawsheen Watershed the TMDL was used to obtain a state grant to identify and prioritize specific stormwater discharges for remediation. In addition, MassDEP has received a grant to a conduct additional sampling and refine field and laboratory techniques that will allow us to differentiate between human and non-human sources that will be useful statewide. MassDEP and EPA Region 1 are also working on a compliance & enforcement strategy to address the worst sources. Additional information related to the non-point source program, including the Management Plan can be found at: http://www.mass.gov/dep/water/resources/nonpoint.htm.

State Revolving Fund: The State Revolving Fund (SRF) Program provides low interest loans to eligible applicants for the abatement of water pollution problems across the Commonwealth. MassDEP has issued millions of dollars in loans for the planning and construction of CSO facilities and to address stormwater pollution. Loans have also been distributed to municipal governments statewide to upgrade and replace failed Title 5 systems. These programs all demonstrate the State's commitment to assist local governments in implementing the TMDL recommendations. Additional information about the SRF Program is located at: http://www.mass.gov/dep/water/wastewater/wastewat.htm#srf.

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

11.0 Public Participation

Two public meetings were held at 2:00 p.m. and 7:00 p.m. at Tufts University, Medford on 8/30/05 to present the Draft Bacteria TMDL and to collect public comments. The public comment period began on August 10, 2005 and closed on September 15, 2005. The attendance list, public comments, and the MassDEP responses are attached as Appendix A.

12.0 References

Ayres Associates 1993. Onsite Sewage Disposal Systems Research in Florida. The Capacity of Fine Sandy Soil for Septic Tank Effluent Treatment: A Field Investigation at an In-Situ Lysimeter Facility in Florida.

Brander, 2006 (b,c). Personal communications with Kevin Brander, Wastewater Section Chief, Department of Environmental Protection, Northeast Regional Office, Wilmington MA.

Center for Watershed Protection, 1999. Watershed Protection Techniques. Vol. 3, No. 1.

CZM 2004. Gloucester Harbor Characterization: Environmental History, Human Influences, and Status of Marine Resources. Massachusetts Office of Coastal Zone Management Technical Report. Massachusetts. Office of Coastal Zone Management, Executive Office of Environmental Affairs, and Commonwealth of Massachusetts. May. Available for download at http://www.mass.gov/czm/glouc_harb_rpt_toc.htm.

CZM 2009. CZ- Mail, The Electronic Newsletter of the Massachusetts Division of Coastal Zone Management, 251 Causeway St., Suite 800, Boston MA CZM Website: http//www.mass.gov/czm

DMF 2002a. Massachusetts Division of Marine Fisheries. Programs and Projects. shellfishing Sanitation and Management. Information from website, downloaded March 2005. http://www.mass.gov/dfwele/dmf/programsandprojects/shelsani.htm

DMF 2002b. The Marine Resources of Salem Sound, 1997. Massachusetts Division of Marine Fisheries, Department of Fisheries, Wildlife and Environmental Law Enforcement, Executive Office of Environmental Affairs, Commonwealth of Massachusetts. DMF Technical Report TR-6. October. Available for download at: http://www.salemsound.org/PDF/salem_sound_report_tr6.pdf

DMF 2006. Massachusetts Division of Marine Fisheries http://www.mass.gov/dfwele/dmf/programsandprojects/shellfish/n/n7.pdf

Duerring 2006. Personal communication with Christine Duerring, Massachusetts Department of Environmental Protection, Bureau of Resource Protection, Division of Watershed Management. Boston, Massachusetts.

ENSR 2005. Mitigation Measures to Address Pathogen Pollution in Surface Waters: A TMDL Implementation Guidance Manual for Massachusetts. A Companion Document to the Watershed-Specific Pathogen TMDL Reports. ENSR International, Westford MA, July, 2005.

EOEA 2003. North Coastal Washed. Information from website, downloaded January 2005. http://www.mass.gov/envir/water/northCoastal/northCoastal.htm

EOEA 2004. North Coastal Watersheds Five-Year Action Plan. Executive Office of Environmental Affairs. North Coastal Watershed Team. Available for download at http://www.NorthCoastal.net

Goodwin, Paul. 2006. Personal Communication. *Town of Essex Sewering Project*. Communication with William Dunn, Massachusetts Department of Environmental Protection, Division of Watershed Management, 25 August 2006. Department of Public Works, Town of Essex.

Horsley Witten Group 2005. . Final Report - Shoreline Survey & Water Quality Sampling of Stormwater Discharge Locations along the Salem Sound Shoreline. DEP Project ID#2002-01/604. Horsley Witten Group, Inc. Sandwich, MA.

Massachusetts Bays Program 2010. http://www.mass.gov/envir/massbays/activities.htm

MassDEP 2000a. North Coastal Watershed 1997/1998 Water Quality Assessment Report. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, Massachusetts. Available for download at: www.mass.gov/dep/water/resources/wqassess.htm

MassDEP 2000b. 314 CMR 4.00: Massachusetts Surface Water Quality Standards. Massachusetts Department of Environmental Protection Bureau of Waste Prevention. Available for download at: http://www.mass.gov/dep/service/regulations/314cmr04.pdf
regulati.htm#wways

MassDEP 2000c. Nonpoint Source Management Plan Volume I Strategic Summary. Massachusetts Department of Environmental Protection Bureau of Waste Prevention. Available for download at: www.mass.gov/dep/water/resources/nonpoint.htm

MassDEP 2002a. North Coastal Watershed 1997-8 Water Quality Assessment Report. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, Massachusetts. Available for download at: www.mass.gov/dep/water/resources/wqassess.htm

MassDEP 2002b. Final Total Maximum Daily Loads of Bacteria for Neponset River Basin. Massachusetts Department of Environmental Protection, Bureau of Resource Protection, Division of Watershed Management. Report MA73-01-2002 CN 121.0. Boston, Massachusetts. Available for download at: http://www.mass.gov/dep/water/resources/tmdls.htm

MassDEP 2002c. North Coastal Watershed 2002 Water Quality Assessment Report. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, Massachusetts. Available for download at: www.mass.gov/dep/water/resources/wqassess.htm

MassDEP 2008. Massachusetts Year 2008 Integrated List of Waters. Part 2 – Final Listing of Individual Categories of Waters. Massachusetts Department of Environmental Protection, Bureau of Resource Protection, Division of Watershed Management. Boston, Massachusetts. Available for download at: http://www.mass.gov/dep/water/resources/tmdls.htm

MassGIS 2005. Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs. MADEP 2002 Integrated List of Waters

(305(b)/303(d)) as of 2005; Land Use as of 1999; Town Boundaries as of 2002. Census TIGER Roads as of 2003. Major Drainage Boundaries as of 2003. Designated shellfishing Growing Area as of July 2000. Downloaded January 2005. http://www.mass.gov/mgis/laylist.htm

MBP 2003. Massachusetts Bays Comprehensive Conservation & Management Plan, 2003 Revisions. Massachusetts Bays Program, US Environmental Protection Agency. Massachusetts Executive Office of Environmental Affairs.

MDC-CDM. 1997. Wachusett Stormwater Study. Massachusetts District Commission and Camp, Dresser, and McKee, Inc.

Metcalf and Eddy 1991. Wastewater Engineering: Treatment, Disposal, Reuse. Third Edition.

Metcalf and Eddy 1992. Casco Bay Stormwater Management Project.

Peabody 2002. City of Peabody Stormwater Management Plan. City of Peabody, Massachusetts.

SRWC 2004. Saugus River Watershed 2003, 2004 Water Quality Reports. Saugus River Watershed Council. www.saugusriver.org.

SSCW 2004. Salem Sound Clean Beaches and Streams Program 2004 Report. Salem Sound Coast Watch. Available for download at: http://www.salemsound.org/clean_beaches.htm.

USEPA 1983. Results of the Nationwide Urban Runoff Program. Volume I. Final Report. Water Planning Division. Washington, D.C. 159 pp.

USEPA 1986. Ambient Water Quality Criteria for Bacteria – 1986. EPA 440/5-84-002.

USEPA. 1997. Urbanization of Streams: Studies of Hydrologic Impacts. EPA 841-R-97-009

USEPA 1999. Regional Guidance on Submittal Requirements for Lake and Reservoir Nutrient TMDLs. USEPA, New England Region. November 1999.

USEPA. 2000. Stormwater Phase II Final Rule: Illicit Discharge Detection and Elimination Minimum Control Measure. Office of Water, US Environmental Protection Agency. Fact Sheet 2.5. USEPA 833-F-00-007. January.

USEPA 2001. Protocol for Developing Pathogen TMDLs. EPA 841-R-00-002

USEPA 2004a. Monitoring and Assessing Water Quality. Information from website, downloaded December 2004.
http://www.epa.gov/OWOW/monitoring/volunteer/stream/vms511.html

USEPA 2004b. Lower Charles River Illicit Discharge Detection & Elimination (IDDE) Protocol Guidance for Consideration - November 2004 United States Environmental Protection Agency Region I New England

USGS 2002. Measured and Simulated Runoff to the Lower Charles River, Massachusetts, October 199-September 2000. 02-4129. United States Geological Survey. Northborough, Massachusetts.

Appendix A Public Meeting Information and Response to Comments

Pathogen TMDL for the North Coastal Watershed

Public Meeting Announcement Published in the Monitor	8/10/05
Date of Public Meeting	8/30/05
Location of Public Meeting	Tufts University, Medford, MA
Times of Public Meeting	2:00 PM and 7:00 PM

PUBLIC MEETING ATTENDEES
Date: 8/30/05 Time: 2:00 PM

Name	Organization
1. Mike Hill	EPA
2. Ted Lavery	EPA
3. Jan Dolan	MyRWA
4. Eben Chesebrough	MassDEP
5. Russ Isaac	MassDEP
6. Nancy Hammett	MyRWA
7. Lisa Bouchelub	Tufts University
8. Paul Kirshen	Tufts University
9. Rachel Szyman	Tufts University
10. Jenny Birnbaum	MyRWA
11. Andrew B. DeSantis	City of Chelsea, DPW

Date: 8/30/05 Time: 7:00 PM

Name	Organization
1. Alison Field-Juma	MyRWA
2. Jenny Birnbaum	MyRWA
3. Eben Chesebrough	MassDEP
4. Russ Isaac	Mass DEP

North Coastal Watershed Comments / Responses

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

General Comments:

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

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

2. Question: What is the Septic System Program?

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

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

Response: The Massachusetts Surface Water Quality Standards, 314 CMR 4.00 (WQS), do not have any waters designated for "non-contact recreation." All Massachusetts surface waters currently are designated in the WQS for both primary and secondary contact recreation, among other uses. The bacteria criteria protect waters for their most sensitive uses, accordingly, the recreation based bacteria criteria for all Class A, SA, B and SB waters are protective of primary contact recreation. While the WQS do contain C and SC water classifications, with associated criteria, which are described to include waters designated for secondary contact recreation, there are no waters assigned to these classes. The bacteria criteria for Class C fresh waters are: "The geometric mean of all E. coli samples taken within the most recent six months shall not exceed 630 colonies per 100 mL, typically based on a minimum of five samples, and 10% of such samples shall not exceed 1260 colonies per 100 mL. This criterion may be applied on a seasonal basis at the discretion of the Department."

The Class C geometric mean bacteria criterion is five times the Class A and B geometric mean bacteria criterion for primary contact recreation. The WQS take the same approach with the Class SC bacteria criteria, that is, the SC geometric mean is five times that for SA and SB waters. With respect to bacteria criteria for secondary contact recreational waters, EPA has guidance that “states and authorized tribes may wish to adopt a criterion five times that of the geometric mean component of the criterion adopted to protect primary contact recreation, similar to the approach states and authorized tribes have used historically in the adoption of secondary contact criterion for fecal coliforms.” Note that in the Massachusetts WQS, secondary contact recreation is defined to include water contact that is "incidental" so that contact incidental to such activities as boating and fishing would be anticipated.

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

Response: DNA testing is a promising but as yet not fully reliable tool in distinguishing between human and other sources of fecal bacteria. When perfected, this tool will be extremely valuable in helping target sources of pathogens and remedial actions. At the same time, one needs to recognize that even if the source of the bacteria is identified as non-human, any concentrations exceeding the criteria still impair the use, such as swimming or shellfishing, associated with those criteria. MassDEP is already working with our Wall Experiment Station to help develop reliable techniques to address this issue. Once developed MassDEP will include those techniques into our sampling programs, however, we hope local monitoring programs will also benefit from them.

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

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

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

Response: Phase I and Phase II municipalities already do regular reporting and provide annual status reports on their efforts. Any additional information can be coupled with existing reporting requirements and monitoring results to determine the success and failure of implementation measures. For non-Phase II municipalities it gets more difficult and MassDEP may have to work directly with each community or possibly add communities with known impairments to the Phase II list. The TMDL does not require volunteer groups, watershed organizations or towns to submit periodic reports - it is not mandatory. The MassDEP is relying on self interest and a sense of duty for communities to move ahead with the needed controls facilitated by some state aid. The MassDEP feels that the cooperative approach is the most desirable and effective but also believes that we possess broad regulatory authority to require action if and when it is deemed appropriate.

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

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

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

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

This approach is consistent with current EPA guidance and regulations. As stated in the November 22, 2002 Wayland/Hanlon memorandum (TMDL Appendix B, Attachment A), "WQBELs for NPDES-regulated stormwater discharges that implement WLAs in TMDLs may be expressed in the form of best management practices (BMPs) under specified circumstances. See 33 U.S.C. 1342(p)(3)(B)(iii); 40 C.F.R. 122.44(k)(2)&(3)" (TMDL Appendix B, Attachment A Wayland/Hanlon memo, page 2). This memorandum goes on to state:

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

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

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

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

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

Response: In general, the MassDEP is pursuing a cooperative approach in addressing non-point sources of contamination by bacteria. A total of 239 cities and towns in Massachusetts do have legal requirements to implement best management practices under their general NPDES storm-water permits. In addition, failing septic systems are required to be corrected once the local Board of Health becomes aware of them and at the time of property transfer should required inspections reveal a problem. Other activities, such as farming involving livestock, are the subject of cooperative control efforts through such organizations as the Natural Resources Conservation Service (NRCS) which has a long history of providing both technical advice and matching funds for instituting best management practices on farms. While MassDEP has broad legal authority to address non-point source pollution and enforcement tools available for use for cases of egregious neglect, it intends to fully pursue cooperative efforts which it feels offer the most promise for improving water quality.

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

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

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

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

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

Response: The 319 Grant program is a major funding program providing up to $2 million per year in grants in MA. TMDL implementation is a high priority in the 319 program. In fact, projects designed to address TMDL requirements are given higher priority points during project evaluation.

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

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

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

Response: Proper design and implementation of stormwater systems during construction will address both pre and post-construction runoff issues and thus eliminate future problems. Post-construction runoff is also one of the six minimum control measures that Phase II communities are required to include in their stormwater management program in order to meet the conditions of their National Pollutant Discharge Elimination System (NPDES) permit. In short, Phase II communities are required to:
Develop and implement strategies which include structural and/or nonstructural best management practices (BMPs);

- Have an ordinance or other regulatory mechanism requiring the implementation of post-construction runoff controls to the extent allowable under State or local law;
- Ensure adequate long-term operation and maintenance controls; and
- Determine the appropriate best management practices (BMPs) and measurable goals for their minimum control measure.

The general permit implementing the Phase II requirements also contains requirements for permittees that discharge into receiving waters with an approved TMDL. In summary, municipalities covered under Phase II are required to incorporate and implement measures and controls into their plans that are consistent with an established TMDL and any conditions necessary for consistency with the assumptions and requirements of the TMDL.

It should be noted that there are a number of other permitting programs that regulate pre/post construction run-off including the construction general permit, wetlands requirements and the Mass DEP General Stormwater permit that is in the process of being developed.

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

Response: MassDEP recommends that the information contained in the pathogen TMDLs guide management activities for all other waters throughout the watershed to help maintain and protect existing water quality. For non-impaired waters, Massachusetts is proposing "pollution prevention TMDLs" consistent with CWA s. 303(d)(3). Pollution prevention TMDLs encourage the Commonwealth, communities and citizens to maintain and protect existing water quality. Moreover it is easier and less costly in the long term to prevent impairments rather than retrofit controls and best management practices to clean up pollution problems. The goal of this approach is take a more proactive role to water quality management.

The analyses methods employed for the pathogen impaired segments in this TMDL would apply to the non-impaired segments, since the sources and their characteristics are similar. The waste load and/or load allocation for each source and designated use would be the same as specified in the TMDL documents. Therefore, the pollution prevention TMDLs would have comparable waste load and load allocations based on the sources present and the designated use of the waterbody segment.

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

Pollution prevention best management practices form the backbone of stormwater management strategies. Operation and maintenance should be an integral component of all stormwater management programs. This applies equally well with the Phase II Program as well as TMDLs. A detailed discussion of this subject and the BMPs involved can be found in the TMDL companion document "Measures to Address Pathogen Pollution in Surface Waters: A TMDL Implementation Guidance Document for Massachusetts" in Section 3.

It should also be noted that sometimes the MassDEP will develop a "preventative " TMDL. Preventative TMDLs are not required by Federal law, however, MassDEP does establish them on occasion to prevent waters from becoming impaired or where it is necessary to maintain waters at a certain level of water quality to meet the goals of a TMDL where the impaired water body is downstream from a non-impaired segment. In simple terms a preventative TMDL establishes goals to prevent degradation of good water quality.

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

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

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

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

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

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

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

Response: All of the sources of impairments listed in Table 6-1 are addressed in Table 7-1, the text of Section 7, or both. Because Table 6-1 and 7-1 serve slightly different purposes it was not intended that the tasks needed to align with and exactly address the eight sources of impairment.

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

Response: Failing infrastructure is a very broad term, and is addressed, in part in such discussions as those on leaking sewer pipes, sanitary sewer overflows, and failed septic systems. It is outside of the scope of the TMDL documents to detail every possible type of infrastructure failure. Nonetheless, additional information is provided in the TMDL companion document titled: "Measures to Address Pathogen Pollution in Surface Waters: A TMDL Implementation Guidance Document for Massachusetts."

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

Response: MassDEP and the EPA recognize that the municipalities have done, and are continuing to do, a tremendous amount of work to control bacterial contamination of surface waters. The TMDL has been expanded to provide additional examples of that overall effort. However, the additional discussion is not designed nor intended to include an exhaustive listing of all the work required by each municipality to finalize this effort and provide as status of that work. Programs, such as Phase II Stormwater, require such status reports, and those will be very valuable in assessing priorities and future work. Phase II reports for each community are available on EPAs website: http://www.epa.gov/ne/npdes/stormwater/2003-permit-archives.html

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

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

For example, the Phase II stormwater program required all communities to submit an application and plan in 2003. That plan must address the six minimum control measures and establish regulatory mechanisms to implement pre/post construction runoff controls and illicit discharge detection and elimination (IDDE) by 2008. Status reports are developed annually to report their progress on achieving that goal. Complete implementation, however, will likely take many more years.

A second example would be the control of combined sewer overflows (CSOs). Many municipalities are required by NPDES permits to develop and implement initial measures (commonly referred to as the Nine Minimum Controls (NMCs) and long-term control plans to address the issue. Since CSO discharges are defined as a point source under the Clean Water Act, an NPDES permit must be jointly issued by EPA and MassDEP for those discharges. The permit sets forth the requirements for implementation and assessment of the EPA mandated NMCs and the requirement for developing a long-term CSO control strategy. Many municipalities are under enforcement orders by EPA and MassDEP that outline timelines for reaching the objectives of the long-term control plan.

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

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

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

Response: The TMDL report has been edited to include groups and individuals that can benefit from the information in this report. It is beyond the scope of the TMDL to provide an exhaustive list of agencies that provide funding and support. Chapter 8.0, however, includes a link to this information, which is provided in the Massachusetts Nonpoint Source Strategy.

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

Response: Please see response to comment #22.

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

Response: The 1995 revisions to the MA Water Quality Standards created a B (CSO) water quality category by establishing regulatory significance for the notation "CSO" shown in the "Other Restriction" column at 314 CMR 4.06 for impacted segments. The B (CSO) designation was given, after public review and comment, to those waters where total elimination of CSOs was not economically feasible and could lead to substantial and widespread economic and social impact and the impacts from remaining CSO discharges were minor. Although a high level of control must be achieved, Class B standards may not be met during infrequent, large storm events.

The goal of the TMDL and the long-term control plan is to minimize impacts to the maximum extent feasible, attain the highest water quality achievable, and to protect critical uses. Given this, the TMDL establishes in Table ES-1 (as well as other tables) the goal of meeting class B standards in CSO impacted waters but recognizes that this criteria cannot be met at all times and therefore defers to the EPA and MassDEP approved long-term control CSO plan to define the infrequent occasions when the criteria may not be met.

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

Response: MassDEP agrees that implementation of new bacteria water quality criteria should be incorporated into the permitting process as well as the state Water Quality Standards. This is already the case. The criteria are also being included in the TMDL because it is a required element of the TMDL process. Readers / users of the bacteria TMDL reports should be aware that new water quality standards were developed and included in the December 29, 2006 revisions to 314 CMR 4.00: Massachusetts Surface Water Quality Standards. These standards have been included in the final Pathogen TMDL for the North Coastal Watershed.

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

Response: Mass Highway is included in the Stormwater Phase II Program, and as such is responsible for completing the six minimum controls mandated by that program, i.e., public education and outreach, public involvement and participation, illicit discharge detection and elimination, construction site stormwater runoff control, post construction stormwater management, and good housekeeping in operations. EPA and MassDEP have authorized MassHighway to discharge stormwater from its designated Small MS4 in accordance with its issued permit. However, as of January 2006, EPA has not approved of MassHighway's SWMP and as a result has not authorized stormwater or allowable non-stormwater discharges from any portion of MassHighway's regulated Small MS4 that could potentially affect species populations or habitat in the North Coastal Watershed.

27. Comment: The current 303d list of impaired waters – is it the 2002 or the 2004 list?

Response: It is the 2010 list. The 2010 list was recently approved by EPA. All of the pathogen TMDLs will apply to the current 2010 303d list and all future EPA approved 303d lists.

28. Comment: Does the NPDES non-delegated state status of Massachusetts affect the TMDLs in any way?

Response: No. The MassDEP and EPA work closely together and the non-delegated status will not affect the TMDLs. The EPA has not written any of the pathogen TMDLs but has helped fund them.

29. Comment: The TMDL report does not tell the watershed associations anything they didn't already know.

Response: True. The MassDEP is taking a cooperative approach and by working together as a team (federal, state, local, watershed groups) we can make progress in addressing bacterial problems – especially stormwater related bacterial problems.

30. Comment: What will the MassDEP do now for communities that they have not already been doing?

Response: Grants that can be used for implementation (such as the 319 grants) will be targeted toward TMDL implementation. Also, the more TMDLs a state completes and gets approved by EPA the more funding it will receive from EPA and thus the more TMDL implementation it can initiate.

31. Comment: The State Revolving Fund (SRF) should support municipalities with TMDLs and Phase II status a lot more.

Response: As with any grant program, there are some very competitive projects looking for funds from the SRF. A lot of these are the traditional sewage treatment plants and sewering projects which are very expensive. The SRF currently does allocate funds to stormwater related projects and gives higher priority points to projects developed in response to TMDLs.

32. Comment: Who will be doing the TMDL implementation?

Response: Each pathogen TMDL report has a section on implementation which includes a table that generally lists the various tasks and the responsible entity. Most of the implementation tasks will fall on the authority of the municipalities. Probably two of the larger tasks in urban areas include implementing stormwater BMPs and eliminating illicit sources. The document "Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts" was developed to support implementation of pathogen TMDLs. The MassDEP working with EPA and other team partners shall make every reasonable effort to assure implementation of the TMDLs.

33. Comment: Several watershed groups believe that active and effective implementation and enforcement is essential to carry out the objectives in the pathogen TMDLs. They define effective implementation as the MassDEP partnering with them and municipalities to identify funding opportunities to develop stormwater management plans, implement Title 5 upgrades, and repair failing sewer infrastructure. The groups define effective enforcement as active MassDEP application of Title 5 regulations and implementation of Stormwater Phase II permitting requirements for Phase II municipalities.

Response: The MassDEP has every intention of assisting watershed groups and municipalities with implementing the high priority aspects of the pathogen TMDLs, including identification of possible funding sources. With respect to Title 5 regulations and the Phase II program requirements, the MassDEP will continue to emphasize and assist entities with activities that lead to compliance with those program requirements.

34. Comment: The MassDEP Division of Watershed Management (DWM) should network implementation planning efforts in the coastal watersheds with the Coastal Zone Management's (CZM) Coastal Remediation Grant Program and the EPA Coastal Nonpoint Source Grant Program. Also, the DWM should make the pathogen TMDL presentation to the Mass Bays Group, and network with them in regards to coordinating implementation tasks.

Response: This is a good comment. The MassDEP DWM intends, through its basin planning program, to do both.

35. Comment: Why are specific segments or tributaries of watersheds addressed in the Draft TMDL but not all of the segments?

Response: In accordance with the EPA regulations governing TMDL requirements, only segments that are included on the state's 303(d) list of impaired waterbodies need to be included in any TMDL.

36. Comment: When a TMDL is developed for waters impaired by both point and nonpoint sources, and the WLA is based on an assumption that nonpoint source reductions will occur; EPA's 1991 TMDL Guidance states that the TMDL should provide reasonable assurances that nonpoint source control measures can achieve expected load reductions in order for the TMDL to be approvable.

Response: Section 10.0, Reasonable Assurances, should provide these assurances. This section has been drastically expanded in the Final version of the Draft Pathogen TMDL reports. The revised section 10.0 describes all of the appropriate state programs and their enabling statutes and relevant regulations which actively address nonpoint source pollution impacting waters of the Commonwealth. Many of these programs involve municipality first line defense mechanisms such as the Wetlands Protection Act (which includes the Rivers Protection Act). This expanded section also covers grant programs available to municipalities to control and abate nonpoint source pollution such as 319 grants, 604b grants, 104b(3) funds, 6217 coastal nonpoint source grants, low interest loans for septic system upgrades, state revolving fund grants, and many others.

37. Comment: The Draft TMDLs indicate that for non-impaired waters the TMDL proposes "pollution prevention BMPs". The term is not defined in any state regulation and the origin of the term is unclear.

Response: An explanation of pollution prevention BMPs can be found in the pathogen TMDL companion document "Mitigation Measures to Address Pathogen Pollution in Surface Waters: A TMDL Implementation Guidance Manual for Massachusetts". Section 3.1 of that manual describes pollution prevention as one of the six control measures for minimizing stormwater contamination under the EPA Phase I or II Stormwater Control Program. Control Measure #6, "Pollution Prevention / Good Housekeeping" involves a number of activities such as maintenance of structural and nonstructural stormwater controls, controls for reducing pollutants from roads, municipal yards and lots, street sweeping and catch basin cleaning, and control of pet waste. Also, the term "pollution prevention" can include a far wider range of pollution control activities to prevent bacterial pollution at the source. For instance, under Phase I and II, minimum control measures #4 and #5, construction site and post construction site runoff controls, would encompass many pollution prevention type BMP measures. Proper septic system maintenance and numerous agricultural land use measures can also be considered pollution prevention activities. Further information may be found in Sections 3.0, 4.0, and 5.0 in the Guidance Manual.

38. Comment: EPA regulations require that a TMDL include Load Allocations (LAs) which identify the portion of the loading capacity attributed to existing and future nonpoint sources and to natural background. Load allocations may range from reasonably accurate estimates to gross allotments (40 C.F.R. s.130.2(g)). Where possible, load allocations should be described separately for natural background and nonpoint sources. The Draft TMDL makes no such allocation. Also, EPA regulations require that a TMDL include Waste Load Allocations (WLAs) which identify the portion of the loading capacity allocated to individual existing and future point sources. The Draft TMDL makes no such allocation. Because it makes no estimate of the TMDL, it makes no WLA for point sources.

Response: This comment (and several others which addressed the same topic) relates to the establishment and allocation of an acceptable pollutant load so that water quality standards can be met and maintained (see response to comment 9 & 16). As touched upon elsewhere in this document, TMDLs can be expressed in a variety of ways so long as they are rational. MassDEP has chosen to use concentration as the metric for bacteria TMDLs for several reasons. First, there is a numeric standard that can be used. Second, and more important, bacteria, unlike some other pollutants, can increase with flow rather than decrease. As such, the bacteria load applicable at low flow (7Q10) would be very stringent if applied to higher flows. In essence, this TMDL recognizes that higher loads are likely at higher flows and therefore the emphasis is on meeting the in-stream water quality.

Watershed Specific Comments

1. Comment: The North Coastal Draft Pathogen TMDL report makes no mention of Walkers Brook in Reading. Should Walkers Brook and its tributaries be included in the TMDL report ? Have any water quality tests been conducted in Walkers Brook ? Reading is a Phase II community.

Response: The MassDEP, Division of Watershed Management (DWM) has not monitored Walkers Brook and it is not on the 303d list of impaired waters. For these reasons the Brook was not specifically mentioned in the report. The TMDL report, however, covers not only the current 303d list of impaired waters but would extend to any future changes in the listing. Consideration will be given to monitoring Walkers Brook during the next water quality survey of the North Coastal Watershed.

2. Comment: "Waterfowl Management" should be added to the "Control Measures" on page iii. Danvers spends a significant portion of its public health budget on geese management in order to control bacterial contamination. Also, please note that reducing public geese feeding is mentioned elsewhere as a priority action to reduce bacteria in stormwater (Section 7.4, bullet two, p. 62).

Response: Good comment. "Waterfowl Management" will be added under 'Control Measures" in the revised edition of the TMDL report.

3. Comment: It would be helpful if the permittees and the types of discharges to Rockport Harbor Segment MA93-17 were identified. It isn't clear if the two permitted discharges mentioned are two outfalls from the Rockport wastewater treatment plant, two CSOs, or two other types of discharges. This comment applies to the other segments as well.

Response: This is a valid comment and if the TMDL were to detail waste load allocations then the specific dischargers would be listed and described. But because the pathogen TMDLs set the criteria as simply meeting the water quality standards then the individual listing of NPDES discharges becomes moot. The two discharges listed for Rockport Harbor in the TMDL report come from the North Coastal Watershed 1997/1998 Water Quality Assessment Report and are for the following: (1) MA0100145 – The Rockport WWTP discharges 0.8 MGD of treated municipal wastewater to Sandy Bay. Sandy Bay is outside of Rockport Harbor proper. (2) MA0090654 – The Town of Rockport Cape Ann Lighthouse discharges 0.0012 MGD of treated sanitary wastewater to the Atlantic Ocean from the facility on Thatchers Island, which is approximately one mile east of Rockport. (This permit was issued July 1982).

4. Comment: Why are vessel sewage pump-out facilities considered a discharge? The vessel sewage pump-outs should be deposing the collected waste into a SESD sewer main. Saying that this is a discharge is misleading and hopefully wrong.

Response: This is a good comment. The vessel sewage pump-out facilities do not discharge to the harbors. They either discharge to a SESD sewer main or are pumped out and appropriately disposed of at a sewage treatment facility. The TMDL report will be edited to reflect this. The TMDL report used the

MassDEP North Coastal Assessment Report as a reference and that report listed the vessel sewage pump-out facilities under the heading: 'Withdrawals and Discharges'. I believe this was a matter of convenience and in retrospect appears confusing. This matter will be brought to the attention of the Assessment Report staff.

5. Comment: Cat Brook MA-93-29 has illegal sewer connections? (p.44 of TMDL report).

Response: The word "possible" will be inserted to indicate the potential for illegal sewer connections. The North Coastal Assessment Report, which was the reference for this section, indicates the following: "Salem Sound 2000's volunteer monitoring program identified elevated fecal coliform bacteria levels in Cat Brook that could potentially be attributed to illegal sewage connections. MassDEP DWM subsequently sampled Cat Brook and confirmed the high levels of bacteria. Therefore, illegal sewer connections need to be identified and corrective action taken." The last sentence should have used the conditional word "suspected" before "illegal sewer connections".

6. Comment: Danvers River has CSOs? [Table 5-1. Some of the Potential Sources of Bacteria in Pathogen Impaired Segments in the North Coastal Watershed]

Response: Table 5-1 lists CSOs as a potential source of bacteria in the Danvers River. The presence of CSOs in the Danvers River is referenced from the MassDEP DWM Water Quality Assessment Report for the North Coastal Watershed 1997/1998, p.77. The Assessment Report in turn, cites the following reference as the basis for the presence of CSOs in the Danvers River: "Chase, Bradford, C. 1993. Preliminary Report on the Danvers River System. Massachusetts Bay Smelt Spawning Habitat Monitoring Program. Massachusetts Division of Marine Fisheries, Sport fisheries Technical Assistance Program, Cat Cove Marine Laboratory. Salem, MA. 49p. In this report the DMF recommended the removal of all active CSOs discharging in the Danvers River.

Watershed Specific Comments from CZM

1. Comment: p. ii, Under "Control Measures," does "Watershed Management" include NPDES permitting? If not, NPDES stormwater and point source permitting are certainly valuable bacterial control measures and should be included under "Control Measures."

Response: Please refer to Comment # 21 and its response in the General Comments Section just above.

2. Comment: p. iii, First Paragraph, Executive Summary, "Illicit discharges of boat waste" should be changed to "Discharges of inadequately treated boat waste" because people using small boats (those under 65') with a Type I Marine Sanitation Device attached to the head can legally discharge waste with up to 1000 CFU/100 ml, well above the state standard for SA and SB waters. A similar change should be made to p. 28 (Section 5.0) where illicit boat discharges are mentioned as a dry weather source.

Response: We have made the suggested changes.

3. **Comment:** p. iii, Absent from the "Who should read this document?" are the governmental agencies that provide planning, technical assistance, and funding to groups to remediate these problems. CZM recommends adding such language.

Response: The following has already been added to the document on p. iii: "(e) government agencies that provide planning, technical assistance, and funding to groups for bacterial remediation".

4. **Comment:** p. vi, Table ES-1, It isn't clear what the difference is between "Waste Load Allocation and "Load Allocation." The distinction is not made until pp. 33 (Section 6). CZM suggests making this distinction earlier (e.g., in footnote 1 of Table ES-1).

Response: First of all, Table ES-1 that you refer to in the Draft Report has been changed to Table ES-2 in the Final Report. For the definitions of Waste Load Allocation and Load Allocation, please refer to Comment #1 and its response in the General Comments Section just above. In direct response to your comment, we have added brief statement definitions of WLA and LA to the first paragraph, pp xiv, following the footnote explanations for Table ES-2. Additionally, these terms are defined and discussed in much greater detail in Section 7, Pathogen TMDL Development.

5. **Comment:** Please note that some figures did not display in the PDF format: Fig. 1-1, 2-1, 2-2, and Appendix A did not appear.

Response: Response: The final submittal will be checked to insure that figures are legible in both the pdf and word versions, and that the appendices are complete.

6. **Comment:** p. 23, Rockport Harbor Segment MA93-17, It would be helpful toward the implementation of this TMDL if the report would identify the permittees and the types of discharges to this segment. It isn't clear if the two permitted discharges mentioned in this paragraph are two outfalls from the Rockport wastewater treatment plant, two CSOs, or two other types of discharges. This comment applies throughout this and other TMDL reports. It is clear that listing this information will require a lot of space (e.g., the Gloucester segment has 41 discharges) so it may be necessary to place it in an appendix. While reporting all of these data maybe cumbersome, the location of all permitted outfalls is necessary for communities, agencies, and other organizations to implement this TMDL.

Response: This has been clarified, with the proper permit numbers presented, in Section 4 of the Final report. The statement in the Draft Report that the Gloucester Harbor has 41 permitted discharges is incorrect.

7. **Comment:** p. 31, Section 5.0, In the discussion of boat waste disposal, CZM suggests changing "…MSDs may discharge sewage in concentrations higher than allowed in ambient water for fishing or shellfishing" to "MSDs may discharge sewage in concentrations higher than allowed in ambient water for shellfishing or primary and secondary contact recreational activities." Swimming and other primary contact activities should be included as activities that may be impaired by boat sewage disposal.

Response: We have made that change.

8. .**Comment:** pp. 33-39 Section 6.1, there is no discussion of load allocations to SB-CSO waters or waters that are under a variance. If a waterbody is currently under a variance from water quality standards for bacteria, will the TMDL standards on p. 34 nullify the variance? Regarding this issue, the following sentence from the bottom of p. 35 should probably be noted on p. 34 "The specific goal for controlling discharges from combined sewer overflows (CSOs) will be based on the site specific studies embodied in the Long Term Control Plan being developed by each community with combined sewers."

Response: Please note that Section 6 of the Draft Report has been changed to Section 7 in the Final Report. Also, this section in the Draft report has been reorganized in the Final Report, with Water Quality Standards information from the Draft Report (pp 34) incorporated into Table 7-1 (as well as Table ES-2), 'Waste Load Allocations (WLAs) and Load Allocations (LAs)' in the Final Report. In Table 7-1 (and Table ES-2), under column "Surface Water Classification", footnote SB[10] refers to your comment above, "The specific goal for controlling discharges from combined sewer overflows (CSOs) will be based on the site specific studies embodied in the Long Term Control Plan". Footnote SB[10], in Table 7-1, refers to (at the bottom of the page): 'SB segments designated as CSO, as having a long term control plan in place that is compatible with water quality goals'. Water bodies covered by this TMDL will not require a variance.

Please also refer to Comment # 24 and its response in the General Comments Section just above for further explanation on the variance issue of B (CSO).

9. **Comment:** p. 40, Section 6.3 "Seasonal Variability", last sentence, The following sentence suggests that primary contact does not take place in winter months: "However, for discharges that do not affect shellfish beds, intakes for water supplies and primary contact recreation is not taking place (i.e., during the winter months) seasonal disinfection is permitted for NPDES point source discharges." However, surfing occurs in many of the Commonwealth's waters year-round. CZM suggests removing this sentence (i.e., the last sentence of Section 6.3) or editing it to: "However, for discharges that do not affect shellfish beds, intakes for water supplies and where primary contact recreation does not take place, seasonal disinfection is permitted for NPDES point source discharges."

Response: Please note that the section on "Seasonal Variability" is Section 7.6, not Section 6.6, of both the Draft and Final Reports.

We have removed that last sentence in the Final Report.

10. **Comment:** p. 42, Table 7-1, While this table lists the Tasks that the agencies (DEP/EPA) believe need to be achieved, it isn't clear exactly how these tasks line up with and address the eight sources of impairment listed in Table 6-1. While some of the text in sections 7.1-7.7 describes some actions that can address the sources in Table 6-1, again there is no direct connection and some issues are not addressed at all (e.g., failing infrastructure is mentioned in the title of 7.3 but not addressed in the text). CZM recommends that the final TMDL be more specific and couple the Implementation Plan tasks with the known or expected sources of contamination. This would make the document more useful to a community.

There is also a need for more specific information about what individual communities are currently doing and how much more effort is required (e.g., how many more miles of pipe need to be inspected for illegal connections in a specific community). In addition there are no milestones to which individual communities should aim (e.g., all stormwater lines upstream of known contamination inspected for illegal connections in five years). As another example, on p. 54 (Section 7.0) it is stated that "The strategy includes a mandatory program for implementing storm water BMPs and eliminating illicit sources" but it is not clear over what timeframe a community should be acting.

It would be helpful to the communities trying to implement this plan if the Department were to provide a short list of probable sources of impairment in each community for each of the impaired segments so that funds could be allocated to specific BMPs or other remedial actions in those segments. For example, Table 5-1 should be expanded to include the responsible communities and should be referenced in the Implementation section. Suggesting that more data be collected in certain areas would also be helpful.

Response: With regard to issues raised in paragraph #1 of this comment, (i.e., Tasks in Table 7-1 lining up with sources of impairment listed in Table 6-1), please refer to Comment # 17 and its response in the General Comments Section just above. Please note that the Table 7-1 and Table 6-1 that you refer to in the Draft Report, have been changed to Table 8-1 and Table 7-1 in the Final Report. With regard to specific milestones to be achieved, as well as infrastructure, and implementation activities in specific communities mentioned in paragraph #1 and paragraph 2 of this comment, please see the next five paragraphs below.

First, with regard to infrastructure and implementation activities, it should be pointed out that the overall Section 8, Implementation part of the Final Report submittal has been significantly updated and enhanced from the original Draft Report submittal. Specifically, considerable discussion has been added in Section 8, Subsections 8.1 and 8.2, on various grant and infrastructure activities and accomplishments that have been achieved to date in the watershed.

Subsection 8.1 outlines numerous grant assessment and implementation projects that have been carried out under the Massachusetts Watershed Initiative, the 319 and 604b Grant programs, CZM Coastal Remediation Programs, as well as Division of Marine Fisheries Studies. Additionally, this section discusses the EPA approval of much of the coastal waters of Salem Harbor and Salem Sound as a vessel No Discharge Area (NDA) Zone, as well as significant bacteria pollution findings under the DEP NERO Bacteria Source Tracking Program.

Section 8.2 covers infrastructure improvements such as: (1) City of Gloucester submitting a Final CSO Long Term Control Plan, which includes $14.6 million in sewer separation projects to substantially reduce CSO discharge events from 53 to 2 annually; (2) Town of Essex entering a consent judgment to address the discharge of pollutants from the town's stormwater conveyance system into Essex coastal waters; (3) Lynn Water and Sewer Commission entering a Second Modified Consent Judgment to eliminate all 4 CSOs (2 to Lynn Harbor, 1 to King's Beach, 1 to the Saugus River) by the end of 2009; (4) City of Peabody completing a comprehensive inventory of the City's existing stormwater conveyances, and finding/ fixing a number of illicit connections and failing septic systems going into the stormwater system; (5) a beefing up of the Stormwater Phase II Program in 15 North Coastal communities through a special MWI Grant 2002-3 to foster public education and training of municipal officials on how to comply with that program's regulations. .

Subsection 8.2 also discusses more fully Illicit Discharge Detection and Elimination (IDDE), including EPA and MassDEP policies, and protocols, as well as suggested steps for municipalities to more effectively activate effective control plans in this regard. Subsection 8.3 on Stormwater Runoff contains detailed updates of the implementation activities and accomplishments for each MS4 community included under the Phase II Stormwater program. Additionally, Section 10, Reasonable Assurances, provides supportive information on financial resources and tools available for addressing pollution problems once these are identified in the communities.

In addition to being more specific and detailed on implementation activities, please refer to Comments # 19 and #20 and their responses in the General Comments Section just above. Please note that Section 7.0 that you refer to in the Draft Report has been changed to Section 8.0 in the Final Report.

With regard to issues raised in paragraph 3of this particular comment, reference to Comments # 19 and #20 and their responses in the General Comments Section just above will provide some perspective to these concerns. Also, reference to Subsection 8.3 on each community's Phase II stormwater implementation activity and accomplishment updates will reveal more detail on specific problems. As the text in the General Comments Section, # 19 suggests, it is impossible for this TMDL to identify all significant underlying bacteria water quality problems, and thereby, outline all the work that would be necessary to resolve all these problems for every community in the watershed. As already indicated, the Final TMDL version has added considerable information (in Section 8), as well as additional water quality data and information (in Section 4), to better identify specific pollution problems and their magnitude in the various communities. With this added information, and the detailed discussion of resources and tools available to communities to address pollution problems in Section 10, Reasonable Assurances, proper identification and resolution of bacteria pollution problems should be made more expeditiously in the communities.

With regard to the concern that more data should be gathered in certain areas, please refer to Section 9, 'Monitoring Plan', of the Final Report. This outlines suggestions for future monitoring efforts and what the monitoring goals should be. Also, available data utilized for this particular TMDL report is outlined in Section 4, 'Problem Assessment', along with suggested references where additional data and information for the watershed can be accessed. Additionally, in Section 8, 'Implementation', Table 8-1 outlines possible organizations besides MassDEP who could potentially gather data. Other parts of Section 8 suggest the need for additional monitoring following the incorporation of pollution reduction implementation BMPs in specific communities in the watershed.

11. **Comment:** p. 59, CZM suggests that the Massachusetts Bays National Estuary Program be listed in the second paragraph, last sentence as an organization that the Department will work with on implementing this TMDL. CZM also suggests that the Massachusetts Bays National Estuary Program be listed as an organization contributing to Tasks 10, 11, and 12 listed in Table 7-1.

Response: We will make all those additions. Please note that Table 7-1 in the Draft Report is Table 8-1 in the Final Report.

12. **Comment:** p. 45, Section 7.7, last sentence, please change this sentence to read "Massachusetts State Representative Bill Strauss has introduced legislation that would clearly define the role of harbormasters and other coastal police officers in enforcing NDAs and would allow them to collect up to $2000 for violations in NDAs."

Response: We have made that change. Please note that Section 7.6, 'Recreational Waters Use Management' (not Section 7.7 as you suggest) in the Draft Report has been changed to Section 8.6 in the Final Report.

13. **Comment:** p. 47, Section 8, item 5, It isn't clear who is expected to collate the data collected throughout the North Coastal watershed and where the data would be stored. Is the Department expected to fill this role?

Response: Item #5, (Section 9 of the Final Report), refers to MassDEP collecting data for Water Quality Assessment and related planning purposes. MassDEP does not anticipate fulfilling the role of gathering, storing, and putting into a report format all the other water quality data in the watershed gathered by other organizations and entities besides MassDEP. MassDEP periodically monitors (on a five year rotating basis) the Waters of the Commonwealth. The MassDEP generated data will be stored in its own specifically developed data base. Data that are generated outside of MassDEP are generally utilized for assessment purposes, subject to properly developed QAPPs.

14. **Comment:** p. 47, Section 9, After the sentence "Financial incentives include Federal monies available under the CWA Section 319 NPS program and the CWA Section 604 and 104b programs, which are provided as part of the Performance Partnership Agreement between MADEP and the EPA" CZM requests that the Department add: "State monies are also available through the Massachusetts Office of Coastal Zone Management's Coastal Pollutant Remediation, Coastal Nonpoint Source Pollution Control, and Coastal Monitoring grant programs. The primary goal of all three programs is to improve coastal water quality by reducing or eliminating nonpoint sources of pollution."

Response: We have added those two sentences to that paragraph in the Final Report. Please note that Section 9, Reasonable Assurances in the Draft Report has been changed to Section 10 in the Final Report, and that this section has been significantly expanded.

Appendix B (EPA: Robert Wayland Guidance)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON, D.C. 20460

OFFICE OF WATER

NOV 22 2002

MEMORANDUM

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

FROM: Robert H. Wayland, III, Director

Office of Wetlands, Oceans and Watersheds

James A. Hanlon, Director

Office of Wastewater Management

TO: Water Division Directors

Regions 1 - 10

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

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

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

Storm water discharges from sources that are not currently subject to NPDES

regulation may be addressed by the load allocation component of a TMDL. See

40 C.F.R. § 130.2(g).

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

The WLAs and LAs are to be expressed in numeric form in the TMDL. See 40

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

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

WQBELs for NPDES-regulated storm water discharges that implement WLAs in TMDLs may be expressed in the form of best management practices (BMPs) under specified circumstances. See 33 U.S.C. §1342(p)(3)(B)(iii); 40 C.F.R.

§122.44(k)(2)&(3). If BMPs alone adequately implement the WLAs, then additional controls are not necessary.

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

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

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

The permit should also provide a mechanism to make adjustments to the required

BMPs as necessary to ensure their adequate performance. This memorandum is organized as follows:

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

WLAs in TMDLs;

(II). Options for addressing storm water in TMDLs; and(III). Determining effluent limits in NPDES permits for storm water discharges consistent with the WLA

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

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

250,000 or systems serving a population between 100,000 and 250,000, respectively. These discharges are referred to as Phase I MS4 discharges.

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

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

Administrator or the State determines appropriate for the control of such pollutants." See 33 U.S.C. §1342(p)(3)(B)(iii).

Storm water discharges that are regulated under Phase I or Phase II of the NPDES storm water program are point sources that must be included in the WLA portion of a TMDL. See 40

C.F.R. § 130.2(h). Storm water discharges that are not currently subject to Phase I or Phase II of the NPDES storm water program are not required to obtain NPDES permits. 33 U.S.C.

§1342(p)(1) & (p)(6). Therefore, for regulatory purposes, they are analogous to nonpoint sources and may be included in the LA portion of a TMDL. See 40 C.F.R. § 130.2(g).

(II). Options for Addressing Storm Water in TMDLs

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

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

(III). Determining Effluent Limits in NPDES Permits for Storm Water Discharges

Consistent with the WLA

Where a TMDL has been approved, NPDES permits must contain effluent limits and conditions consistent with the requirements and assumptions of the wasteload allocations in the TMDL. See 40 CFR § 122.44(d)(1)(vii)(B). Effluent limitations to control the discharge of pollutants generally are expressed in numerical form. However, in light of 33 U.S.C.

§1342(p)(3)(B)(iii), EPA recommends that for NPDES-regulated municipal and small construction storm water discharges effluent limits should be expressed as best management practices (BMPs) or other similar requirements, rather than as numeric effluent limits. See *Interim Permitting Approach for Water*

Quality-Based Effluent Limitations in Storm Water Permits, 61 FR 43761 (Aug. 26, 1996). The Interim Permitting Approach Policy recognizes the need for an iterative approach to control pollutants in storm water discharges. Specifically, the policy anticipates that a suite of BMPs will be used in the initial rounds of permits and that these BMPs will be tailored in subsequent rounds.

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

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

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

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

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

. . . and adjustments made as necessary. *NRC Report* at ES-5.

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

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

cc:

Water Quality Branch Chiefs

Regions 1 - 10

Permit Branch Chiefs

Regions 1 - 10