Final Massachusetts Statewide Total Maximum Daily Load for Pathogen-Impaired Waterbodies

Appendix W: Ipswich River Basin & Coastal Drainage Area

Commonwealth of Massachusetts
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December 2024

CN 515.1.23

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Available Online

https://www.mass.gov/lists/total-maximum-daily-loads-by-watershed

Massachusetts Department of Environmental Protection

The mission of the Massachusetts Department of Environmental Protection (MassDEP) is to protect and enhance the Commonwealth's natural resources – air, water, and land – to provide for the health, safety, and welfare of all people, and to ensure a clean and safe environment for future generations. In carrying out this mission MassDEP commits to address and advance environmental justice and equity for all people of the Commonwealth; provide meaningful, inclusive opportunities for people to participate in agency decisions that affect their lives; and ensure a diverse workforce that reflects the communities we serve.

Watershed Planning Program

The mission of the Watershed Planning Program (WPP) in the Massachusetts Department of Environmental Protection is to protect, enhance, and restore the quality and value of the waters of the Commonwealth. Guided by the federal Clean Water Act, WPP implements this mission statewide through five Sections that each have a different technical focus: (1) Surface Water Quality Standards; (2) Surface Water Quality Monitoring; (3) Data Management and Water Quality Assessment; (4) Total Maximum Daily Load; and (5) Nonpoint Source Management. Together with other MassDEP programs and state environmental agencies, WPP shares in the duty and responsibility to secure the environmental, recreational, and public health benefits of clean water for all people of the Commonwealth.

Acknowledgements

FB Environmental Associates, under contractual agreements with MassDEP, previously prepared two separate documents for the Watershed Planning Program: (1) *Massachusetts TMDL for Pathogen-Impaired Inland Fresh Water Rivers* and (2) *Massachusetts Statewide TMDL for Pathogen-Impaired Coastal Waterbodies*. MassDEP combined these two documents into a single statewide approach encompassing both inland fresh water and coastal impairments to prepare the *Final Massachusetts Statewide Total Maximum Daily Load for Pathogen-Impaired Waterbodies*.

Disclaimer

References to trade names, commercial products, manufacturers, or distributors in this report constituted neither endorsement nor recommendations by the Massachusetts Department of Environmental Protection.

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1. Introduction

This appendix to the Massachusetts Statewide Total Maximum Daily Load (TMDL) for Pathogen-Impaired Waterbodies provides additional information to support the determination of the TMDL for the nine pathogen-impaired segments in the Ipswich River Basin & Coastal Drainage Area, hereinafter referred to as the Ipswich River watershed (Figure 1-1). The core document and appendix together complete the TMDL for each of these pathogen-impaired segments.

This appendix includes a description of the watershed and maps to identify the segments of focus for the TMDLs; the impaired uses, and the water classification and qualifiers as designated by the Massachusetts Surface Water Quality Standards (SWQS, 314 CMR 4.00); the water quality standards applicable to the impaired uses; the data supporting the pathogen impairment determination; and a description of the sources of pathogen loading with supporting maps.

This appendix also includes a summary of the allocation of the current indicator bacteria load into two categories: point sources (waste load allocation, WLA) and nonpoint sources (load allocation, LA), based on an analysis of watershed percent impervious cover. This appendix identifies the percent reduction in indicator bacteria pollutant load from current conditions required to meet the TMDL, based on the highest levels of indicator bacteria recorded in the monitoring data, if applicable. The TMDLs for the six freshwater segments were calculated with the flow-based equation, and those for the three estuarine segments were calculated with the load-based equation. Refer to Tables 1-1 through 1-4.

Finally, for each impaired segment, this appendix presents existing local management efforts to reduce pathogen pollutant loading. General recommended next steps for implementation of this TMDL are provided in the Ipswich River Watershed Overview section.

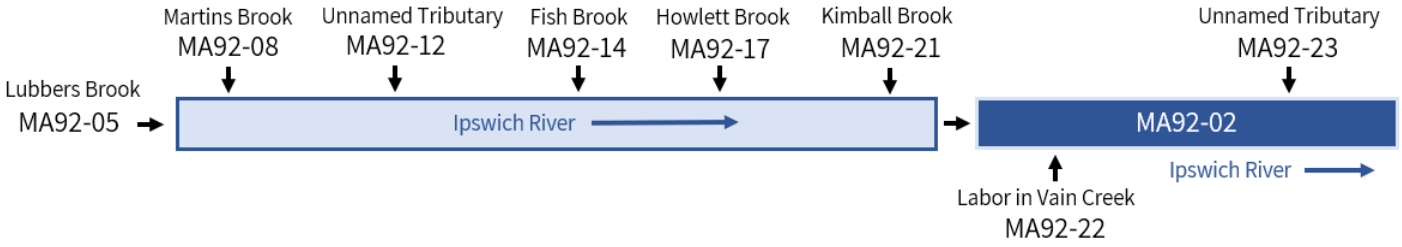


Figure 1-1. Conceptual diagram of water flow through the Ipswich River watershed for the nine pathogen-impaired segments. The mainstem of the Ipswich River is highlighted in blue. Tributary segments to the Ipswich River are shown with black arrows. Not to scale. Impaired segments are shown with the assessment unit.

Table 1-1. ***E. Coli*** Total Maximum Daily Loads (TMDLs), the percent reductions needed to meet the TMDL target (126 CFU/100ml) based on the Massachusetts Surface Water Quality Standards (SWQS), and the flow-based TMDL allocations for pathogen-impaired **freshwater** assessment units in the Ipswich River Basin and Coastal Drainage Area.

Waterbody & Assessment Unit	Class (Qualifier)	TMDL Type	SWQS-Based TMDL target (CFU/100ml)	Maximum Geomean (CFU/100ml)	Geomean Percent Reduction	TMDL Allocation	*Flow (cfs)*					
							1	*10*	*100*	*1,000*	*10,000*	*100,000*
							Flow-Based Target TMDL (CFU/day*10^9)					
Lubbers Brook		R	126	191	34%	WLA (19%)	0.6	5.7	57.3	572.6	5,726.4	57,263.6
MA92-05	B			(90 day)		LA (81%)	2.5	25.1	251.0	2,510.0	25,100.4	251,004.4
Martins Brook		R	126	375	66%	WLA (12%)	0.4	3.8	37.7	377.4	3,773.9	37,738.8
MA92-08	B			(90 day)		LA (88%)	2.7	27.1	270.5	2,705.3	27,052.9	270,529.2
Unnamed Tributary		R	126	1,200	90%	WLA (6%)	0.2	1.7	17.0	170.0	1,699.7	16,997.2
MA92-12	B			(90 day)		LA (94%)	2.9	29.1	291.3	2,912.7	29,127.1	291,270.8
Fish Brook		R	126	389	68%	WLA (7%)	0.2	2.2	22.3	222.8	2,228.1	22,281.1
MA92-14	B			(90 day)		LA (93%)	2.9	28.6	286.0	2,859.9	28,598.7	285,986.9
Howlett Brook		R	126	360	65%	WLA (7%)	0.2	2.0	20.3	202.9	2,028.7	20,287.0
MA92-17	B			(90 day)		LA (93%)	2.9	28.8	288.0	2,879.8	28,798.1	287,981.0
Kimball Brook		R	126	990	87%	WLA (11%)	0.3	3.5	34.7	346.9	3,468.5	34,685.4
MA92-21	B			(90 day)		LA (89%)	2.7	27.4	273.6	2,735.8	27,358.3	273,582.6

Table 1-2. **Enterococci** Total Maximum Daily Loads, the percent reductions needed to meet the TMDL target (35 CFU/100ml) based on the Massachusetts Surface Water Quality Standards (SWQS), and the flow-based TMDL allocations for pathogen-impaired **freshwater** assessment units in the Ipswich River Basin and Coastal Drainage Area.

Waterbody & Assessment Unit	Class (Qualifier)	TMDL Type	SWQS-Based TMDL target (CFU/100ml)	Maximum Geomean (CFU/100ml)	Geomean Percent Reduction	TMDL Allocation	*Flow (cfs)*					
							1	*10*	*100*	*1,000*	*10,000*	*100,000*
							Flow-Based Target TMDL (CFU/day*10^9)					
Lubbers Brook		P	35	NA	-	WLA (19%)	0.2	1.6	15.9	159.1	1,590.7	15,906.6
MA92-05	B					LA (81%)	0.7	7.0	69.7	697.2	6,972.3	69,723.4
Martins Brook		P	35	NA	-	WLA (12%)	0.1	1.0	10.5	104.8	1,048.3	10,483.0
MA92-08	B					LA (88%)	0.8	7.5	75.1	751.5	7,514.7	75,147.0
Unnamed Tributary		P	35	NA	-	WLA (6%)	-	0.5	4.7	47.2	472.1	4,721.5
MA92-12	B					LA (94%)	0.8	8.1	80.9	809.1	8,090.9	80,908.5
Fish Brook		P	35	NA	-	WLA (7%)	0.1	0.6	6.2	61.9	618.9	6,189.2
MA92-14	B					LA (93%)	0.8	7.9	79.4	794.4	7,944.1	79,440.8
Howlett Brook		P	35	NA	-	WLA (7%)	0.1	0.6	5.6	56.4	563.5	5,635.3
MA92-17	B					LA (93%)	0.8	8.0	80.0	799.9	7,999.5	79,994.7
Kimball Brook		P	35	NA	-	WLA (11%)	0.1	1.0	9.6	96.3	963.5	9,634.8
MA92-21	B					LA (89%)	0.8	7.6	76.0	760.0	7,599.5	75,995.2

Table 1-3. Enterococci Total Maximum Daily Loads, the percent reductions needed to meet the TMDL target (35 CFU/100ml) based on the Massachusetts Surface Water Quality Standards (SWQS), and the TMDL allocations for pathogen-impaired **marine** assessment units in the Ipswich River Basin and Coastal Drainage Area.

Waterbody & Assessment Unit	Class (Qualifier)	TMDL Type	SWQS-Based TMDL target (CFU/100ml)	Maximum Geomean (CFU/100ml)	Geomean Percent Reduction	TMDL Allocation	Watershed Area (acres)	Impervious Area in Watershed (acres)	TMDL (CFU/day*10^9)
Ipswich River MA92-02	SA (SF)	P	35	NA	-	WLA (10%) LA (90%)	99,829	9,854	44.42 213.01
Labor in Vain Creek MA92-22	SA (SF)	P	35	NA	-	WLA (2%) LA (98%)	1,334	30	0.13 3.09
Unnamed Tributary MA92-23	SA (SF)	P	35	NA	-	WLA (5%) LA (95%)	349	17	0.08 0.79

Table 1-4. Fecal Coliform Total Maximum Daily Loads, the percent reductions needed to meet the TMDL target (14 CFU/100ml for Class SA) based on the Massachusetts Surface Water Quality Standards (SWQS), and the TMDL allocations for pathogen-impaired **marine** assessment units in the Ipswich River Basin and Coastal Drainage Area.

Waterbody & Assessment Unit	Class (Qualifier)	TMDL Type	SWQS-Based TMDL target (CFU/100ml)	Maximum Geomean (CFU/100ml)	Geomean Percent Reduction	TMDL Allocation	Watershed Area (acres)	Impervious Area in Watershed (acres)	TMDL (CFU/day*10^9)
Ipswich River MA92-02	SA (SF)	R	14	NA	-	WLA (10%) LA (90%)	99,829	9,854	17.77 85.20
Labor in Vain Creek MA92-22	SA (SF)	R	14	NA	-	WLA (2%) LA (98%)	1,334	30	0.05 1.24
Unnamed Tributary MA92-23	SA (SF)	R	14	NA	-	WLA (5%) LA (95%)	349	17	0.03 0.31

Class *defined in the Massachusetts Surface Water Quality Standards (SWQS) at 314 CMR 4.02.*
Qualifiers *that identify segments with special characteristics are defined at 314 CMR 4.06(1)(d).*
SF *= Shellfishing; waters subject to more stringent regulation by Massachusetts Division of Marine Fisheries (DMF) pursuant to M.G.L. c. 130, § 75*
Pathogen bacteria units are presented in colony-forming units or CFU per 100 milliliter or ml.
TMDL Type *identifies the restorative or protective action approach:*
R *= Restorative TMDL addressing a pathogen impairment identified in the 2018/2020 Integrated List of Waters*
R* *= Restorative TMDL addressing a historic impairment of former indicator bacteria for which no current applicable criteria are available See Section 2.3 of the core document for summary of water quality criteria and designated uses.*
P *= Protective TMDL addressing all applicable uses, regardless of impairment status, for the associated pathogen (refer to the Massachusetts SWQS 314 CMR 4.00)*
Target TMDL or Total Maximum Daily Load is presented as both SWQS-Based and Flow-Based.
SWQS-Based TMDL Target *is the target concentration applicable to the TMDL pollutant indicator bacteria based on the Surface Water Quality Standards (314 CMR 4.00).*
Flow-Based Target TMDL *is the target concentration (CFU/100mL) multiplied by the standard flow volume (cubic feet per second or cfs). See Section 4.2.2 in core document for full equation and conversion factors.*
Maximum Geomean *is the highest calculated 30- or 90- day rolling geometric mean for TMDL pollutant indicator bacteria associated with the segment.*
Geomean Percent Reduction *is the percent reduction from the highest calculated 30- or 90- day rolling geomean needed to achieve the target concentration. Percent reductions are for planning purposes only.*

2. Ipswich River Watershed Overview

The Ipswich River watershed covers an area of approximately 155 square miles in northeastern Massachusetts (Figure 2-1). It includes the mainstem of the Ipswich River, which flows northeast from Wilmington to the Atlantic Ocean in Ipswich, MA, as well as numerous tributaries. Overall, there are 18 named freshwater rivers measuring approximately 103 river miles, two unnamed freshwater rivers, two tidal creeks, and 2,226 acres of lakes and ponds in the watershed (MassDEP, 2004). The two tidal creeks and the Ipswich River estuary span an area of roughly 0.47 square miles (MassDEP, 2004).

The mainstem of the Ipswich River is formed by the confluence of Maple Meadow Brook and Lubbers Brook in Wilmington and flows over 31 miles before reaching the Ipswich Mills Dam, where the river then transitions into a tidal estuary (MassDEP, 2004). The watershed upstream of the Ipswich Mill Dam contains six freshwater pathogen-impaired segments, while the remaining three, tidally-influenced pathogen-impaired segments are located in the watershed below the dam.

In addition to the Ipswich Mill Dam, prominent infrastructure along the mainstem of the Ipswich River includes: the Salem Beverly Waterway Canal that diverts water to the communities of Salem and Beverly; the Bostik Company Dam in Middleton; and the Willowdale Dam in Hamilton (MassDEP, 2004). The average precipitation in the Ipswich River watershed is 42.5 inches per year (MassDEP, 2004). Stream flow in surface waters exhibits a seasonal cycle, with lowest values around August and September when losses from evapotranspiration exceed groundwater recharge (MassDEP, 2004). Since groundwater constitutes nearly all of the base flow in surface waters in the watershed, extended periods of drought have resulted in depleted groundwater reserves, leading to dry streams and rivers (MassDEP, 2004).

The Ipswich River watershed overlaps a portion of 22 municipalities in Massachusetts. Of these municipalities, the towns of Middleton, North Reading and Topsfield are completely contained within the watershed. Less than 3% of the land area of the towns of Billerica, Essex, Georgetown, Rowley, Tewksbury, and Woburn are within the Ipswich watershed (MassDEP, 2004), while larger portions of the remaining municipalities lie there. See Figure 2-1 for a map showing impaired segments and watershed municipalities.

All municipalities in the watershed operate and maintain municipal separate storm sewer systems (MS4s) in urban areas. These networks of drains and pipes convey polluted runoff from streets and developed areas to streams. In addition, these networks are sometimes subject to direct wastewater inflows through illegal cross-connections, leaks from sewer pipes or septic systems, dumping, or other unauthorized wastewater sources, and together these sources are termed illicit discharges.

EPA and MassDEP jointly issued the General Permits for Stormwater Discharges from MS4s, which became effective on July 1, 2018, with modifications effective on January 6, 2021 (USEPA, 2020). Communities that discharge to pathogen-impaired waterbodies with approved TMDLs are required to implement enhanced best management practices (BMPs) for public education and designate the catchments as Problem Catchments or High Priority under the Illicit Discharge Detection and Elimination (IDDE) Program, in addition to the MS4 requirement to reduce pollutants to the Maximum Extent Practicable (USEPA, 2020).

The geographic range of three Regional Planning Agencies (RPAs) includes the Ipswich River watershed. RPAs are public organizations advising municipalities, private business groups, and state and federal governments on a range of matters. Their research, coordination and technical assistance are especially valuable on watershed issues such as pathogen pollutants and stormwater that cross town boundaries. These Ipswich RPAs include:

- Merrimack Valley Planning Commission (MVPC; MVPC, 2021)
- Metropolitan Area Planning Council (MAPC; MAPC, 2021)
- Northern Middlesex Council of Governments (NMCOG; NMCOG, 2021)

The following RPA initiatives and tools utilized in the Ipswich watershed are especially noteworthy:

- Regional stormwater coalitions operate within the RPAs, including MVPC's Merrimack Valley Stormwater Collaborative and NMCOG's Northern Middlesex Stormwater Collaborative.

- The MAPC utilizes the Integrated Water Management (IWM) approach to coordinate planning across the wastewater, drinking water, and stormwater sectors.

Beyond these activities, the Massachusetts Statewide Municipal Stormwater Coalition (MSMSC), composed of about 10 stormwater groups around the state, further coordinates with and assists municipalities on pathogen pollutant concerns through their "Think Blue" campaign (Think Blue Massachusetts, 2019).

Additional watershed-scale initiatives are carried out by several organizations, including:

- **Ipswich River Watershed Association** (IRWA) aims to "protect nature and make sure there is enough clean, safe, reliable water for people, fish, and wildlife" (IRWA, 2021).
- **Massachusetts Office of Coastal Zone Management** (CZM) has a North Shore Regional office that "serves the coastal communities from Salisbury to Revere, which are located in the Merrimack, Parker, Ipswich, and North Coastal watersheds." (CZM, 2022a).
- **Nor'East Chapter Trout Unlimited** is involved in spearheading and assisting with stream restoration projects throughout the Ipswich River watershed (TU, 2021).

The following actions by identified stakeholders will help reduce pathogen loads to the impaired segments. The list represents a starting point and is not intended to be comprehensive. For a more detailed discussion of pollutant reduction actions, see Section 5, "Implementation" of the Pathogen TMDL core document.

- **Municipalities:** Continue to implement the MS4 permit, which includes specific requirements for waterbodies with an approved Bacteria/Pathogen TMDL, such as prioritization and reporting, enhanced BMPs, IDDE, and education (USEPA, 2020).
- **Regional Planning Agencies (RPAs) and municipalities:** Continue and expand collaboration on MS4 and stormwater issues. Cooperatively develop tools and share knowledge to reduce costs, increase innovation, and generate consistent and effective stream restoration efforts at the watershed scale.
    - Two tools developed by MAPC are potentially valuable in all MS4 communities across the state; municipalities and other RPAs (with permission from MAPC) should consider adapting and/or expanding these tools in their area:
        - Stormwater Utility/Funding Starting Kit (MAPC, 2014); and
        - a GIS toolkit to calculate MS4 outfall catchments, which is a requirement under the MS4 General Permit, created by MAPC and the Neponset River Watershed Association (MAPC, 2018).
- **USDA NRCS and landowners:** Develop comprehensive nutrient management plans for agriculture, reaching farmers through local connections.
- **Parks departments, schools, private landowners, and others** who maintain large, mowed fields with direct connections to surface water should consider maintaining a vegetated buffer along the shoreline. Buffers slow and filter stormwater runoff, provide a visual screen that can discourage large aggregations of waterfowl, and offer many other water quality benefits at low cost.

Sanitary wastes associated with boating activities are a potential source of pathogens to surface waters. Since 2014, all Massachusetts waters are designated as a No-Discharge Zone (NDZ) in which the discharge of boat sewage is prohibited. Many free boat pump-out services are available at various sites along the coast, funded by the Clean Vessel Act (CZM, 2022b). The Massachusetts CZM webpage maintains online maps of these boat pump-out facilities, and the Clean Vessel Act Program offers a *Boaters Pocket Guide to Pumpout Facilities*. Any sewage discharges from boats or boating infrastructure in the waters covered by this TMDL are therefore illicit discharges.

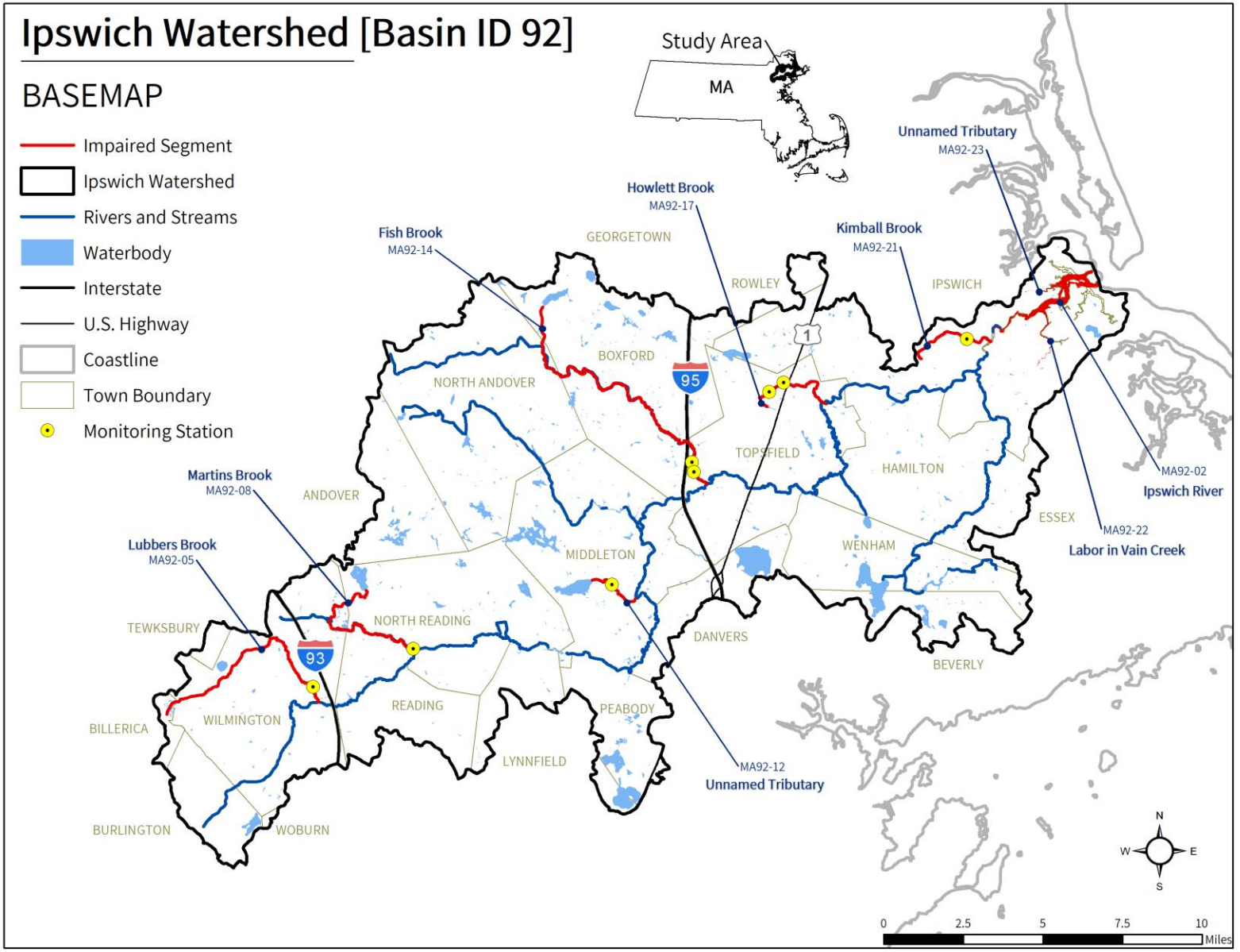


Figure 2-1: Map of all pathogen-impaired segments, water quality monitoring stations, municipal borders, waterbodies, and major roads in the Ipswich River watershed.

3. MA92-02 Ipswich River

3.1. Waterbody Overview

The Ipswich River segment MA92-02 is 0.39 square miles in area and begins at the Ipswich Mills Dam in Ipswich, MA. The segment is tidally influenced, but generally flows in a northeasterly direction to the mouth of the river at Ipswich Bay in Ipswich, MA.

Tributaries to the Ipswich River segment MA92-02 include several tidal creeks, two of which are also pathogen-impaired segments: Labor in Vain Creek (MA92-22) and an unnamed tributary (MA92-23). The contributing watershed encompasses the entire Ipswich River basin and includes 2,226 acres of lakes and ponds, the most notable of which are Salem and Beverly Reservoir, Mill Pond Reservoir, Wenham Lake, Suntaug Lake, Teal Pond, Middleton Pond, Martins Pond, Stiles Pond, and Hood Pond. Much of the river flows through tidal flats and salt marsh wetlands.

Key landmarks in the watershed include the town centers of Middleton, North Reading, Topsfield, Burlington, Wenham, South Hamilton, and Ipswich; the Ipswich River Wildlife Sanctuary; Ipswich River Marshes; Cedar Swamp; the State Forests of Harold Parker and Willowdale; and Bradley Palmer State Park. From upstream to downstream, segment MA92-02 is crossed by a pedestrian bridge downstream of the Ipswich Mills Dam, South Main Street/MA-1A, County Street, and Green Street, all located in Ipswich, MA.

The Ipswich River (MA92-02) drains an area of 156 square miles (mi^2), of which 15.4 mi^2 (10%) are impervious and 8.1 mi^2 (5%) are directly connected impervious area (DCIA). The watershed is partially served by public sewer systems in Burlington, Ipswich, Reading, and Wilmington[1], and 68% of that area is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are eight additional NPDES permits on file governing point source discharges of pollutants to surface waters. Of these eight permits, one is a NPDES permit for a wastewater treatment facility (not within the immediate drainage area to the impaired segment). There are 21 MassDEP discharge-to-groundwater permits for on-site wastewater

Reduction from Highest Calculated Geomean: NA

Watershed Area (Acres): 99,828

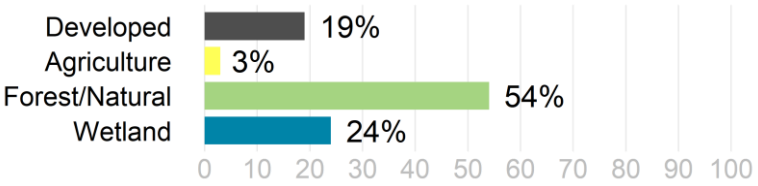
Segment Area (mi^2): 0.39

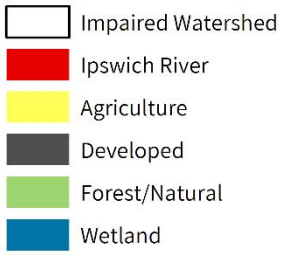
Impairment(s): Fecal Coliform (Shellfish)

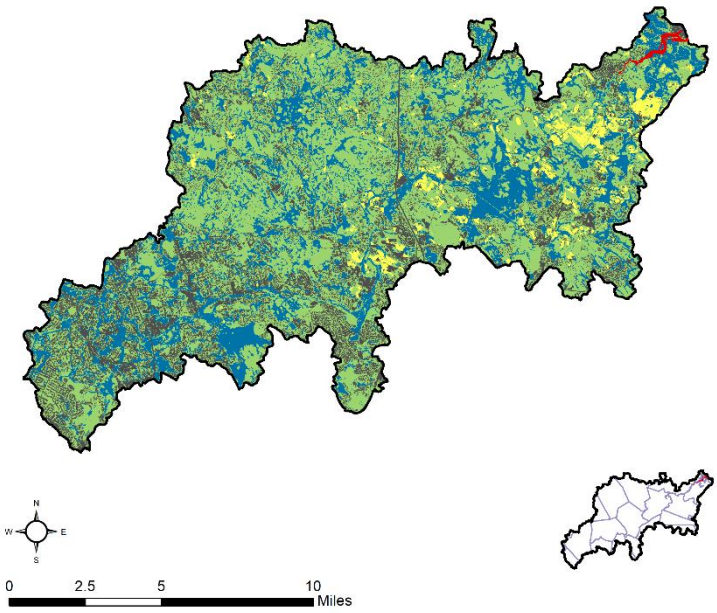
Class (Qualifiers): SA (Shellfishing)

Impervious Area (Acres, %): 9,854 (10%)

DCIA Area (Acres, %): 5,201 (5%)







[1] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project (MassDEP, 2021b), MS4 reports, and local knowledge.

discharges within the watershed (12 of which are within the immediate drainage area to the impaired segment, Table 3-1). There are no combined sewer overflows (CSOs) within the watershed. There are eight landfills and three unpermitted land disposal dumping grounds within the segment watershed. See Figure 3-1.

The Ipswich River watershed is located in a moderately-developed part of the state, covered predominantly with forest and natural lands but with a significant amount of urban area. The developed land (19%) is more than six times greater than the agricultural land (3%) in the watershed. Together, forest/natural and wetland areas make up 78% of the segment's watershed area. The segment itself is surrounded predominantly by wetlands, with some development in the Town of Ipswich near the upstream portion of the segment.

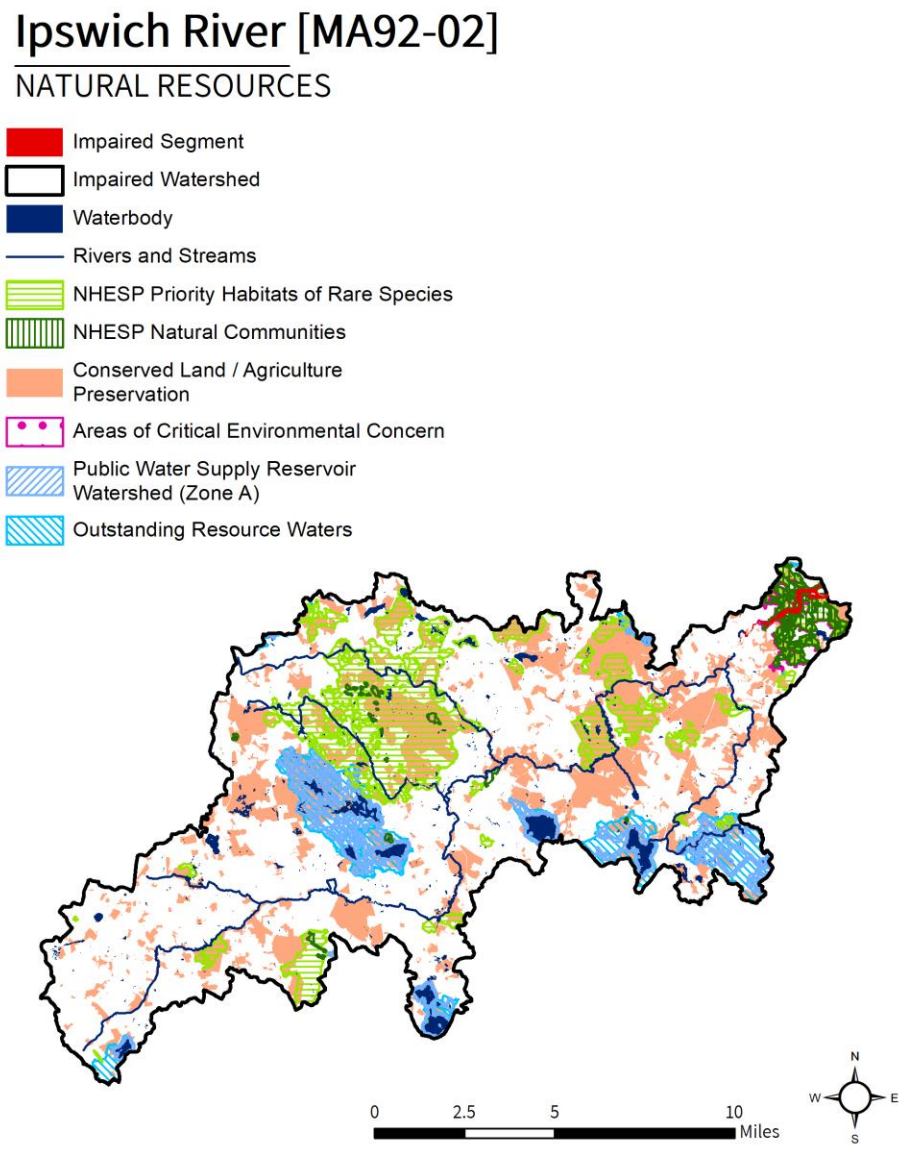
In the watershed of the Ipswich River (MA92-02), under the Natural Heritage and Endangered Species Program, there are 15,124 acres (15%) of Priority Habitats of Rare Species and 1,538 acres (2%) of Priority Natural Vegetation Communities. There are 3,982 acres (4%) under Public Water Supply protection, 1,986 acres (2%) within the Great Marsh Area of Critical Environmental Concern, and 9,529 acres (10%) of Outstanding Resource Waters in the watershed. Over 27,563 acres (28%) of land within the segment watershed are protected in perpetuity[2], part of the total 30,862 acres (31%) of Protected and Recreational Open Space[3]. See Figure 3-1.

Table 3-1. Groundwater discharge permits in the segment watershed. Only permits unique to this segment are shown. PERR = permit number plus renewal number. TYPE = type of groundwater discharge. FLOW = permitted effluent in gallons per day (gpd).

PERR	NAME	TOWN	TYPE	FLOW (GPD)
19-5	GORDON-CONWELL	HAMILTON	Sanitary Discharge	58,000
34-5	WILMINGTON REALTY TRUST	WILMINGTON	Sanitary Discharge	30,000
250-5	FULLER POND VILLAGE	MIDDLETON	Sanitary Discharge	48,000
580-4	MASCONOMET HEALTHCARE CTR	TOPSFIELD	Sanitary Discharge	12,500
624-3	HAMILTON/WENHAM HIGH	HAMILTON	Sanitary Discharge	14,690
666-3	MASCONOMET REG. SCHOOL	BOXFORD	Sanitary Discharge	37,548
730-2	TURNER HILL WWTF	IPSWICH	Sanitary Discharge	99,000
750-1	ASBURY CAMP MTG CORP.	HAMILTON	Sanitary Discharge	38,560
752-2	MIDDLETON MARKETPLACE	MIDDLETON	Sanitary Discharge	13,520
843-1	REGENCY PLACE GARDENS	WILMINGTON	Sanitary Discharge	24,200
916-1	NEW ENGLAND BIOLABS, INC	IPSWICH	Industrial	27,500
931-1	NORTH READING HIGH/MIDDLE SCHOOL	NORTH READING	Sanitary Discharge	17,500

[2] Land protected in perpetuity includes conservation restrictions, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[3] All Protected and Recreational Open Space land is shown on the natural resources map.



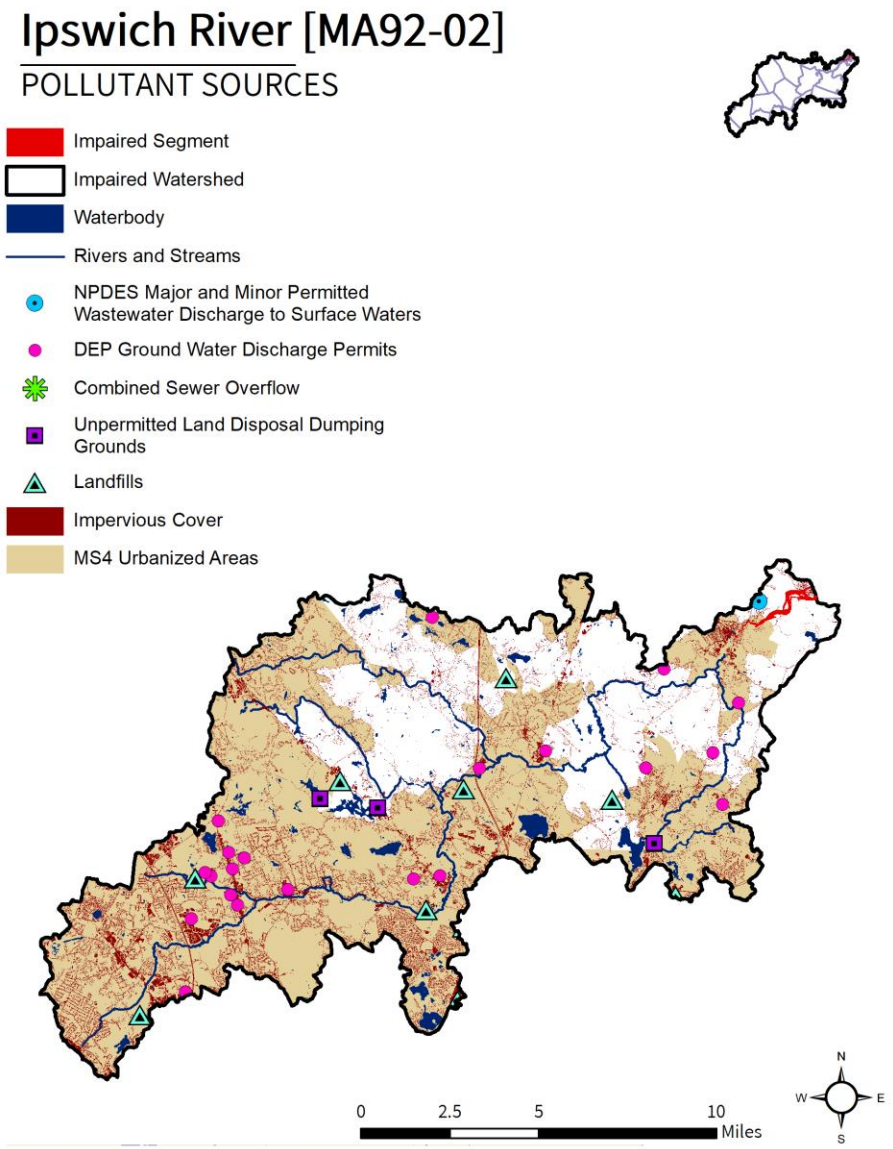


Figure 3-1. Natural resources and potential pollution sources draining to the Ipswich River segment MA92-02. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollutant sources, including impervious cover, MS4 areas, permitted facilities, etc.

3.2. Waterbody Impairment Characterization

The Ipswich River (MA92-02) is a Class SA tidal estuary, with a Shellfishing qualifier (MassDEP, 2021a).

The Shellfish Harvesting use was assessed for attainment of SWQS using fecal coliform indicator bacteria at eight shellfish growing areas that cover 0.37 mi^2 (95% of the segment area; refer to Figure 3-2). MassDEP assessed the Shellfish Harvesting use as not supporting since the growing area normalized to the segment area is less than 100% approved for shellfishing by the Massachusetts Division of Marine Fisheries (Table 3-2).

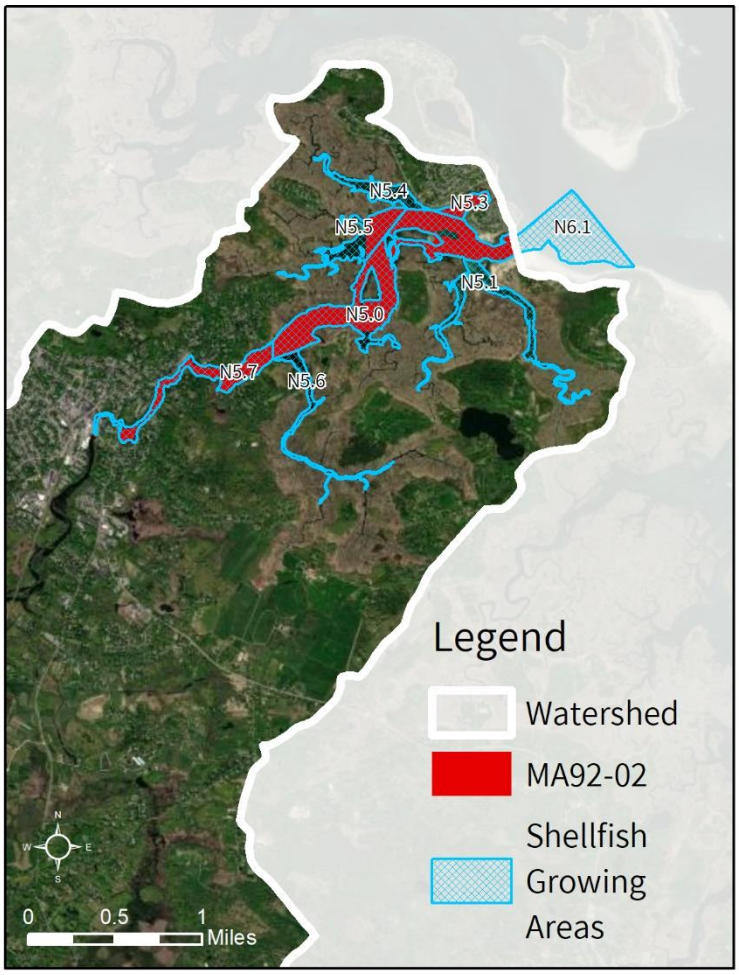


Figure 3-2. Location of shellfish growing areas associated with the impaired segment.

Table 3-2. Summary of MA DFG-Division of Marine Fisheries classification data from January 2014 for eight shellfish growing areas in the Ipswich River segment MA92-02. Percentage indicates the relative area within the segment covered by each shellfish growing area. Shellfish Harvesting is classified as not supporting if the growing area normalized to the segment area is less than 100% approved for shellfishing by the Massachusetts Division of Marine Fisheries.

Name	Area Description	Class	Area (mi^2)	Percentage
N5.0	Ipswich River	Conditionally Approved	0.2547	65%
N5.1	Fox and Treadwell Island Creeks	Conditionally Approved	0.0002	<1%
N5.3	Neck Cove	Conditionally Approved	0.0184	5%
N5.4	Neck Creek	Conditionally Approved	0.0006	<1%
N5.5	Greenwoods	Prohibited	0.0303	8%
N5.6	Labor-in-Vain Creek	Conditionally Approved	0.0011	<1%
N5.7	Upper Ipswich River	Prohibited	0.0651	17%
N6.1	Steep Hill Beach	Prohibited	0.0009	<1%

3.3. Potential Pathogen Sources

Each potential pathogen source is described in further detail below.

Urban Stormwater: There is a sizable amount of development in the watershed, with 68% of the land area subject to MS4 permit conditions, 10% is classified as impervious area, and 5% as DCIA. Major highways that run through the watershed include I-95, I-93, and U.S. Route 1. Urban areas are clustered in a few locations alongside the Ipswich River and its tributaries. Stormwater runoff from these areas is likely a significant source of pathogens.

Illicit Sewage Discharges: Public sewer service is available in the watershed within the towns of Burlington, Reading and Wilmington. Sewerage-related threats to water quality include leaking infrastructure (pipes, pump stations, etc.) and sanitary sewer overflows (SSOs), which may be caused by undersized infrastructure, blockages, or excessive infiltration of groundwater or rainwater into pipes, exceeding system capacity. Illicit connections of wastewater to stormwater conveyances are also a potential source.

On-Site Wastewater Disposal Systems: Most of the watershed utilizes on-site septic systems for wastewater treatment. There are 21 MassDEP permits for on-site wastewater discharges to groundwater. In addition to these permitted point sources, it is likely that some septic systems are not properly maintained and are discharging untreated effluent to groundwater. MassDEP identified failing on-site wastewater disposal systems as a likely source of the Shellfish Harvesting impairment in this segment of the Ipswich River.

Illicit Boat Discharges: The segment is navigable by marine vessels. Vessels with onboard toilets are required to have a marine sanitation device (MSD) to treat or store wastewater. MSDs that treat wastewater may be improperly maintained or malfunctioning and therefore could discharge untreated sewage to coastal waterbodies. For MSDs that store wastewater, this sewage can either be pumped out at shore-based pump-out facilities or discharged directly into the water when the vessel is more than three miles offshore, beyond the designated No Discharge Zone (NDZ). Negligent boaters may ignore these laws and discharge untreated sewage to coastal waterbodies.

Vessel Pump-Out Facilities: There are no vessel sewage pump-out facilities directly adjacent to the Ipswich River segment MA92-02 (CZM, 2022b). Although pump-out facilities provide boaters with a means of disposing of onboard sewage without discharging it into coastal waters, these facilities are generally associated with high boating activity. As a result, waterbodies adjacent to pump-out facilities are likely at high risk of illicit boat (or facility) discharges.

Agriculture: Agricultural activities in the watershed account for a small portion (3%) of the total land use. These areas are predominantly located in the downstream portion of the watershed, close to the segment. The agricultural lands are largely used for pasture and hay production, as well as other crops. Manure storage and spreading activities, if not properly conducted, are possible sources of pathogens to waterbodies.

Pet Waste: A few high-density residential neighborhoods are located directly adjacent to the impaired segment. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths or residential neighborhoods are adjacent to rivers, ponds, or wetlands, represent possible sources of pathogens.

Wildlife Waste: There are large wetland areas adjacent to the segment. Large mowed areas, fields, or wetlands with a clear sightline to a waterbody may attract large congregations of waterfowl, resulting in elevated indicator bacteria counts in the water.

3.4. Existing Local Management

This section identifies the major municipalities immediately surrounding the impaired segment and its contributing watershed. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Boxford

A little over half of Boxford is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (Permit ID # MAR041184), and the town has an EPA-approved Notice of Intent (NOI). Boxford has mapped 100% of its MS4 system and has also submitted the required year-one Annual Report. Boxford

completed an illicit discharge detection and elimination (IDDE) plan in 2006, and an erosion and sedimentation control (ESC) plan and post-construction stormwater regulations in 2016. According to the NOI, pathogen-impaired MS4 receiving waters include Fish Brook (6 outfalls), with elevated *E. coli* levels. The town did not report the segment Assessment Unit ID for any of the listed receiving waters.

Boxford has the following ordinances and bylaws, mostly accessible online via the town website https://www.town.boxford.ma.us/ (Town of Boxford, 2021):

- Wetland protection ordinance
- Stormwater control ordinance and Title 5 supplemental regulations
- Pet Waste: None found

A comprehensive town-wide Master Plan was not found online. An Open Space and Recreation Plan was developed in 2015, and includes a section dedicated to water resources. Within this section is an inventory of existing resources and a sub-section describing impaired waters. The plan also notes that Boxford utilizes on-site private, subsurface septic systems. A Climate Change Action Plan was under development in 2021 (Town of Boxford, 2021).

Town of Hamilton

About 40% of Hamilton is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (Permit ID # MAR041196), and the town has an EPA-approved Notice of Intent (NOI). Hamilton completed an illicit discharge detection and elimination (IDDE) plan, an erosion and sedimentation control (ESC) plan, and post-construction stormwater regulations, all in 2007. The entire MS4 system within Hamilton has been mapped. According to Hamilton's NOI, there are 23 stormwater outfalls into the Miles River (MA92-03, previously pathogen-impaired, but now meeting water quality standards).

Hamilton has the following ordinances and bylaws, mostly accessible online via the town website https://www.hamiltonma.gov/ (Town of Hamilton, 2021):

- Wetland protection bylaw
- A stormwater bylaw
- Stormwater Utility: None found
- Pet Waste: None found

Hamilton has a 2004 Master Plan and has already allocated funds toward producing an updated Master Plan. Within the 2004 plan there is an Open Space and Resource Protection section, with a list of actions that the town is planning to take to protect primary and secondary waterways, as well as the public groundwater supply. These actions include creating a public funding source to acquire more land for conservation and establishing more regulations to strengthen buffers along waterways (Town of Hamilton, 2021).

Town of Ipswich

About 70% of Ipswich is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (Permit ID #MAR041199), and the town has an EPA-approved Notice of Intent (NOI). The town has mapped 90% of its MS4 system, and the year-one Annual Report was submitted. In 2008, Ipswich completed an illicit discharge detection and elimination (IDDE) plan, an erosion and sedimentation control (ESC) plan, and post-construction stormwater regulations. According to the NOI, pathogen-impaired MS4 receiving waters with elevated levels of fecal coliform include Labor-in-Vain Creek (MA92-22, four stormwater outfalls), Ipswich River (MA92-02 and MA92-15, 351 outfalls), Kimball Brook (MA92-21, eight outfalls); and Miles River (MA92-03, previously pathogen-impaired, but now meeting water quality criteria).

Ipswich has the following ordinances and bylaws, mostly accessible online via the town website https://www.ipswichma.gov/ (Town of Ipswich, 2021):

- Stormwater control bylaw and stormwater utility fee
- Wetland protection bylaw
- Pet Waste: None found

Ipswich has a 2021 Community Development Plan. This plan features goals for climate-resilient infrastructure, including maintenance and improvements to Ipswich's water system and the implementation of stricter stormwater bylaws (pgs. 27 & 28). This plan also identifies natural resource protection as a major goal, specifically related to best management practices as required by the town's MS4 permit (pg. 38). Upgrading the town's sewer system is also a major goal. Ipswich has a 2013 Open Space and Recreation Plan, which includes detailed inventories of relevant resources within the town (Town of Ipswich, 2021).

Town of Middleton

About 90% of Middleton is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (Permit ID #MAR041211), and the town has an EPA-approved Notice of Intent (NOI). The town has mapped 70% of its MS4 system and the year-one Annual Report has been submitted. In 2014, Middleton completed an illicit discharge detection and elimination (IDDE) plan, an erosion and sedimentation control (ESC) plan, and post-construction stormwater regulations. According to the NOI, pathogen-impaired MS4 receiving waters include an unnamed tributary (MA92-12, 160 outfalls), which has elevated *E. coli* levels.

Middleton has the following ordinances and bylaws, mostly accessible online via the town website (Town of Middleton, 2021):

- Stormwater control bylaws and utility fees
- Wetland protection bylaw
- Pet Waste: None found

Middleton has a 2018 Master Plan which identifies local natural resources and challenges to them. For example, flooding and erosion control are identified as environmental challenges. Stormwater is not mentioned in this plan, and a sewer-specific section was not developed. No Open Space and Recreation Plan was found online.

Town of North Andover

The majority of North Andover is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (Permit ID #MAR041214), and the town has an EPA-approved Notice of Intent (NOI). All of the MS4 system within the town has been mapped and the year-one Annual Report has been submitted. In 2009, North Andover completed an illicit discharge detection and elimination (IDDE) plan, an erosion and sedimentation control (ESC) plan, and post-construction stormwater regulations.

North Andover has the following ordinances and bylaws, mostly accessible online via the town website (Town of North Andover, 2021):

- Wetland protection bylaw
- Stormwater control bylaw and utility fee
- Pet Waste: None found

North Andover adopted a Master Plan in 2018. This plan includes multiple sections related to the environment, such as natural resources and open space. Within the natural resources section, specific waterbodies are identified but no impairments are mentioned. Stormwater is mentioned throughout the Master Plan, with expanding and updating existing infrastructure identified as a goal. North Andover also developed the 2016 Open Space and Recreation Plan.

Town of North Reading

All of North Reading is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (Permit ID #MAR041215), and the town has an EPA-approved Notice of Intent (NOI). All of the MS4 system within the town has been mapped and the year-one Annual Report has been submitted. North Andover completed an illicit discharge detection and elimination (IDDE) plan in 2006, and an erosion and sedimentation control (ESC) plan and post-construction stormwater regulations in 2010. According to the NOI, pathogen-impaired MS4 receiving waters include Martins Brook (MA92-08, 18 stormwater outfalls), with elevated levels of *E. coli.*

North Reading has the following ordinances and bylaws mostly accessible online via the town website (Town of North Reading, 2021)

- Wetland protection bylaw
- Stormwater control bylaw and utility fee
- Pet waste control bylaw

The town of North Reading has a 2020 Master Plan, which includes a natural resources section describing the existing environment within the town; stormwater was not noted in this plan. The town has no public sewer system or wastewater treatment facilities. North Reading also has a 2020 Open Space and Recreation Plan, which further identifies water resources.

Town of Topsfield

Most of Topsfield is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (Permit ID #MAR041227), and the town has an EPA-approved Notice of Intent (NOI). The town has mapped 70% of the MS4 system and the year-one Annual Report has been submitted. Topsfield completed an illicit discharge detection and elimination (IDDE) plan in 2010, an erosion and sedimentation control (ESC) plan in 2005, and post-construction stormwater regulations in 2015. The town's NOI indicates segment MA92-17 as pathogen-impaired (based on elevated *E. coli,* levels) but does not specify the waterbody name (Howlett Brook) or number of outfalls to that stream.

Topsfield has the following ordinances and bylaws, mostly accessible online via the town website (Town of Topsfield, 2021):

- Wetland protection bylaw
- Stormwater control bylaw and utility fees
- Pet Waste: None found

No Master Plan was found online for Topsfield; an Open Space and Recreation Plan was developed in 2010. This plan features a water resources section but does not list specific waterbodies or impairments.

Town of Wenham

The majority of Wenham is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (Permit ID #MAR041230), and the town has an EPA-approved Notice of Intent (NOI). All of the MS4 system within the town has been mapped and the year-one Annual Report has been submitted. Wenham completed an illicit discharge detection and elimination (IDDE) plan in 2008, and an erosion and sedimentation control (ESC) plan and post-construction stormwater regulations in 2009. According to the town's NOI, pathogen-impaired MS4 receiving waters include the Miles River (MA92-03, five stormwater outfalls); however, recent data show that pathogen levels now meet water quality criteria.

Wenham has the following ordinances and bylaws, mostly accessible online via the town website (Town of Wenham, 2021):

- Wetland protection bylaw
- Stormwater control bylaw
- Contact recreation bylaw
- Stormwater Utility: None found
- Pet Waste: None found

The most recent Master Plan for the Town of Wenham was developed in 1960, although funding for an updated Master Plan was approved in 2021. The town has a 2019 Open Space and Recreation Plan, which contains a water resources section. This section identifies stormwater runoff and failing sewer system infrastructure as a major source of pollution to water bodies. The plan also includes a section about specific pathogen-impaired waterbodies, and it lists Wenham's town beaches.

Town of Wilmington

All of Wilmington is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (Permit ID #MAR041234), and the town has an EPA-approved Notice of Intent (NOI). All of the MS4 system within the town has been mapped and the year-one Annual Report has been submitted. Wilmington completed an illicit discharge detection and elimination (IDDE) plan in 2007, and an erosion and sedimentation control (ESC) plan and post-construction stormwater regulations in 2009. According to the town's NOI, pathogen-impaired MS4 receiving waters include Lubbers Brook (MA92-05, 152 outfalls), which has elevated *E. coli* levels; and Martins Brook (MA92-08, 61 outfalls), with elevated *E. coli* and fecal coliform levels.

Wilmington has the following ordinances and bylaws, mostly accessible online via the town website (Town of Wilmington, 2021):

- Stormwater control bylaws and utility fee
- Wetland protection bylaws
- Pet Waste: None found

Wilmington has a 2001 Master Plan, with a section dedicated to water resources and wastewater needs and planning. Included are ways in which the town can improve stormwater runoff and associated problems. Additionally, Wilmington has a 2015 Open Space and Recreation Plan that identifies water resources and specifies impairment status. There are freshwater beaches within the town, including one on Silver Lake. Local beaches have been closed in the past due to bacterial contamination. In Wilmington, 82% of households use on-site septic systems while the MWRA provides sewer services to the remaining 18%.

4. MA92-05 Lubbers Brook

4.1. Waterbody Overview

Lubbers Brook segment MA92-05 is 5.6 miles long and begins in a wetland in Billerica, MA. The segment flows northeast before bending south and joining Maple Meadow Brook to form the mainstem of the Ipswich River in Wilmington, MA.

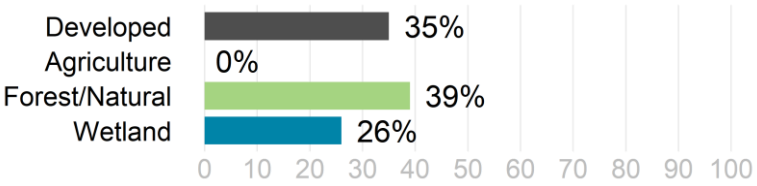
Tributaries to Lubbers Brook include a few small unnamed streams and several wetlands. Lakes and ponds in the watershed include Lubbers Pond West (MA9036), Lubbers Pond East (MA92035), Silver Lake, and a few small unnamed ponds. Much of the stream flows through marsh, swamp, and other wetlands.

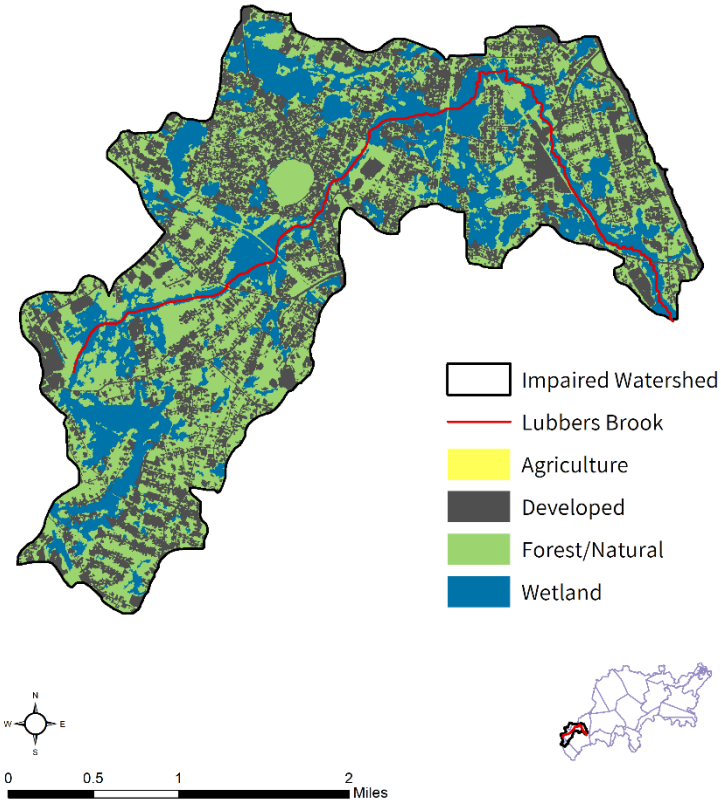
Key landmarks in the watershed include Wilmington Town Hall, the North Wilmington Transit Station, Silver Lake Town Beach (Silver Lake), Wilmington Middle School, North Intermediate School, and Woburn Street School. From upstream to downstream, segment MA92-05 is crossed by Shawsheen Avenue/MA-129, Phillips Ave, Main Street/MA-38, Glen Road, Middlesex Avenue/MA-62, Concord Street, all within Wilmington.

Lubbers Brook (MA92-05) drains an area of 5.9 square miles, of which 1.1 mi^2 (19%) are impervious and 0.6 mi^2 (11%) are directly connected impervious area (DCIA). The watershed is partially served by public sewer in Burlington and Wilmington[4], and all land area is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are no NPDES permits on file governing point source discharges of pollutants to surface waters, MassDEP discharge-to-groundwater permits for on-site wastewater discharges, or combined sewer overflows (CSOs) within the watershed. There are no landfills or unpermitted land disposal dumping grounds within the segment watershed. See Figure 4-1.

The Lubbers Brook watershed is located in a highly developed part of the state, with land area split almost evenly between developed, forest/natural, and wetland areas. There is no

Reduction from Highest Calculated Geomean: 34%
Watershed Area (Acres): 3,772
Segment Length (Miles): 5.6
Impairment(s): *E. coli* (Primary Contact Recreation)
Class (Qualifier): B
Impervious Area (Acres, %): 701 (19%)
DCIA Area (Acres, %): 399 (11%)





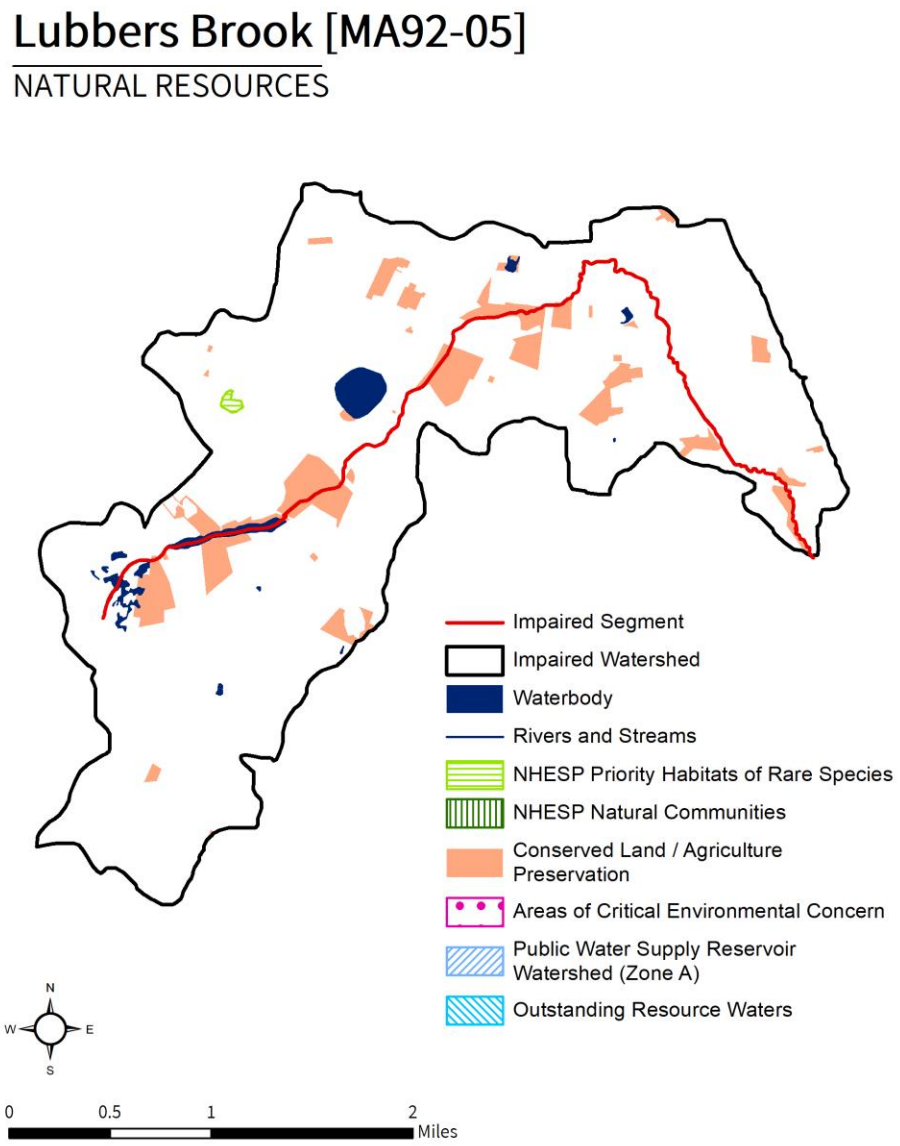
[4] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project (MassDEP, 2021b), MS4 reports, and local knowledge.

identified agricultural activity in the watershed, and forest/natural and wetland areas combined make up 65% of the segment's watershed area. The other 35% of the watershed is developed, predominately with residential homes as well as commercial and residential development along major roads. The segment itself is surrounded by wetlands and forest, with development closest to the segment near the road crossings.

In the Lubbers Brook (MA92-05) watershed, under the Natural Heritage and Endangered Species Program, there are four acres (<1%) of Priority Habitats of Rare Species and no Priority Natural Vegetation Communities. There are no acres under Public Water Supply protection, within Areas of Critical Environmental Concern, or Outstanding Resource Waters in the watershed. Over 274 acres (7%) of land within the segment watershed are protected in perpetuity[5], part of the total 306 acres (8%) of Protected and Recreational Open Space[6]. See Figure 4-1.

[5] Land protected in perpetuity includes conservation restrictions, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[6] All Protected and Recreational Open Space land is shown on the natural resources map.



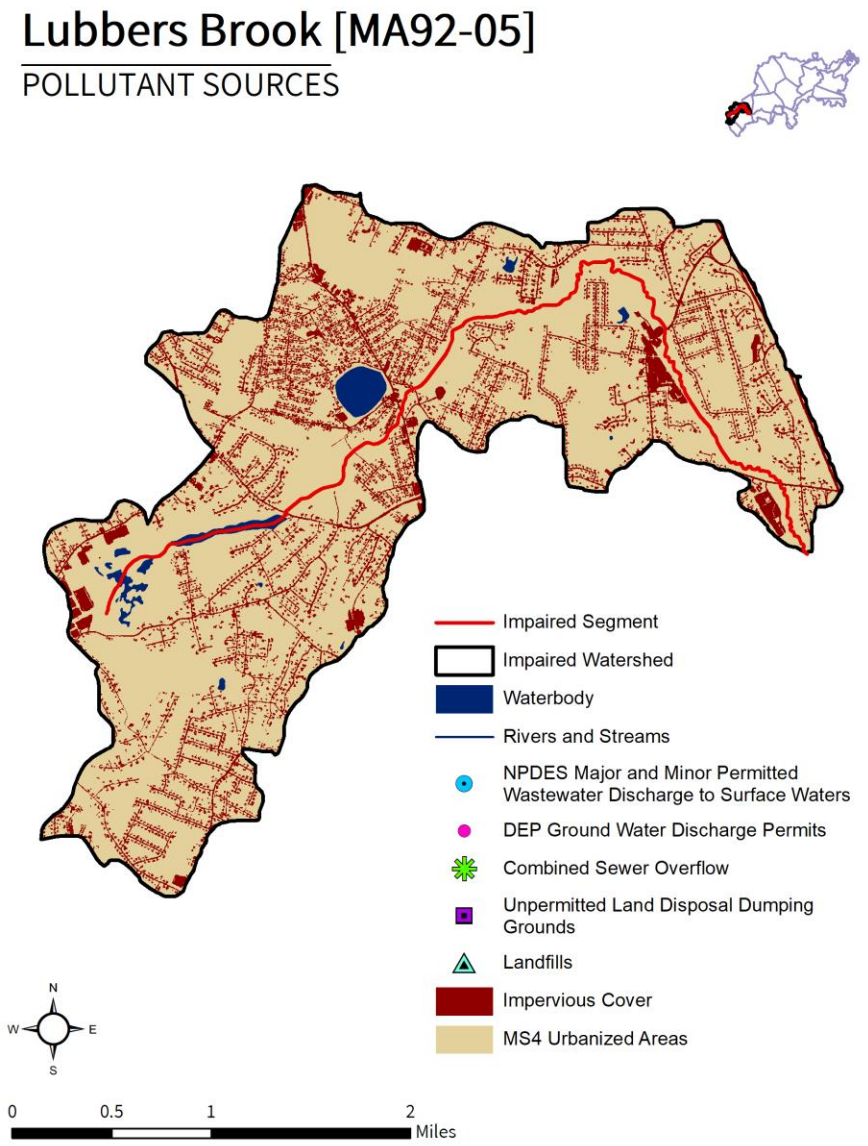


Figure 4-1. Natural resources and potential pollution sources draining to the Lubbers Brook segment MA92-05. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollutant sources, including impervious cover, MS4 areas, permitted facilities, etc.

4.2. Waterbody Impairment Characterization

Lubbers Brook (MA92-05) is a Class B Water (MassDEP, 2021a).

The Primary Contact Recreation use was assessed for attainment of the Massachusetts Surface Water Quality Standards (SWQS) at the station listed below (refer to Tables 4-1, 4-2; Figure 4-2) using the indicator bacteria *E. coli*. Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 90-day rolling basis.

- In 2005, five samples were collected at W0139; data indicated two days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the Statistical Threshold Value (STV) criterion was applied to single sample results. None of the five samples exceeded the STV criterion.

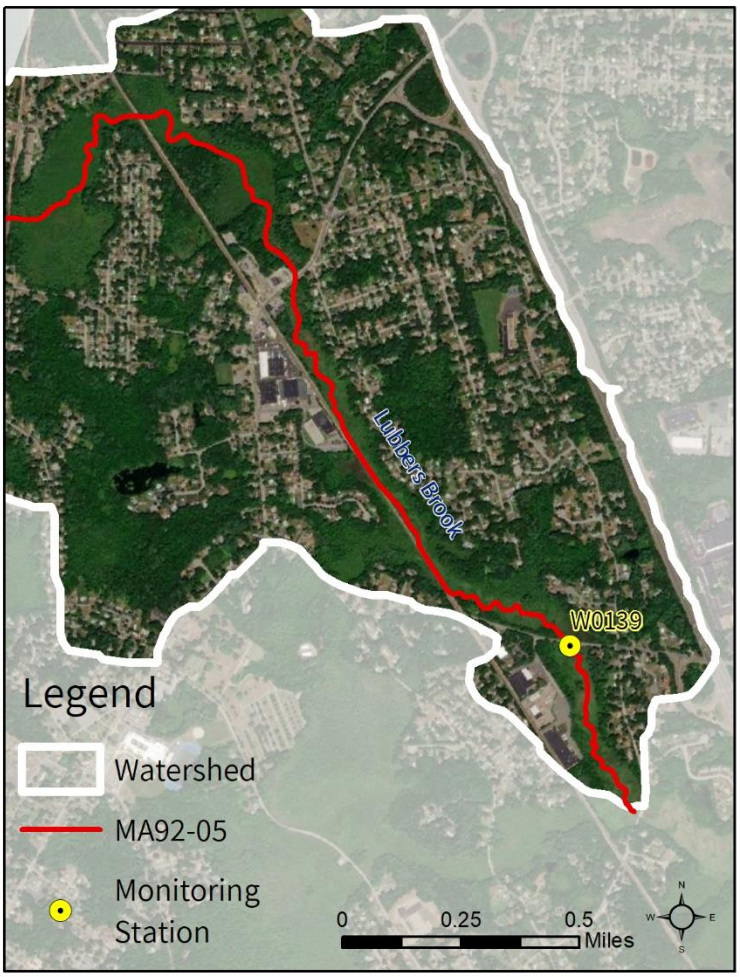


Figure 4-2. Location of monitoring station(s) along the impaired segment.

Table 4-1. Summary of indicator bacteria sampling results by station for Lubbers Brook (MA92-05). The maximum 90-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the STV criterion of 410 CFU/100 mL for *E. coli* indicator bacteria are shown. The STV criterion is applied to the single sample results if less than 10 samples were collected within a calendar year at a site. The highest maximum 90-day rolling geomean of the sites is used to calculate the percent load reduction required to meet SWQS.

Unique Station ID	First Sample	Last Sample	Count	Maximum 90-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
W0139	5/24/2005	9/27/2005	5	191	2	0

Table 4-2. Indicator bacteria data by station, indicator, and date for Lubbers Brook (MA92-05). Each sample date was designated as representing wet or dry weather conditions with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text in the Results column highlights criteria exceedances of 410 CFU/100 mL (applied to single-sample "Result" since there were no more than 10 samples in a year to calculate the STV; and red text in the Geomean column highlights exceedances of the 126 CFU/100 mL criterion (applied to rolling 90-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W0139	*E. coli*	5/24/2005	WET	160	160	
W0139	*E. coli*	6/21/2005	DRY	32	72	
W0139	*E. coli*	7/27/2005	DRY	97	79	
W0139	*E. coli*	8/24/2005	DRY	210	87	
W0139	*E. coli*	9/27/2005	DRY	340	191	
W0139	Fecal Coliform	5/24/2005	WET	210		
W0139	Fecal Coliform	6/21/2005	DRY	26		
W0139	Fecal Coliform	7/27/2005	DRY	71		
W0139	Fecal Coliform	8/24/2005	DRY	150		
W0139	Fecal Coliform	9/27/2005	DRY	190		

4.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information that can be used to focus pollutant reduction activities. Pathogen levels (as estimated by indicator bacteria) are usually higher in wet weather conditions as storm sewer systems overflow and/or stormwater runoff carries fecal matter that has accumulated on the landscape to surface waters via overland flow and stormwater conduits. Wet weather sources include wildlife and domesticated animal waste (including pets), urban stormwater runoff (including MS4 areas), CSOs, and sanitary sewer overflows (SSOs). In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants during dry weather, which then becomes diluted by precipitation. Dry weather sources include leaking sewer pipes, illicit connections of sanitary sewers to storm drains, failing septic systems, recreational use (such as swimmers), and direct wildlife and domesticated animal waste (including pets).

Indicator bacteria data for Lubbers Brook (MA92-05) were elevated during both wet and dry weather. Elevated results during wet weather are consistent with urban stormwater, pet waste, and wildlife pathogen sources, as are certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation. Elevated results during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be the major sources of pathogens. Given the relatively small sample set, additional sampling under both wet and dry conditions, ideally at more than one location, would likely help identify specific pollutant sources.

Each potential pathogen source is described in further detail below.

Urban Stormwater: The entire watershed is densely developed, with all land area subject to MS4 permit conditions, 19% of the land is classified as impervious area, and 11% as DCIA. In addition to medium- to high-density residential development, there are many large commercial and industrial developments near the segment in downstream areas. Stormwater runoff from urban areas is likely a significant source of pathogens.

Illicit Sewage Discharges: Public sewer service is available in the watershed within the towns of Burlington and Wilmington. Sewerage-related threats to water quality include leaking infrastructure (pipes, pump stations, etc.) and SSOs, which may be caused by undersized infrastructure, blockages, or excessive infiltration of groundwater or rainwater into pipes, exceeding system capacity. Illicit connections of wastewater to stormwater conveyances are also potential sources.

On-Site Wastewater Disposal Systems: Waste disposal in some of the residential developments in the upper watershed consists of on-site septic systems, due to the absence of public sewer services. It is likely that a portion of such systems are not properly maintained and are discharging untreated effluent to groundwater.

Agriculture: There is no identified agricultural activity in the watershed, therefore stormwater runoff from agricultural land is not a likely source of pathogens to the impaired segment.

Pet Waste: There are many medium- to high-density residential developments near Lubbers Brook. Conservation lands, parks, ballfields, and residential neighborhoods popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent possible sources of pathogens.

Wildlife Waste: Nearly the entire segment is surrounded by wooded buffers, with a few areas containing open wetlands. Large mowed areas, fields, or wetlands with a clear sightline to a waterbody may attract large congregations of waterfowl, resulting in elevated indicator bacteria counts in the water.

4.4. Existing Local Management

This section identifies the major municipalities immediately surrounding the impaired segment and its contributing watershed. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Burlington

All of Burlington is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (Permit ID # MAR041030), and the town has an EPA-approved Notice of Intent (NOI). Burlington has mapped 90% of its MS4 system and has submitted the year-one Annual Report. The town has an illicit discharge detection and elimination (IDDE) plan, an erosion and sedimentation control (ESC) plan, and post-construction stormwater regulations, all completed in 2006.

Burlington has the following ordinances and bylaws, mostly accessible online via the town website https://www.burlington.org/ (Town of Burlington, 2021):

- Wetland protection bylaw
- A stormwater regulation bylaw
- Pet Waste: None found

Burlington's 2018 Master Plan features in-depth sections relating to the environment and stormwater in general. Stormwater runoff is addressed as it affects town resources (pg. 90), and is noted in the natural resources section (pg. 93). The plan identifies specific watersheds that are impaired (pg. 84). Open space and wetlands protection are included in both the Master Plan and the 2019 Open Space and Recreation Plan. Burlington boasts its own sewer system, constructed in the mid 1900's (pg. 138), and the town currently provides water and sewer services (pg. 140). This plan does not specifically address bacterial impairment or freshwater beach resources (Town of Burlington, 2021).

Town of Tewksbury

All of Tewksbury is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (Permit ID #MAR041226), and the town has an EPA-approved Notice of Intent (NOI). All of the MS4 system within the town has been mapped and the year-one Annual Report has been submitted. Tewksbury completed an illicit discharge detection and elimination (IDDE) plan in 2010, and an erosion and sedimentation control (ESC) plan and post-construction stormwater regulations in 2011.

Tewksbury has the following ordinances and bylaws, mostly accessible online via the town website https://www.tewksbury-ma.gov/ (Town of Tewksury, 2021):

- Wetland protection bylaw
- Stormwater control bylaw and utility fees
- Pet Waste: None found

Tewksbury has a 2016 Master Plan, which includes an inventory of all waterbodies within the town's borders. This section features descriptions of the issues occurring within the waterbodies and highlights issues with

nonpoint source pollution as a source of pathogens. Additional planning includes $1.4 million in stormwater improvements. A section is dedicated to identifying water pollution sources and effects. The town owns and operates 166 miles of public sewer system. Tewksbury also has a 2019 Open Space and Recreation Plan, with an in-depth description of waterbodies within Tewksbury (Town of Tewksury, 2021).

Town of Wilmington. See Section 3.4

5. MA92-08 Martins Brook

5.1. Waterbody Overview

The Martins Brook segment MA92-08 is 4.6 miles long and begins at the outlet of Martins Pond in North Reading, MA. The segment flows in a westerly direction into Wilmington before turning south, then east to end at its confluence with the Ipswich River in North Reading, MA.

Tributaries to Martins Brook segment MA92-08 include the Skug River which drains into Martins Pond, Rapier Brook, and a few small unnamed streams. Lakes and ponds in the watershed include Bear Pond, Berry Pond, Brackett Pond, Bradford Pond, Collins Pond, Field Pond, Frye Pond, and Martins Pond. Much of the brook flows through forested swamp and other wetlands.

Key landmarks in the watershed include Hillview Country Club, Harold Parker State Forest, Skug River Reservation, Sherborne Park Green Area, and J. Turner Hood School. From upstream to downstream, segment MA92-08 is crossed by Burroughs Road (North Reading), Salem Street/MA-62 (Wilmington), Main Street/MA-28 (North Reading), and Park Street (North Reading).

Martins Brook (MA92-08) drains an area of 13.2 square miles (mi^2), of which 1.6 mi^2 (12%) are impervious and 0.9 mi^2 (7%) are directly connected impervious area (DCIA). The watershed is partially served by a public sewer system in Wilmington[7], and all of the land area is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are two additional NPDES permits on file governing point source discharges of pollutants to surface waters (neither are for a wastewater treatment facility). There are eight MassDEP discharge-to-groundwater permits for on-site wastewater discharges within the watershed (all of which are within the immediate drainage area to the impaired segment, Table 5-1). There are no combined sewer overflows (CSOs) within the watershed. There is one landfill and no unpermitted land disposal dumping grounds within the segment watershed. See Figure 5-1.

Reduction from Highest Calculated Geomean: 66%

Watershed Area (Acres): 8,460

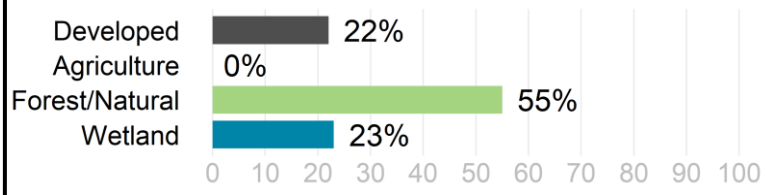
Segment Length (Miles): 4.6

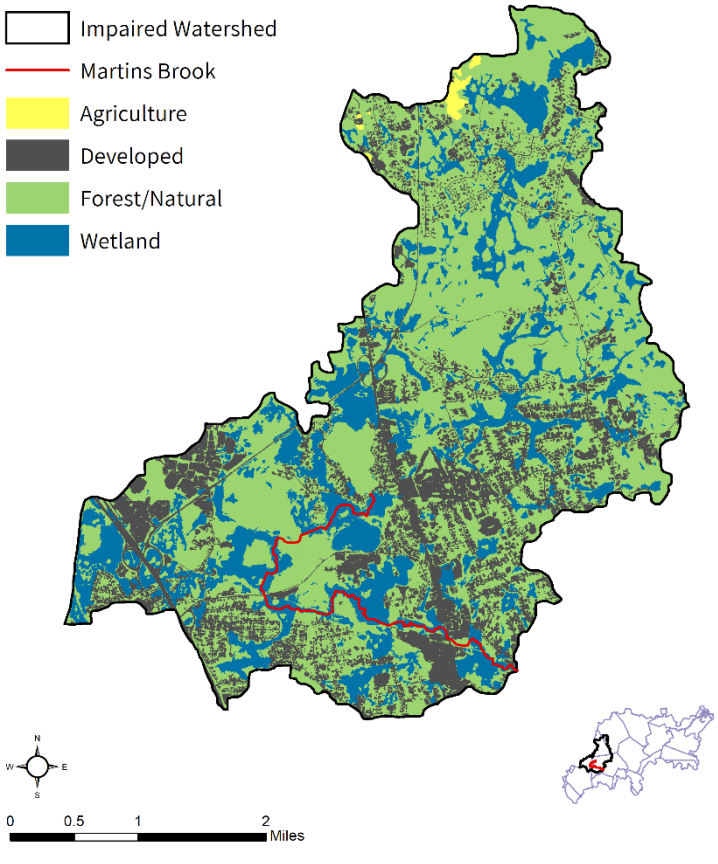
Impairment(s): *E. coli* and fecal coliform (Primary Contact Recreation)

Class (Qualifier): B

Impervious Area (Acres, %): 1,035 (12%)

DCIA Area (Acres, %): 596 (7%)





[7] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project (MassDEP, 2021b), MS4 reports, and local knowledge.

The upper Martins Brook watershed is mostly forest with low density residential development, while the lower watershed is more urbanized, containing a mix of medium-density residential areas and medium- to high-density commercial, industrial, and transportation infrastructure. There is no identified agricultural activity in the watershed (<1%), and forest/natural and wetland areas combined make up 78% of the segment's watershed area; the remaining 22% of the watershed is developed. The segment is located in the less developed part of the lower watershed, flowing through forest and wetland areas, as well as some commercial and industrial development.

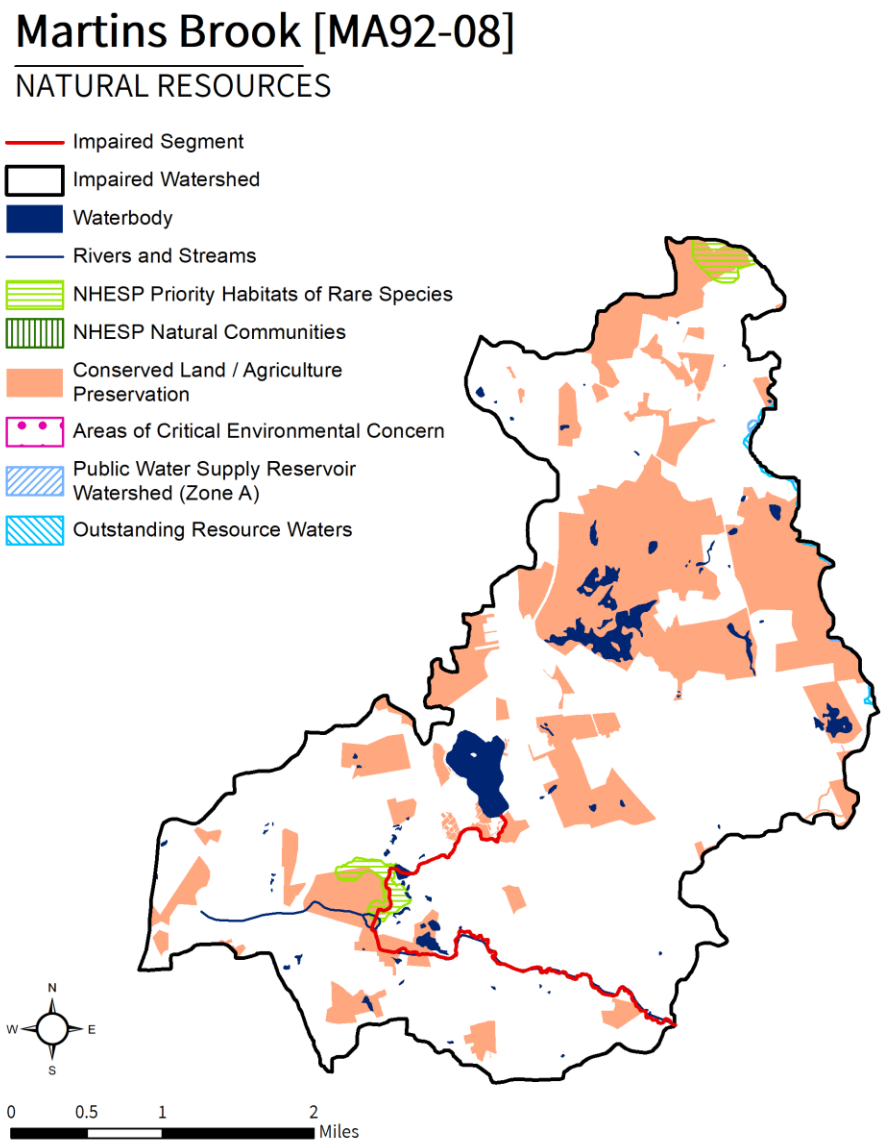
In the Martins Brook (MA92-08) watershed, under the Natural Heritage and Endangered Species Program, there are 103 acres (1%) of Priority Habitats of Rare Species and no Priority Natural Vegetation Communities. There are six acres (<1%) under Public Water Supply protection and 16 acres (<1%) of Outstanding Resource Waters, but no Areas of Critical Environmental Concern. Over 2,388 acres (28%) of land within the segment watershed are protected in perpetuity[8], part of the total 2,401 acres (28%) of Protected and Recreational Open Space[9]. See Figure 5-1.

Table 5-1. Groundwater discharge permits in the segment watershed. Only permits unique to this segment watershed are shown. PERR = permit number plus renewal number. TYPE = type of groundwater discharge. FLOW = permitted effluent in gallons per day (gpd).

PERR	NAME	TOWN	TYPE	FLOW (GPD)
45-5	GREENBRIAR ESTATES CONDOMINIUMS	NORTH READING	Sanitary Discharge	40,000
96-5	COLONIAL DRIVE CONDO.	ANDOVER	Sanitary Discharge	33,110
142-4	PARK COLONY CONDOMINIUM	NORTH READING	Sanitary Discharge	26,000
642-3	ROYAL MEADOW VIEW	NORTH READING	Sanitary Discharge	17,000
662-3	U.S. POSTAL SERVICE	NORTH READING	Sanitary Discharge	16,000
832-1M1	EDGEWOOD LUXURY APARTMENTS	NORTH READING	Sanitary Discharge	63,240
953-1	ATLANTIC SHOPPING PLAZA	NORTH READING	Sanitary Discharge	25,000
971-0	MARTINS LANDING WWTF	NORTH READING	Sanitary Discharge	60,000

[8] Land protected in perpetuity includes conservation restrictions, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[9] All Protected and Recreational Open Space land is shown on the natural resources map.



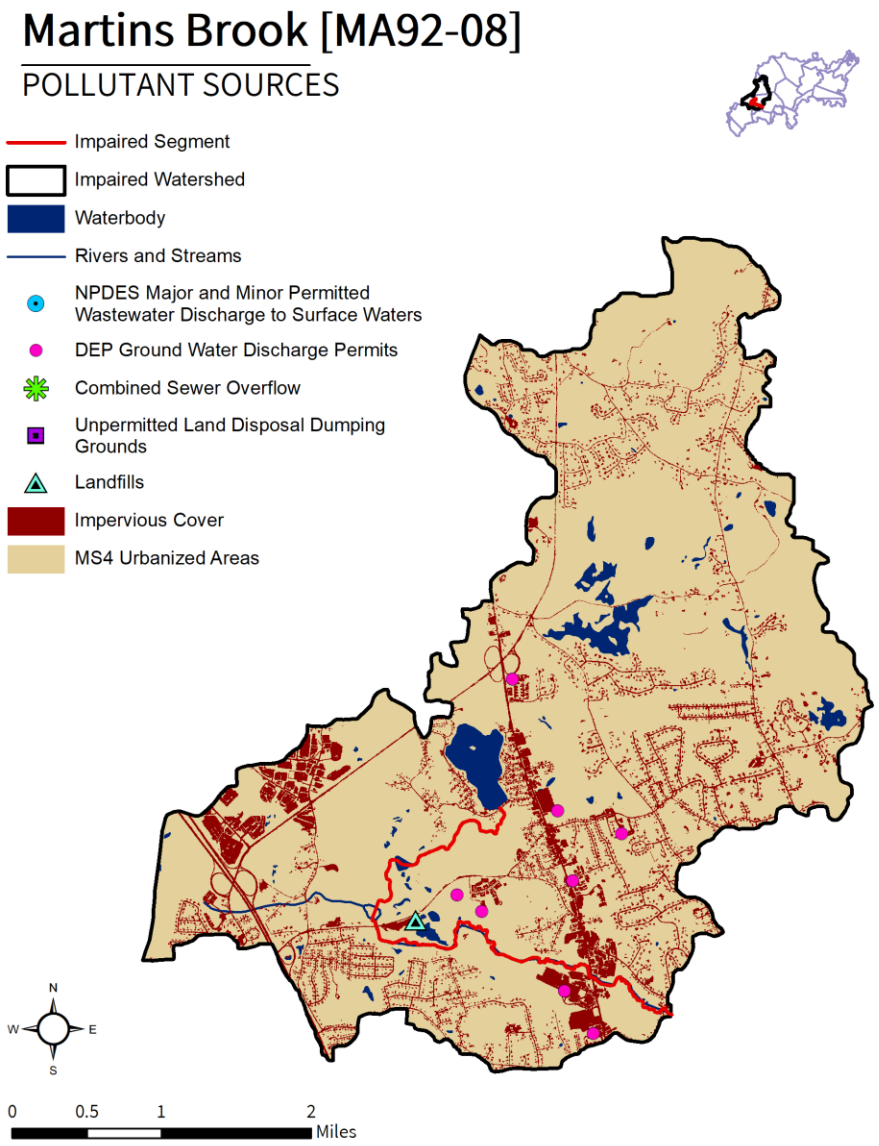


Figure 5-1. Natural resources and potential pollution sources draining to the Martins Brook segment MA92-08. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollutant sources, including impervious cover, MS4 areas, permitted facilities, etc.

5.2. Waterbody Impairment Characterization

Martins Brook (MA92-08) is a Class B Water (MassDEP, 2021a).

The Primary Contact Recreation use was assessed for attainment of SWQS at the station listed below (refer to Tables 5-2, 5-3; Figure 5-2) using the indicator bacteria *E. coli*. Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 90-day rolling basis.

- In 2005, five samples were collected at W0136; data indicated five days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of five samples, one exceeded the STV criterion during dry weather.

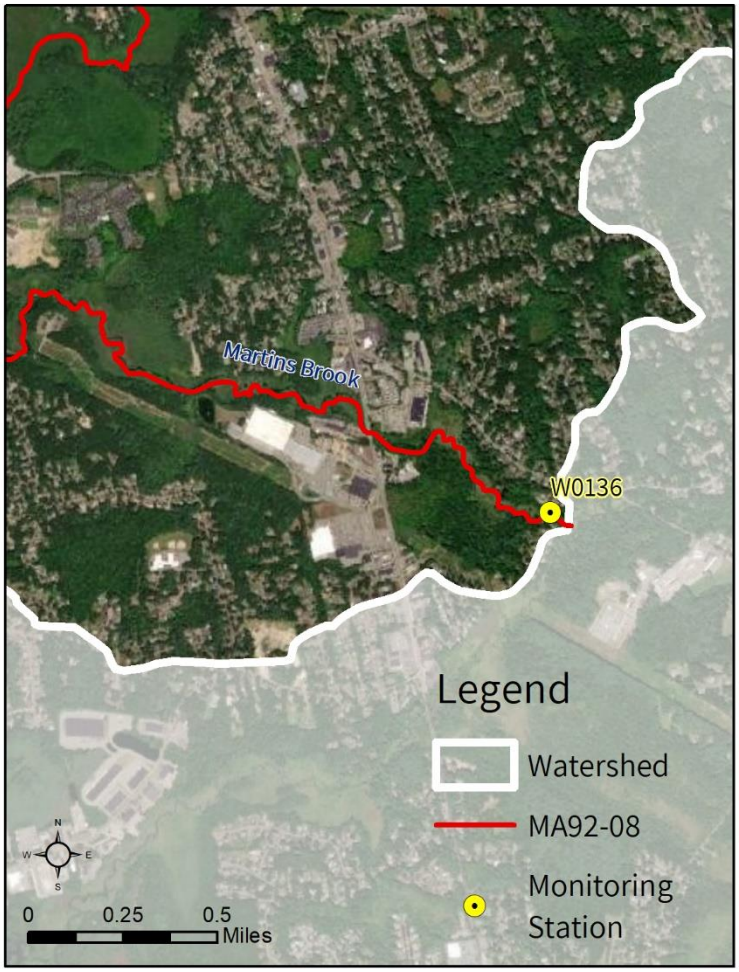


Figure 5-2. Location of monitoring station(s) along the impaired segment.

Table 5-2. Summary of indicator bacteria sampling results by station for Martins Brook (MA92-08). The maximum 90-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the STV criterion of 410 CFU/100 mL for *E. coli* indicator bacteria are shown. The STV criterion is applied to the single sample results if less than 10 samples were collected within a calendar year at a site. The highest maximum 90-day rolling geomean of the sites is used to calculate the percent load reduction required to meet SWQS.

Unique Station ID	First Sample	Last Sample	Count	Maximum 90-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
W0136	5/24/2005	9/27/2005	5	375	5	1

Table 5-3. Indicator bacteria data by station, indicator, and date for Martins Brook (MA92-08). Each sample date was designated as representing wet or dry weather conditions with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text in the Results column highlights *E. coli* criteria exceedances of 410 CFU/100 mL (applied to single-sample "Result" since there were no more than 10 samples in a year to calculate the STV; and red text in the Geomean column highlights exceedances of the 126 CFU/100 mL criterion (applied to rolling 90-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W0136	*E. coli*	5/24/2005	WET	220	220	
W0136	*E. coli*	6/21/2005	DRY	120	162	
W0136	*E. coli*	7/27/2005	DRY	2000	375	
W0136	*E. coli*	8/24/2005	DRY	190	357	
W0136	*E. coli*	9/27/2005	DRY	58	280	
W0136	Fecal Coliform	5/24/2005	WET	260		
W0136	Fecal Coliform	6/21/2005	DRY	130		
W0136	Fecal Coliform	7/27/2005	DRY	1200		
W0136	Fecal Coliform	8/24/2005	DRY	190		
W0136	Fecal Coliform	9/27/2005	DRY	65		

5.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information that can be used to focus pollutant reduction activities. Pathogen levels (as estimated by indicator bacteria) are usually higher in wet weather conditions as storm sewer systems overflow and/or stormwater runoff carries fecal matter that has accumulated on the landscape to the river via overland flow and stormwater conduits. Wet weather sources include wildlife and domesticated animal waste (including pets), urban stormwater runoff (including MS4 areas), CSOs, and sanitary sewer overflows (SSOs). In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants during dry weather, which then becomes diluted by precipitation. Dry weather sources include leaking sewer pipes, illicit connections of sanitary sewers to storm drains, failing septic systems, recreational use (such as swimmers), and wildlife and domesticated animals in the stream (including pets).

Indicator bacteria data for Martins Brook (MA92-08) were elevated during both wet and dry weather. Elevated results during wet weather are consistent with urban stormwater, pet waste, and wildlife pathogen sources. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated levels of indicator bacteria during wet weather events. Elevated results during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens. Given the relatively small sample set, additional sampling under both wet and dry conditions, ideally at more than one location, would likely help identify pollutant sources.

Each potential pathogen source is described in further detail below.

Urban Stormwater: Portions of the watershed are heavily developed, with all of the land area subject to MS4 permit conditions; 12% of the land is classified as impervious area, and 7% as DCIA. The lower watershed contains a mix of medium-density residential areas and medium- to high-density commercial, industrial, and transportation infrastructure. Stormwater runoff from urban areas is likely a significant source of pathogens.

Illicit Sewage Discharges: Public sewer service is available in the watershed within the town of Wilmington. Sewerage-related threats to water quality include leaking infrastructure (pipes, pump stations, etc.) and SSOs, which may be caused by undersized infrastructure, blockages, or excessive infiltration of groundwater or rainwater into pipes, exceeding system capacity. Illicit connections of wastewater to stormwater conveyances are also a potential source.

On-Site Wastewater Disposal Systems: Most of the residential development in the watershed uses septic systems for wastewater treatment. There are eight MassDEP permits for on-site wastewater discharges to groundwater. In addition to these permitted point sources, it is likely that a portion of septic systems are not properly maintained and are discharging untreated effluent to groundwater.

Agriculture: There is minimal (<1%) agricultural activity in the watershed. The few agricultural areas present are located in the upper portion of the watershed far from the segment. As a result, stormwater runoff from agricultural land is not a likely source of pathogens to the impaired segment.

Pet Waste: There are many medium-density residential developments near Martins Brook. Conservation lands, parks, ballfields, and residential neighborhoods popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent possible sources of pathogens.

Wildlife Waste: Nearly the entire segment is surrounded by wooded buffers with a few wetland areas, except where it flows through areas of commercial and industrial development. Large, mowed areas, fields, or wetlands with a clear sightline to a waterbody may attract large congregations of waterfowl, resulting in elevated indicator bacteria counts in the water.

5.4. Existing Local Management

This section identifies the major municipalities immediately surrounding the impaired segment and its contributing watershed. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Andover

All of Andover is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (Permit ID # MAR041178), and the town has an EPA-approved Notice of Intent (NOI). Andover completed an illicit discharge detection and elimination (IDDE) plan in 2007, and an erosion and sedimentation control (ESC) plan and post-construction stormwater regulations in 2009. All of the MS4 system within Andover has been mapped.

Andover has the following ordinances and bylaws, mostly accessible online via the town website https://andoverma.gov/ (Town of Andover, 2021):

- Stormwater ordinance with title 5 supplemental regulations
- Stormwater Utility: None found
- Pet Waste: None found

Andover has a 2012 Master Plan and is developing an updated Plan in 2022. Within the 2012 plan there is a section about natural resources, with an extensive list of actions that the town is planning to take towards furthering water conservation. The town also plans to divert 80% of rainfall away from town-operated sewer systems through use of pervious pavements, bioswales, and infiltration planters. Andover also has a 2018 Open Space and Recreation Plan that contains a comprehensive environmental inventory and analysis, with a section focused on water resources that outlines the steps being taken to protect them, including conserving land within the watershed, hosting regular river cleanups, and dismantling dams along the Shawsheen River to support fish passage (Town of Andover, 2021).

Town of North Andover. See Section 3.4

Town of North Reading. See Section 3.4

Town of Wilmington. See Section 3.4

6. MA92-12 Unnamed Tributary

6.1. Waterbody Overview

The unnamed tributary segment MA92-12 is 1.4 miles long and begins at the outlet of Middleton Pond in Middleton, MA. The segment flows southeast to the Ipswich River in Middleton, MA.

There are several small tributaries to the unnamed tributary segment MA92-12. Lakes and ponds in the watershed include Middleton Pond, Salem Pond, and Swan Pond. Most of the stream flows within swamp, fen, and other wetlands.

Key landmarks in the watershed include the town center of Middleton, Harold Parker State Forest, and Thomson Country Club. From upstream to downstream, segment MA92-12 is crossed by the access road to the Middleton Pond Water Supply Facilities property, Pleasant Street, South Main Street/MA-62/MA-114, and Mount Vernon Street, all in Middleton.

The unnamed tributary (MA92-12) drains an area of 3.4 square miles (mi^2), of which 0.2 mi^2 (6%) are impervious and 0.1 mi^2 (3%) is directly connected impervious area (DCIA). The watershed is not served by a public sewer system[10], and all of the land area is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There is one additional NPDES permit on file governing point source discharges of pollutants to surface waters (not for a wastewater treatment facility). There are no MassDEP discharge-to-groundwater permits for on-site wastewater discharges or combined sewer overflows (CSOs) within the watershed. There are no landfills or unpermitted land disposal dumping grounds within the segment watershed. See Figure 6-1.

The upper segment watershed mostly contains forest/natural and wetland areas, with some low-density residential development. The lower watershed is more developed, containing a mix of medium-density residential and commercial areas as well as transportation infrastructure and agricultural fields. Although there is little agricultural land in the watershed (3%), much is directly adjacent to the segment, where there are

Reduction from Highest Calculated Geomean: 90%

Watershed Area (Acres): 2,184

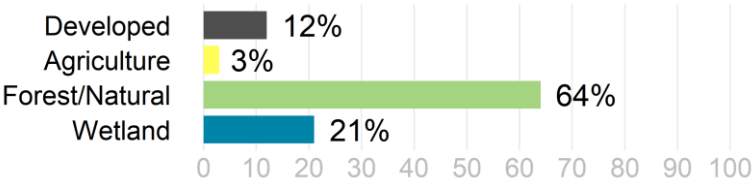
Segment Length (Miles): 1.4

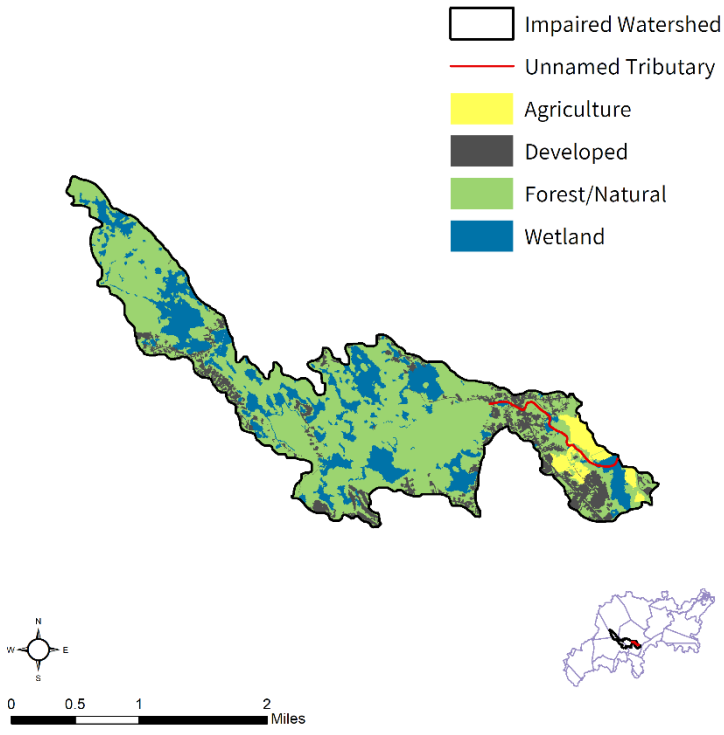
Impairment(s): *E. coli* and fecal coliform (Primary Contact Recreation)

Class (Qualifier): B

Impervious Area (Acres, %): 120 (6%)

DCIA Area (Acres, %): 62 (3%)





[10] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project (MassDEP, 2021b), MS4 reports, and local knowledge.

large fields of hay and cultivated crops. The majority of development in the watershed, which covers 12% of the total area, is also adjacent to the segment, near the town center of Middleton.

In the watershed of the unnamed tributary (MA92-12), under the Natural Heritage and Endangered Species Program, there are 22 acres (1%) of Priority Natural Vegetation Communities and no Priority Natural Vegetation Communities. There are 753 acres (34%) under Public Water Supply protection and 1,737 acres (80%) of Outstanding Resource Waters, but no Areas of Critical Environmental Concern. Over 468 acres (21%) of land within the segment watershed are protected in perpetuity[11], part of the total 883 acres (40%) of Protected and Recreational Open Space[12]. See Figure 6-1.

[11] Land protected in perpetuity includes conservation restrictions, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[12] All Protected and Recreational Open Space land is shown on the natural resources map.

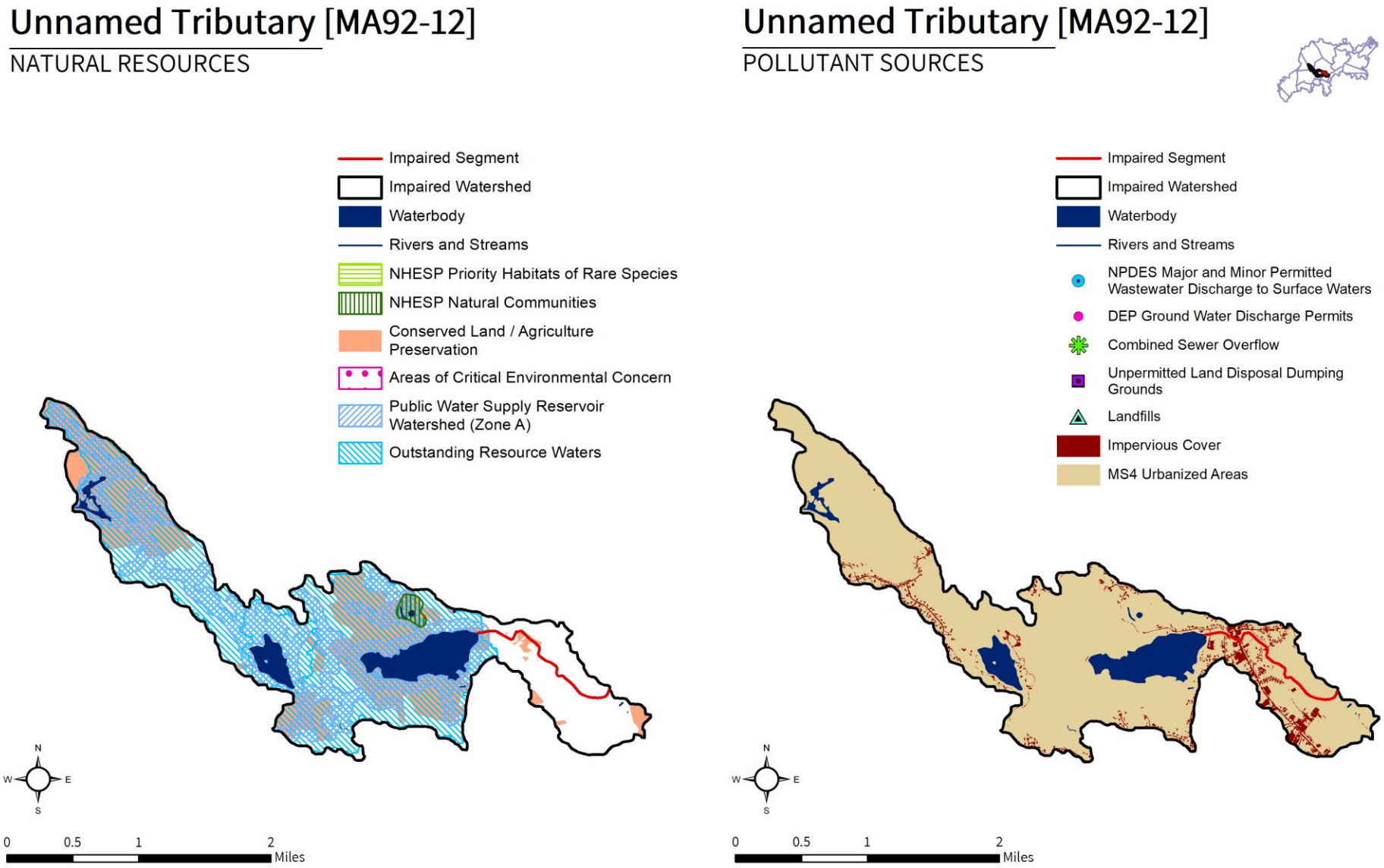


Figure 6-1. Natural resources and potential pollution sources draining to the Martins Brook segment MA92-12. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollutant sources, including impervious cover, MS4 areas, permitted facilities, etc.

6.2. Waterbody Impairment Characterization

Unnamed tributary (MA92-12) is a Class B Water (MassDEP, 2021a).

The Primary Contact Recreation use was assessed for attainment of SWQS at the stations listed below (refer to Tables 6-1, 6-2; Figure 6-2) using the indicator bacteria *E. coli*. Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 90-day rolling basis.

- In 2005, five samples were collected at W0105 data indicated five days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of five samples, three exceeded the STV criterion, one during wet conditions and two during dry conditions. On one occasion during the 2005 sampling the water was noted to be “grey-like, septage looking”.

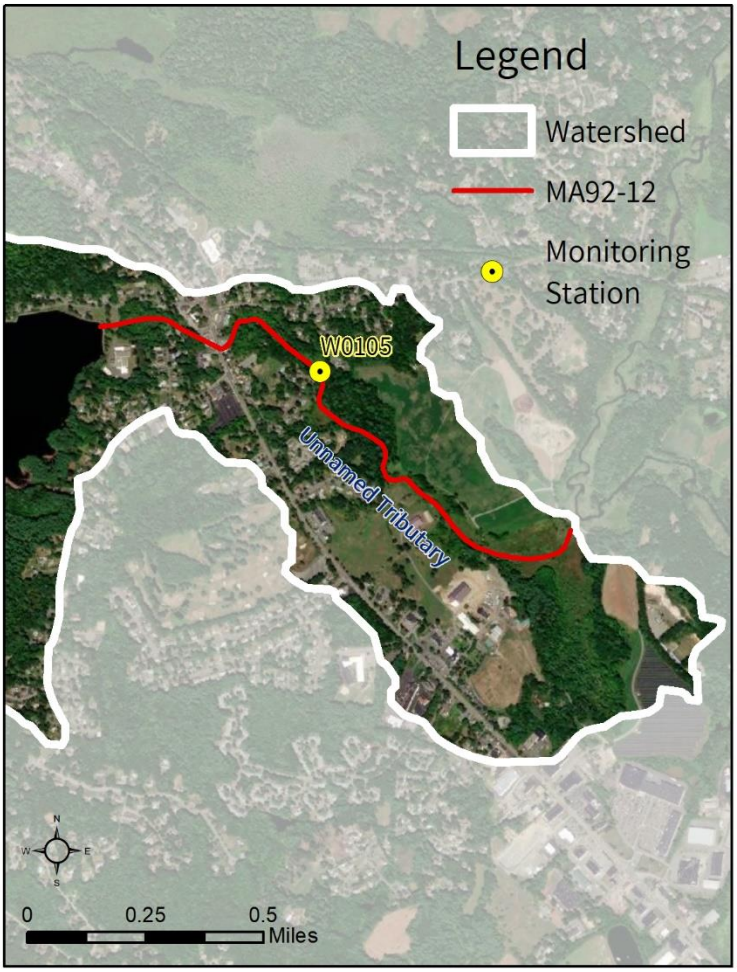


Figure 6-2. Location of monitoring station(s) along the impaired segment.

Table 6-1. Summary of indicator bacteria sampling results by station for the unnamed tributary (MA92-12). The maximum 90-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the STV criterion of 410 CFU/100 mL for *E. coli* indicator bacteria are shown. The STV criterion is applied to the single sample results if less than 10 samples were collected within a calendar year at a site. The highest maximum 90-day rolling geomean of the sites is used to calculate the percent load reduction required to meet SWQS.

Unique Station ID	First Sample	Last Sample	Count	Maximum 90-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
W0105	5/24/2005	9/27/2005	5	1,200	5	3

Table 6-2. Indicator bacteria data by station, indicator, and date for the unnamed tributary (MA92-12). Each sample date was designated as representing wet or dry weather conditions with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text in the Results column highlights criteria exceedances of 410 CFU/100 mL (applied to single-sample "Result" since there were no more than 10 samples in a year to calculate the STV; and red text in the Geomean column highlights exceedances of the 126 CFU/100 mL criterion (applied to rolling 90-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W0105	*E. coli*	5/24/2005	WET	1,200	1,200	
W0105	*E. coli*	6/21/2005	DRY	210	502	
W0105	*E. coli*	7/27/2005	DRY	160	343	
W0105	*E. coli*	8/24/2005	DRY	970	319	
W0105	*E. coli*	9/27/2005	DRY	1,200	571	
W0105	Fecal Coliform	5/24/2005	WET	3,000		
W0105	Fecal Coliform	6/21/2005	DRY	210		
W0105	Fecal Coliform	7/27/2005	DRY	180		
W0105	Fecal Coliform	8/24/2005	DRY	570		
W0105	Fecal Coliform	9/27/2005	DRY	800		

6.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information that can be used to focus pollutant reduction activities. Pathogen levels (as estimated by indicator bacteria) are usually higher in wet weather conditions as storm sewer systems overflow and/or stormwater runoff carries fecal matter that has accumulated on the landscape to the river via overland flow and stormwater conduits. Wet weather sources include wildlife and domesticated animals (including pets), urban stormwater runoff (including MS4 areas), CSOs, and sanitary sewer overflows (SSOs). In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants during dry weather, which then becomes diluted by precipitation. Dry weather sources include leaking sewer pipes, illicit connections of sanitary sewers to storm drains, failing septic systems, recreational use (such as swimmers), and direct wildlife and domesticated animal waste (including pets).

Indicator bacteria data for the unnamed tributary (MA92-12) were elevated during both wet and dry weather. Elevated results during wet weather are consistent with urban stormwater, pet waste, and wildlife pathogen sources. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated levels of indicator bacteria during wet weather events. Elevated results during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens. Given the relatively small sample set, additional sampling under both wet and dry conditions, ideally at more than one location, would likely help identify pollutant sources.

Each potential pathogen source is described in further detail below.

Urban Stormwater: Portions of the watershed are moderately developed, with all of the land area subject to MS4 permit conditions; 6% of the land is classified as impervious area, and 3% as DCIA. Development within the watershed consists of medium-density residential and commercial properties and transportation infrastructure near the Middleton town center in the lower watershed. Stormwater runoff from urban areas is likely a contributing source of pathogens.

Illicit Sewage Discharges: There are no known areas in the watershed that are served by public sewer. Sewerage-related threats to water quality include leaking infrastructure (pipes, pump stations, etc.) and SSOs, which may be caused by undersized infrastructure, blockages, or excessive infiltration of groundwater or rainwater into pipes, exceeding system capacity. Illicit connections of wastewater to stormwater conveyances are also a potential source.

On-Site Wastewater Disposal Systems: Development in the watershed utilizes on-site septic systems for wastewater treatment. It is likely that a portion of septic systems are not properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Although agricultural activity in the watershed only accounts for 3% of the total land use, these areas are large fields of hay and cultivated crops that are located adjacent to the segment. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: Conservation lands, parks, ballfields, and residential neighborhoods popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent possible sources of pathogens. Although there are no public fields or parks adjacent to the impaired segment, the segment flows near medium density residential development where dog walking likely occurs and where runoff may transport pet waste.

Wildlife Waste: There are large open agricultural fields and wetlands adjacent to segment. Large mowed areas, fields, or wetlands with a clear sightline to a waterbody may attract large congregations of waterfowl, resulting in elevated indicator bacteria counts in the water.

6.4. Existing Local Management

This section identifies the major municipalities immediately surrounding the impaired segment and its contributing watershed. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Middleton. See Section 3.4

Town of North Andover. See Section 3.4

Town of North Reading. See Section 3.4

7. MA92-14 Fish Brook

7.1. Waterbody Overview

Fish Brook segment MA92-14 is 8.2 miles long and begins at the outlet of Stiles Pond in Boxford, MA. The segment flows south, briefly passing through North Andover before turning east back through Boxford (where it serves as the boundary between Boxford and Topsfield) to end at the Ipswich River.

Tributaries to Fish Brook segment MA92-14 include Mosquito Brook, a large wetland area in North Andover, and a few small unnamed streams. Lakes and ponds in the watershed include Cedar Pond, Crooked Pond, Howes Pond (MA92026), Kimballs Pond, Stiles Pond, Towne Pond, and a few other small unnamed waterbodies. Much of the stream flows through marsh, swamp, and other wetlands.

Key landmarks in the watershed include I-95, Stiles Pond Beach (Stiles Pond), Harold Parker State Forest, Boxford State Forest, Masconomet Regional Middle School, and Harry Lee Cole School. From upstream to downstream, segment MA92-14 is crossed by Stiles Pond Road (Boxford), Main Street (Boxford), an unnamed access road, Ogunquit Road (North Andover), Boxford Street (North Andover), Brookview Road (Boxford), Towne Road (Boxford), Middleton Road (Boxford), Mill Road (Boxford), Lockwood Lane (Boxford), I-95 (Boxford), River Road (Topsfield), and Endicott Road/Washington Road (Boxford).

Fish Brook (MA92-14) drains an area of 18.1 square miles (mi^2), of which 1.3 mi^2 (7%) are impervious and 0.6 mi^2 (3%) are directly connected impervious area (DCIA). The watershed may be served by a public sewer system in North Andover[13] and 39% is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are no NPDES permits on file governing point source discharges of pollutants to surface waters, MassDEP discharge-to-groundwater permits for on-site wastewater discharges, or combined sewer overflows (CSOs) within the watershed. There are no landfills or unpermitted land disposal dumping grounds within the segment watershed. See Figure 7-1.

The Fish Brook watershed contains mostly forest, natural, and wetland areas, comprising 84% of the

Reduction from Highest Calculated Geomean: 68%

Watershed Area (Acres): 11,602

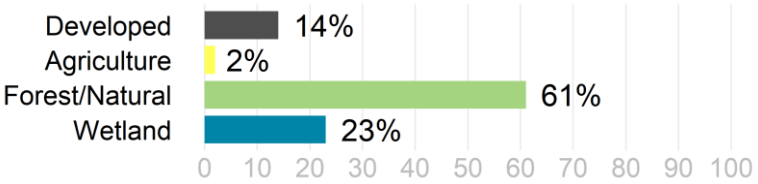
Segment Length (Miles): 8.2

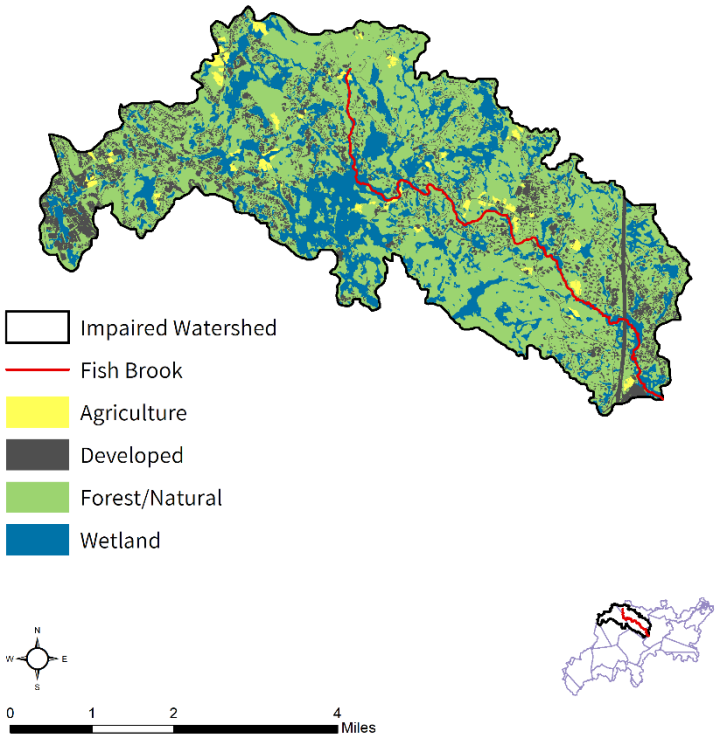
Impairment(s): *E. coli* (Primary Contact Recreation)

Class: B

Impervious Area (Acres, %): 839 (7%)

DCIA Area (Acres, %): 404 (3%)





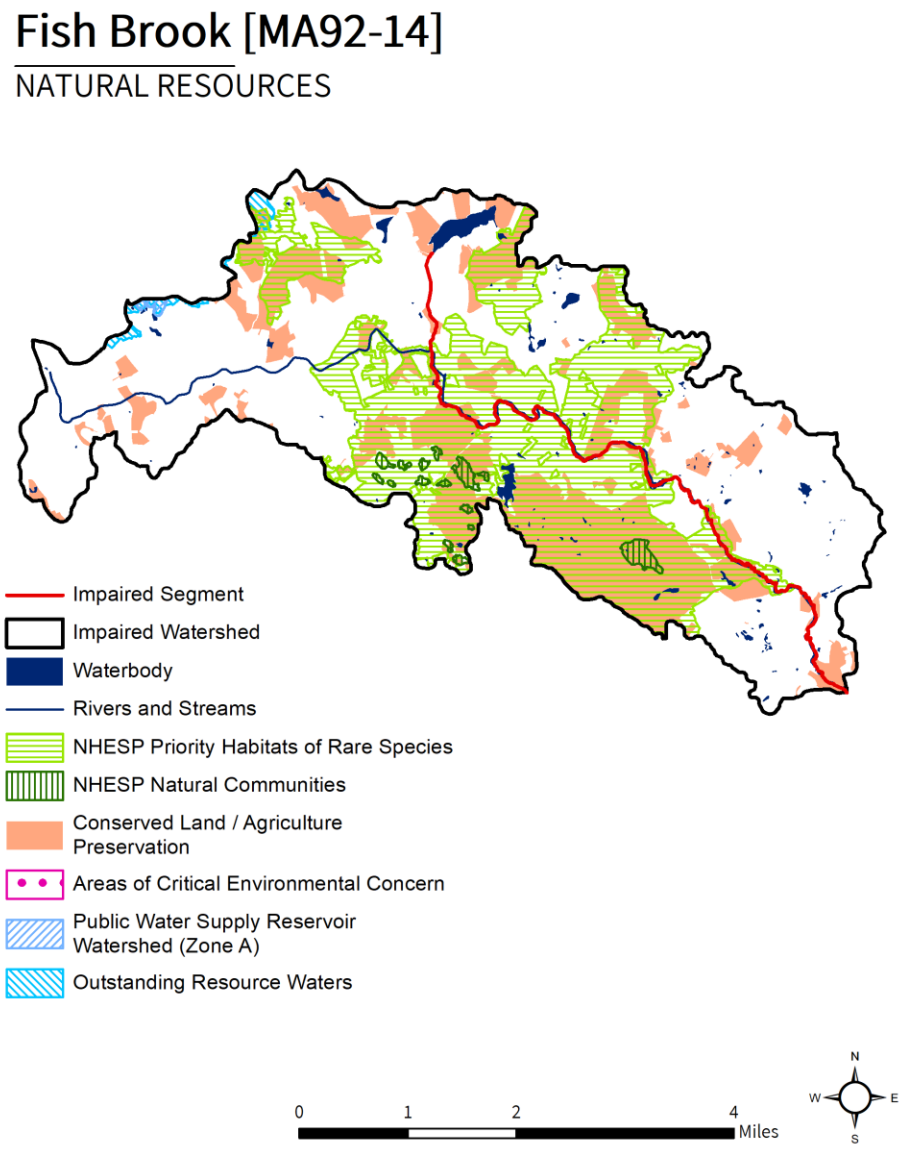
[13] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project (MassDEP, 2021b), MS4 reports, and local knowledge.

land cover. Some portions of the watershed contain low- to medium--density residential, commercial, and industrial development, accounting for 14% of land cover. There is a high density of transportation infrastructure in the lower watershed where I-95 crosses the segment. Agricultural activities are scattered throughout the watershed and make up only 2% of land cover. The segment itself flows primarily through forest/natural and wetland land uses.

In the Fish Brook (MA92-14) watershed, under the Natural Heritage and Endangered Species Program, there are 4,591 acres (40%) of Priority Habitats of Rare Species and 108 acres (1%) of Priority Natural Vegetation Communities. There are 17 acres (<1%) under Public Water Supply protection and 86 acres (1%) of Outstanding Resource Waters, but no Areas of Critical Environmental Concern. Over 2,918 acres (25%) within the segment watershed are protected in perpetuity[14], part of the total 3,132 acres (27%) of Protected and Recreational Open Space[15]. See Figure 7-1.

[14] Land protected in perpetuity includes conservation restrictions, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[15] All Protected and Recreational Open Space land is shown on the natural resources map.



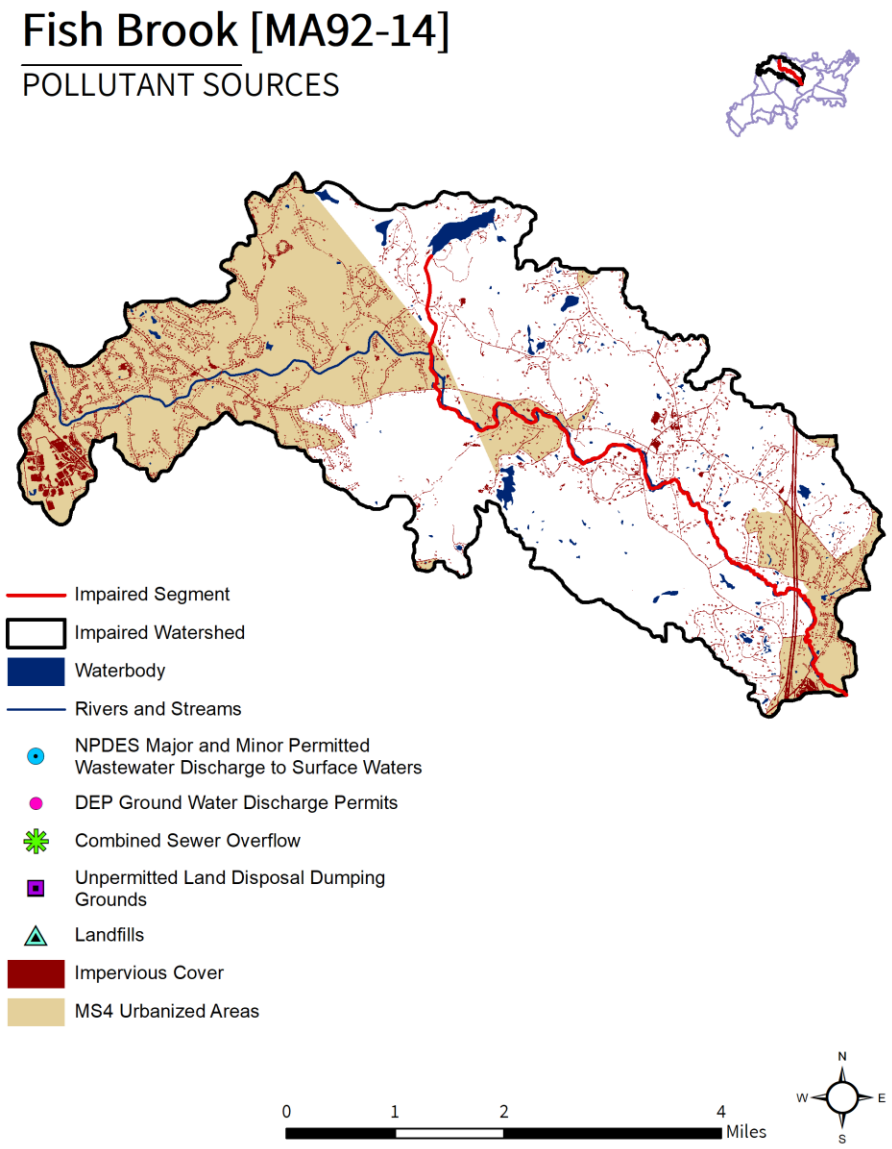


Figure 7-1. Natural resources and potential pollution sources draining to the Fish Brook segment MA92-14. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollutant sources, including impervious cover, MS4 areas, permitted facilities, etc.

7.2. Waterbody Impairment Characterization

Fish Brook (MA92-14) is a Class B Water (MassDEP, 2021a).

The Primary Contact Recreation use was assessed for attainment of SWQS at the station listed below (refer to Tables 7-1, 7-2; Figure 7-2) using the indicator bacteria *E. coli*. Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 90-day rolling basis.

- In 2005, five samples were collected at W0128; data indicated five days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of five samples, one exceeded the STV criterion during dry weather.
- In 2015, five samples were collected at W2521; data indicated five days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of five samples, two exceeded the STV criterion, one during wet weather and one during dry weather.

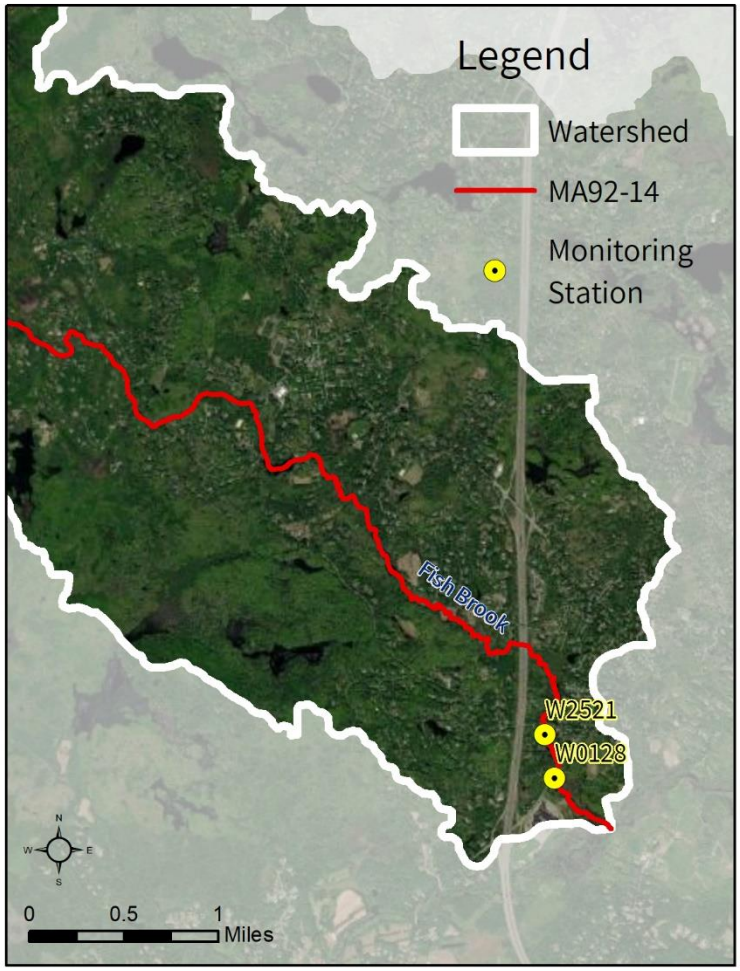


Figure 7-2. Location of monitoring station(s) along the impaired segment.

Table 7-1. Summary of indicator bacteria sampling results by station for Fish Brook (MA92-14). The maximum 90-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the STV criterion of 410 CFU/100 mL for *E. coli* indicator bacteria are shown. The STV criterion is applied to the single sample results if less than 10 samples were collected within a calendar year at a site. The highest maximum 90-day rolling geomean of the sites is used to calculate the percent load reduction required to meet SWQS.

Unique Station ID	First Sample	Last Sample	Count	Maximum 90-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
W0128	5/24/2005	9/27/2005	5	267	5	1
W2521	5/6/2015	9/1/2015	5	389	5	2

Table 7-2. Indicator bacteria data by station, indicator, and date for Fish Brook (MA92-14). Each sample date was designated as representing wet or dry weather conditions with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text in the Results column highlights criteria exceedances of 410 CFU/100 mL (applied to single-sample "Result" since there were no more than 10 samples in a year to calculate the STV; and red text in the Geomean column highlights exceedances of the 126 CFU/100 mL criterion (applied to rolling 90-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W0128	*E. coli*	5/24/2005	WET	250	250	
W0128	*E. coli*	6/21/2005	DRY	100	158	
W0128	*E. coli*	7/27/2005	DRY	530	237	
W0128	*E. coli*	8/24/2005	DRY	150	200	
W0128	*E. coli*	9/27/2005	DRY	240	267	
W0128	Fecal Coliform	5/24/2005	WET	220		
W0128	Fecal Coliform	6/21/2005	DRY	110		
W0128	Fecal Coliform	7/27/2005	DRY	630		
W0128	Fecal Coliform	8/24/2005	DRY	120		
W0128	Fecal Coliform	9/27/2005	DRY	260		
W2521	*E. coli*	5/6/2015	DRY	150	150	
W2521	*E. coli*	6/3/2015	WET	960	379	
W2521	*E. coli*	7/9/2015	DRY	170	290	
W2521	*E. coli*	8/4/2015	WET	360	389	
W2521	*E. coli*	9/1/2015	DRY	470	306	

7.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information that can be used to focus pollutant reduction activities. Pathogen levels (as estimated by indicator bacteria) are usually higher in wet weather conditions as storm sewer systems overflow and/or stormwater runoff carries fecal matter that has accumulated on the landscape to the river via overland flow and stormwater conduits. Wet weather sources include wildlife and domesticated animal waste (including pets), urban stormwater runoff (including MS4 areas), CSOs, and sanitary sewer overflows (SSOs). In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants during dry weather, which then becomes diluted by precipitation. Dry weather sources include leaking sewer pipes, illicit connections of sanitary sewers to storm drains, failing septic systems, recreational use (such as swimmers), and direct wildlife and domesticated animal waste (including pets).

Indicator bacteria levels for Fish Brook (MA92-14) were elevated during both wet and dry weather. Elevated results during wet weather are consistent with urban stormwater, pet waste, and wildlife pathogen sources. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated levels of indicator bacteria during wet weather events. Elevated results during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens.

Each potential pathogen source is described in further detail below.

Urban Stormwater: Portions of the watershed are moderately developed, with 39% of the land area subject to MS4 permit conditions; 7% of the land is classified as impervious area, and 3% as DCIA. Development within the watershed consists of low- to medium-density residential, commercial, and industrial properties in a few areas. Additionally, there is a high density of transportation infrastructure in the lower watershed, notably I-95 which both crosses and runs parallel to a lower reach of the segment. Stormwater runoff from urban areas is likely a contributing source of pathogens.

Illicit Sewage Discharges: Public sewer service may be available in the watershed within the Massachusetts town of North Andover. Sewerage-related threats to water quality include leaking infrastructure (pipes, pump

stations, etc.) and SSOs, which may be caused by undersized infrastructure, blockages, or excessive infiltration of groundwater or rainwater into pipes, exceeding system capacity. Illicit connections of wastewater to stormwater conveyances are also a potential source.

On-Site Wastewater Disposal Systems: Development in the watershed utilizes on-site septic systems for wastewater treatment. It is likely that some septic systems are not properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Agricultural activities in the watershed only account for 2% of the total land use; however, a few large open hayfields and pastures are adjacent to the segment. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: Much of the segment flows through forest and natural areas, with a few locations where low-density residential development is close to the segment. Conservation lands, parks, ballfields, and residential neighborhoods popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent possible sources of pathogens.

Wildlife Waste: Although most of the immediate area surrounding the segment is forest, there are a few large open fields adjacent to the segment. Large mowed areas, fields, or wetlands with a clear sightline to a waterbody may attract large congregations of waterfowl, resulting in elevated indicator bacteria counts in the water.

7.4. Existing Local Management

This section identifies the major municipalities immediately surrounding the impaired segment and its contributing watershed. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Boxford. See Section 3.4

Town of North Andover. See Section 3.4

8. MA92-17 Howlett Brook

8.1. Waterbody Overview

Howlett Brook segment MA92-17 is 2.7 miles long and begins just north of Great Hill near the intersection of Ipswich Road and North Street in Topsfield, MA. The segment generally meanders eastward to the Ipswich River in Topsfield, MA.

Tributaries to Howlett Brook segment MA92-17 include Pye Brook and one other unnamed tributary. Lakes and ponds in the watershed include Fourmile Pond, Hood Pond, Lowe Pond, Lower Fourmile Pond, Spofford Pond, and Stevens Pond. Some of the stream corridor flows within wooded swamp wetlands.

Key landmarks in the watershed include I-95, U.S. Route 1, New Meadows Golf Club, Bare Hill Park, and Willowdale State Forest. From upstream to downstream, segment MA92-17 is crossed by an unnamed road north of Aaron Drive, North Street, Boston Street/U.S. Route 1, East Street, and Ipswich Road, all located in Topsfield.

Howlett Brook (MA92-17) drains an area of 10.4 square miles (mi^2), of which 0.7 mi^2 (7%) are impervious and 0.3 mi^2 (3%) are directly connected impervious area (DCIA). The watershed may be served by a public sewer system in Ipswich[16] and 45% is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are no NPDES permits on file governing point source discharges of pollutants to surface waters, one MassDEP discharge-to-groundwater permit for an on-site wastewater discharge (Table 8-1), and no combined sewer overflows (CSOs) within the watershed. There is one landfill and no unpermitted land disposal dumping grounds within the segment watershed. See Figure 8-1.

The Howlett Brook watershed contains mostly forest, natural, and wetland areas, comprising 86% of land area. There is minimal agricultural activity in the watershed, representing only 1% of land area. Development in the watershed accounts for the remaining 13%, consisting predominantly of low- to medium-density

Reduction from Highest Calculated Geomean: 65%

Watershed Area (Acres): 6,686

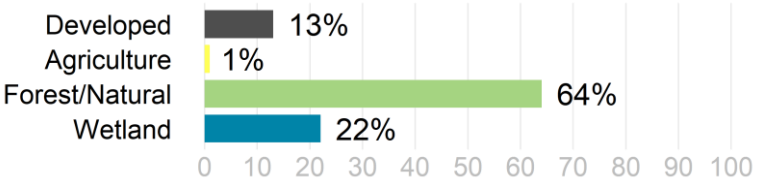
Segment Length (Miles): 2.7

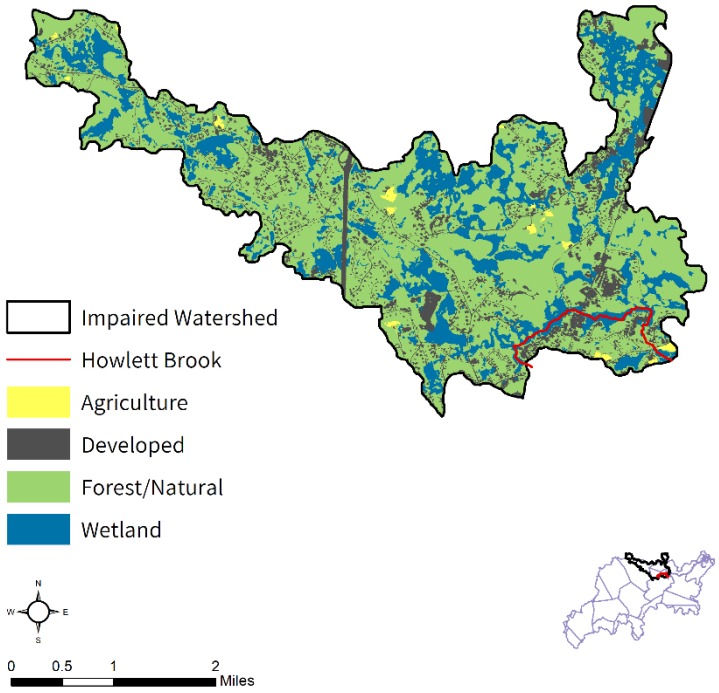
Impairment(s): *E. coli* and fecal coliform (Primary Contact Recreation)

Class: B

Impervious Area (Acres, %): 440 (7%)

DCIA Area (Acres, %): 214 (3%)





[16] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project (MassDEP, 2021b), MS4 reports, and local knowledge.

residential properties. In the lower watershed close to the segment, there are large commercial and industrial properties, as well as a higher density of transportation infrastructure along U.S. Route 1.

In the Howlett Brook (MA92-17) watershed, under the Natural Heritage and Endangered Species Program, there are 964 acres (40%) of Priority Habitats of Rare Species and none (0%) of Priority Natural Vegetation Communities. There are no acres under Public Water Supply protection, within Areas of Critical Environmental Concern, or Outstanding Resource Waters in the watershed. Over 1,967 acres (29%) of land within the segment watershed are protected in perpetuity[17], part of the total 2,122 acres (32%) of Protected and Recreational Open Space[18]. See Figure 8-1.

Table 8-1. Groundwater discharge permits in the segment watershed. Only permits unique to this segment watershed are shown. PERR = permit number plus renewal number. TYPE = type of groundwater discharge. FLOW = permitted effluent in gallons per day (gpd).

PERR	NAME	TOWN	TYPE	FLOW (GPD)
749-2	FOUR MILE VILLAGE	BOXFORD	Sanitary Discharge	8,668

[17] Land protected in perpetuity includes conservation restrictions, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[18] All Protected and Recreational Open Space land is shown on the natural resources map.

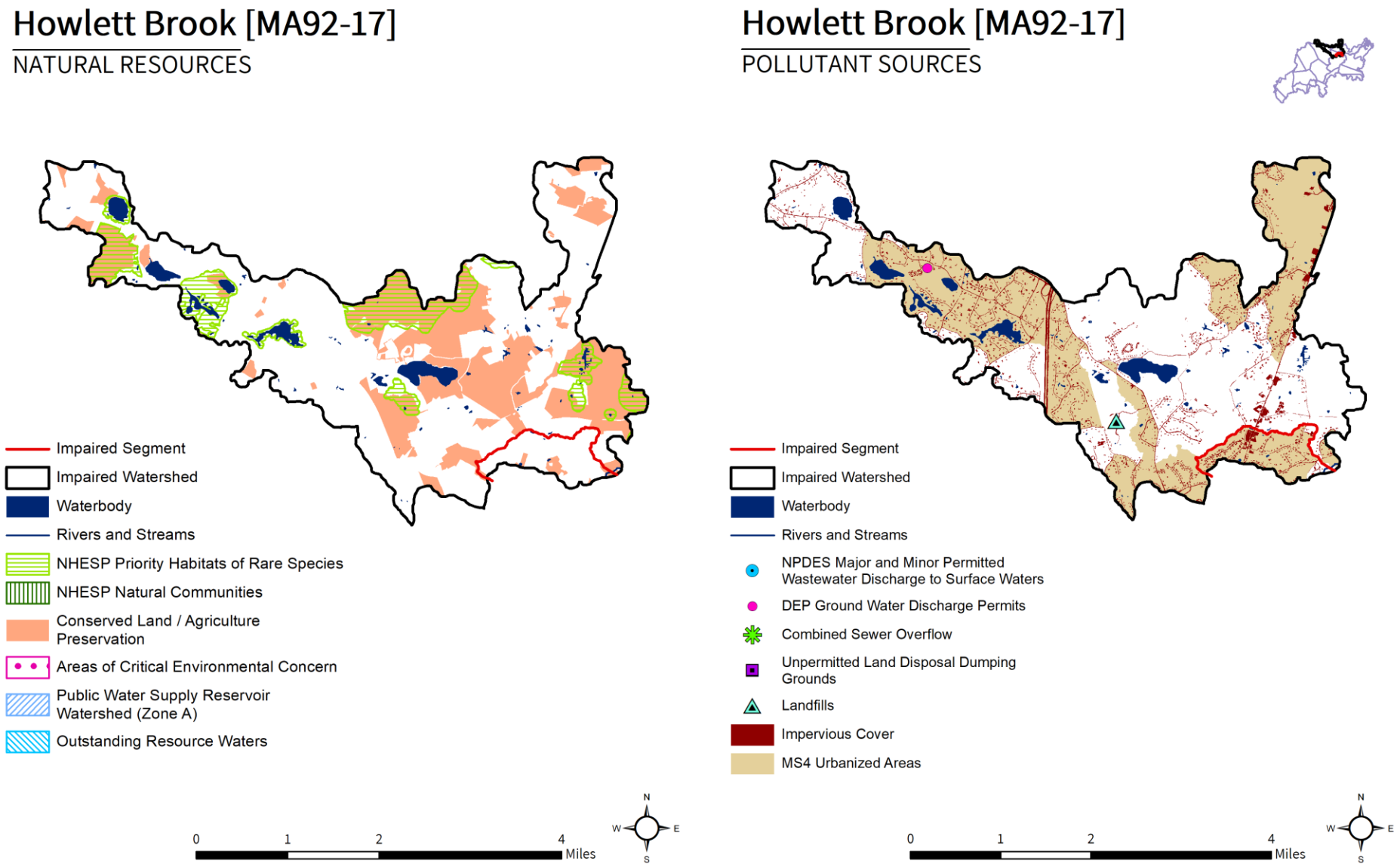


Figure 8-1. Natural resources and potential pollution sources draining to the Howlett Brook segment MA92-17. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollutant sources, including impervious cover, MS4 areas, permitted facilities, etc.

8.2. Waterbody Impairment Characterization

Howlett Brook (MA92-17) is a Class B Water (MassDEP, 2021a).

The Primary Contact Recreation use was assessed for attainment of SWQS at the stations listed below (refer to Tables 8-2, 8-3; Figure 8-2) using the indicator bacteria *E. coli*. Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 90-day rolling basis.

- In 2005, five samples were collected at W0126; data indicated five days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of five samples, one exceeded the STV criterion during dry weather.
- In 2010, four samples were collected at W2168, resulting in three days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. None of the four samples collected exceeded the STV criterion.

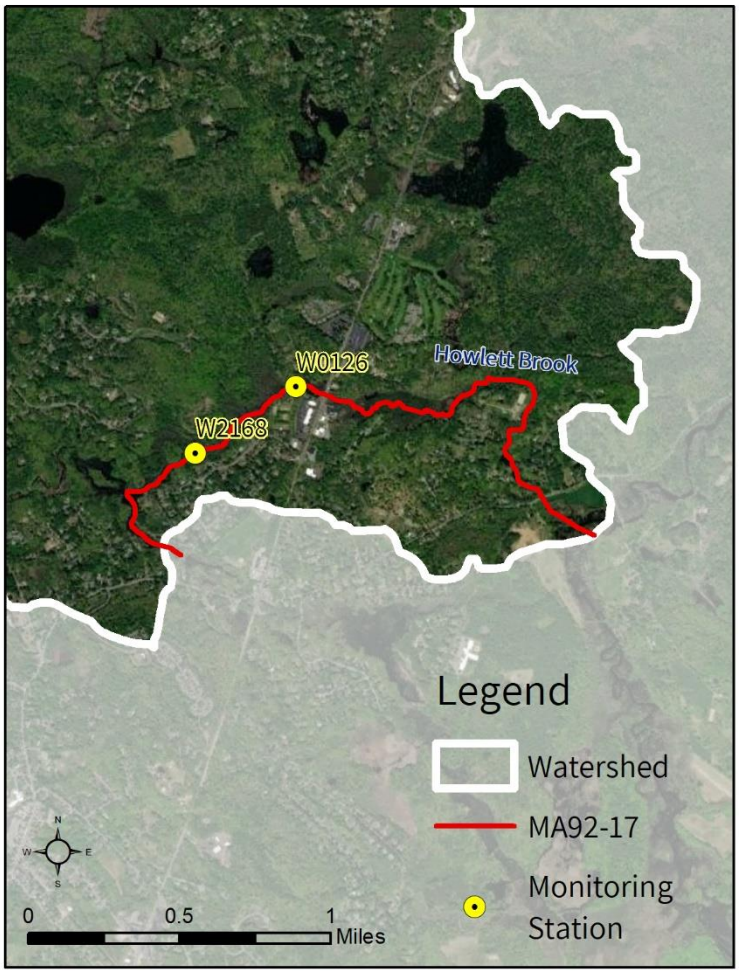


Figure 8-2. Location of monitoring station(s) along the impaired segment.

Table 8-2. Summary of indicator bacteria sampling results by station for Howlett Brook (MA92-17). The maximum 90-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the STV criterion of 410 CFU/100 mL for *E. coli* indicator bacteria are shown. The STV criterion is applied to the single sample results if less than 10 samples were collected within a calendar year at a site. The highest maximum 90-day rolling geomean of the sites is used to calculate the percent load reduction required to meet SWQS.

Unique Station ID	First Sample	Last Sample	Count	Maximum 90-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
W0126	5/24/2005	9/27/2005	5	360	5	1
W2168	6/17/2010	10/5/2010	4	196	3	0

Table 8-3. Indicator bacteria data by station, indicator, and date for Howlett Brook (MA92-17). Each sample date was designated as representing wet or dry weather conditions with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text in the Results column highlights criteria exceedances of 410 CFU/100 mL (applied to single-sample "Result" since there were no more than 10 samples in a year to calculate the STV; and red text in the Geomean column highlights exceedances of the 126 CFU/100 mL criterion (applied to rolling 90-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W0126	*E. coli*	5/24/2005	WET	360	360	
W0126	*E. coli*	6/21/2005	DRY	84	174	
W0126	*E. coli*	7/27/2005	DRY	410	231	
W0126	*E. coli*	8/24/2005	DRY	110	156	
W0126	*E. coli*	9/27/2005	DRY	150	189	
W0126	Fecal Coliform	5/24/2005	WET	1,000		
W0126	Fecal Coliform	6/21/2005	DRY	97		
W0126	Fecal Coliform	7/27/2005	DRY	390		
W0126	Fecal Coliform	8/24/2005	DRY	130		
W0126	Fecal Coliform	9/27/2005	DRY	150		
W2168	*E. coli*	6/17/2010	DRY	170	170	
W2168	*E. coli*	6/29/2010	DRY	100	130	
W2168	*E. coli*	8/30/2010	DRY	110	123	
W2168	*E. coli*	10/5/2010	DRY	350	196	

8.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information that can be used to focus pollutant reduction activities. Pathogen levels (as estimated by indicator bacteria) are usually higher in wet weather conditions as storm sewer systems overflow and/or stormwater runoff carries fecal matter that has accumulated on the landscape to the river via overland flow and stormwater conduits. Wet weather sources include wildlife and domesticated animal waste (including pets), urban stormwater runoff (including MS4 areas), CSOs, and sanitary sewer overflows (SSOs). In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants during dry weather, which then becomes diluted by precipitation. Dry weather sources include leaking sewer pipes, illicit connections of sanitary sewers to storm drains, failing septic systems, recreational use (such as swimmers), and direct wildlife and domesticated animal waste (including pets).

Indicator bacteria data for Howlett Brook (MA92-17) were elevated during both wet and dry weather. Elevated results during wet weather are consistent with urban stormwater, pet waste, and wildlife pathogen sources. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated levels of indicator bacteria during wet weather events. Elevated results during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens. More sampling under both wet and dry conditions would likely help identify pollutant sources.

Each potential pathogen source is described in further detail below.

Urban Stormwater: Portions of the watershed are moderately developed, with 45% of the land area subject to MS4 permit conditions;7% of the land is classified as impervious area, and 3% as DCIA. Development within the watershed consists largely of low- to medium-density residential properties, with a higher density of commercial and industrial properties and transportation infrastructure in the lower watershed adjacent to the segment. Stormwater runoff from urban areas is likely a contributing source of pathogens.

Illicit Sewage Discharges: Public sewer service may be available in the watershed within the Massachusetts town of Ipswich. Sewerage-related threats to water quality include leaking infrastructure (pipes, pump stations, etc.) and SSOs, which may be caused by undersized infrastructure, blockages, or excessive infiltration of

groundwater or rainwater into pipes, exceeding system capacity. Illicit connections of wastewater to stormwater conveyances are also a potential source.

On-Site Wastewater Disposal Systems: Some development in the watershed utilizes on-site septic systems for wastewater treatment. There is one MassDEP permit for an on-site wastewater discharge to groundwater. In addition to this permitted point source, it is likely that some septic systems are not properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Agricultural activity in the watershed accounts for only 1% of the total land use and is generally located far from the segment, except for a hayfield located near the confluence of Howlett Brook and the Ipswich River. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: Much of the segment flows through forest and natural areas, with a few locations where medium density residential development is near the segment. Conservation lands, parks, ballfields, and residential neighborhoods popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent possible sources of pathogens.

Wildlife Waste: Although most of the immediate area surrounding the segment is forest, there are a few large wetland areas and open fields adjacent to the segment where wildlife might congregate. Large mowed areas, fields, or wetlands with a clear sightline to a waterbody may attract large congregations of waterfowl, resulting in elevated indicator bacteria counts in the water.

8.4. Existing Local Management

This section identifies the major municipalities immediately surrounding the impaired segment and its contributing watershed. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Boxford. See Section 3.4

Town of Ipswich. See Section 3.4

Town of Topsfield. See Section 3.4

9. MA92-21 Kimball Brook

9.1. Waterbody Overview

Kimball Brook segment MA92-21 is 2.2 miles long and begins west of Scott Hill in Ipswich, MA. The segment flows generally eastward to the Ipswich River in Ipswich, MA.

There are several small tributaries to Kimball Brook segment MA92-21, and there are no named lakes or ponds within the segment watershed. In some areas, the stream flows through wooded swamp and other wetlands.

Key landmarks in the watershed include the western portion of the Ipswich town center and a few farms and residential neighborhoods. From upstream to downstream, segment MA92-21 is crossed by an unnamed road north of Bush Hill Road, Heard Drive, Hodgkins Drive, Topsfield Road, Stafford Street, Peabody Street, Hayward Street, and Kimball Street, all located in Ipswich.

Kimball Brook (MA92-21) drains an area of 1.0 square miles, of which 0.12 mi^2 (11%) are impervious and 0.07 mi^2 (7%) are directly connected impervious area (DCIA). The watershed may be served by a public sewer system in Ipswich[19] and 88% is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are no NPDES permits on file governing point source discharges of pollutants to surface waters, MassDEP discharge-to-groundwater permits for on-site wastewater discharges, or combined sewer overflows (CSOs) within the watershed. There are no landfills or unpermitted land disposal dumping grounds within the segment watershed. See Figure 9-1.

The Kimball Brook watershed has forest/natural areas (58%), as well as development (21%) and agriculture (10%). Wetlands comprise the remaining area (11%), predominately located adjacent to the segment. Almost all of the development is low- to medium-density residential properties, with some industrial development in the lower watershed near the Ipswich town center. The agricultural land in the watershed consists predominately of large

Reduction from Highest Calculated Geomean: 87%

Watershed Area (Acres): 661

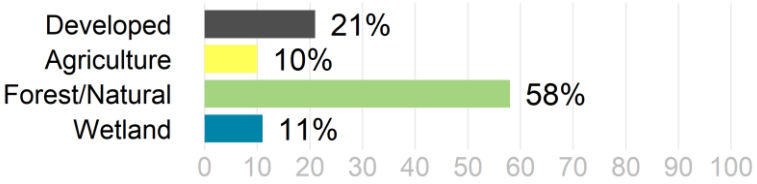
Segment Length (Miles): 2.2

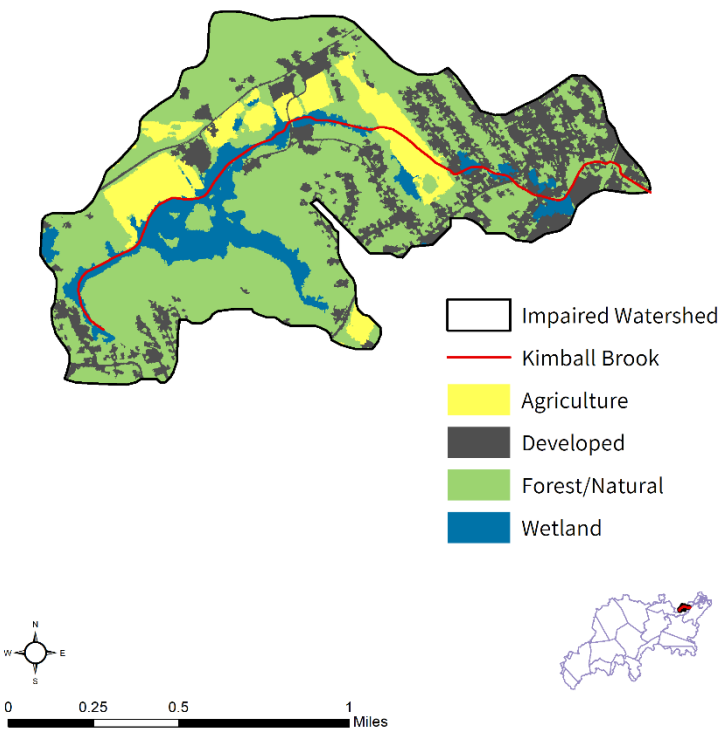
Impairment(s): *E. coli* and fecal coliform (Primary Contact Recreation)

Class (Qualifier): B

Impervious Area (Acres, %): 74 (11%)

DCIA Area (Acres, %): 43 (7%)





[19] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project (MassDEP, 2021b), MS4 reports, and local knowledge.

hayfields adjacent to the segment with little or no wooded buffers.

In the Kimball Brook (MA92-21) watershed, under the Natural Heritage and Endangered Species Program, there are no Priority Habitats of Rare Species or Priority Natural Vegetation Communities. There are no Areas of Critical Environmental Concern, 0.4 acres (<1%) under Public Water Supply protection and three acres (<1%) of Outstanding Resource Waters in the watershed. Over 62 acres (9%) of land within the segment watershed are protected in perpetuity[20], which accounts for all the Protected and Recreational Open Space[21]. See Figure 9-1.

[20] Land protected in perpetuity includes conservation restrictions, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[21] All Protected and Recreational Open Space land is shown on the natural resources map.

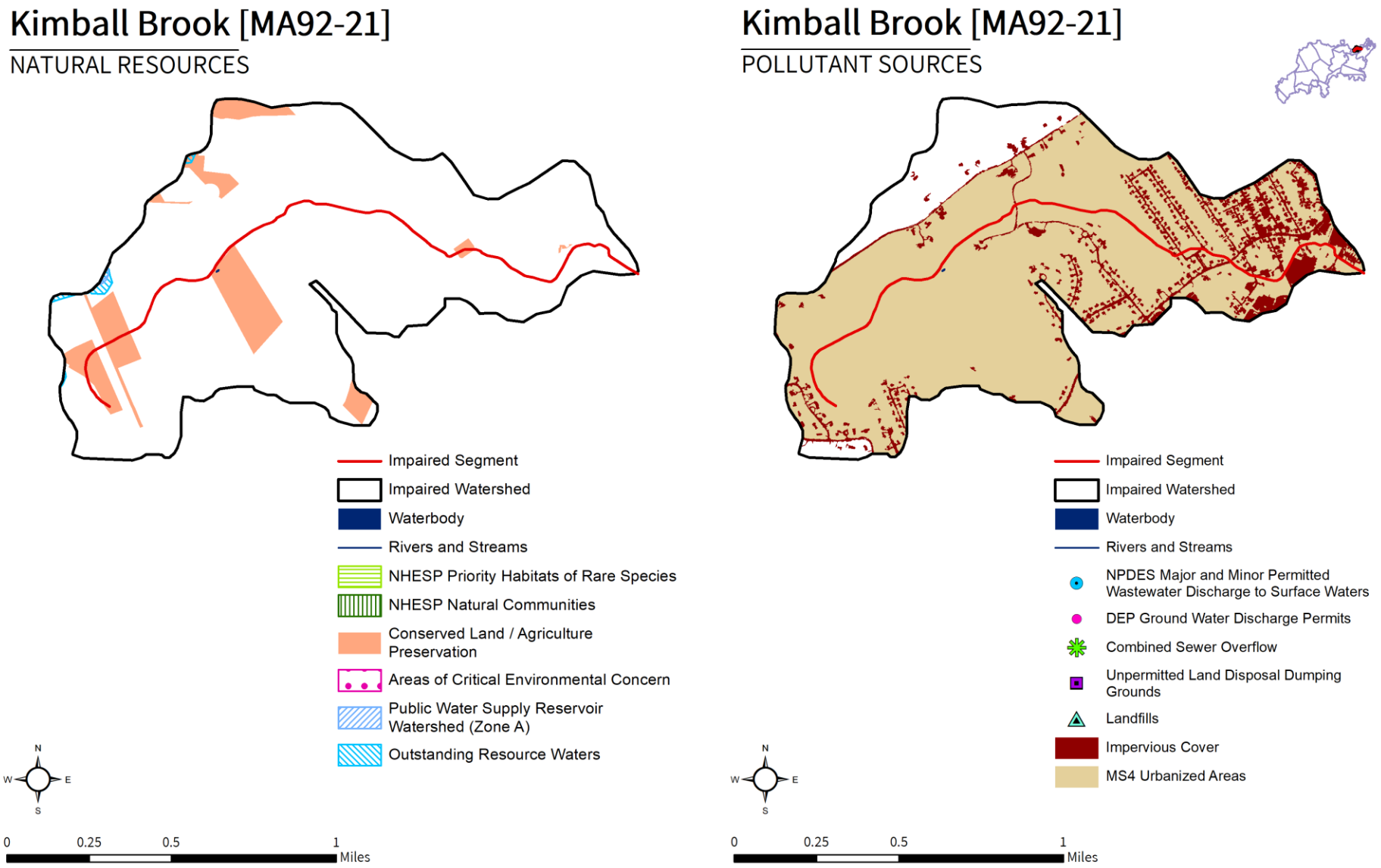


Figure 9-1. Natural resources and potential pollution sources draining to the Kimball Brook segment MA92-21. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollutant sources, including impervious cover, MS4 areas, permitted facilities, etc.

9.2. Waterbody Impairment Characterization

Kimball Brook (MA92-21) is a Class B Water (MassDEP, 2021a).

The Primary Contact Recreation use was assessed for attainment of SWQS at the station listed below (refer to Tables 9-1, 9-2; Figure 9-2) using the indicator bacteria *E. coli*). Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 90-day rolling basis.

- In 2005, five samples were collected at W0120; data indicated five days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the STV criterion was applied to single sample results. Out of five samples, two exceeded the STV criterion, one during wet weather and one during dry weather.

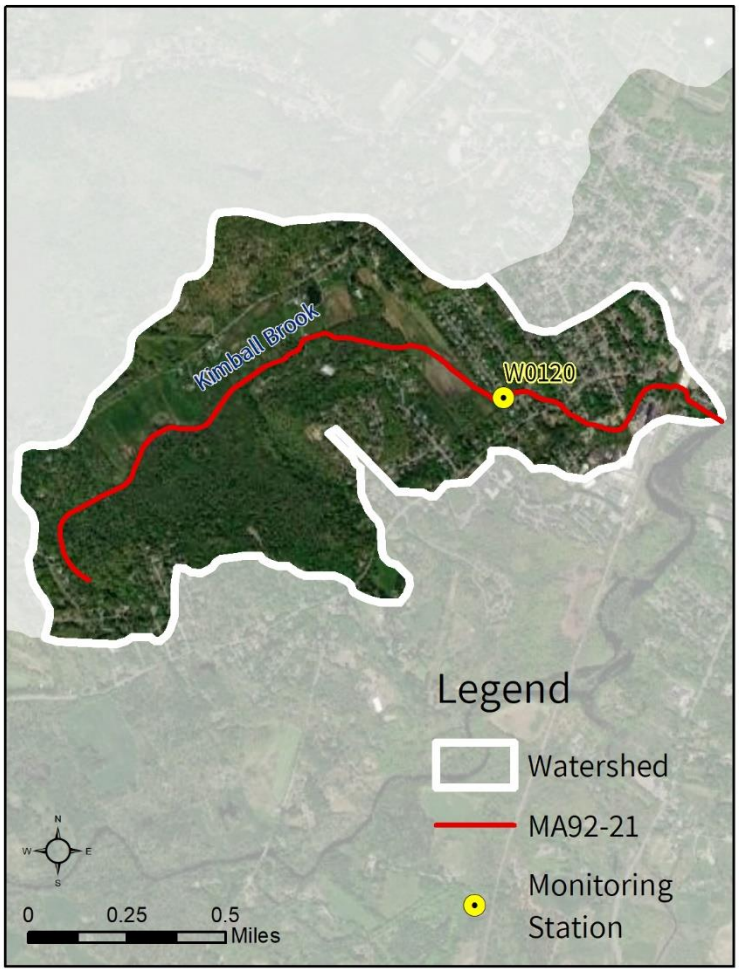


Figure 9-2. Location of monitoring station(s) along the impaired segment.

Table 9-1. Summary of indicator bacteria sampling results by station for Kimball Brook (MA92-21). The maximum 90-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the STV criterion of 410 CFU/100 mL for *E. coli* indicator bacteria are shown. The STV criterion is applied to the single sample results if less than 10 samples were collected within a calendar year at a site. The highest maximum 90-day rolling geomean of the sites is used to calculate the percent load reduction required to meet SWQS.

Unique Station ID	First Sample	Last Sample	Count	Maximum 90-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
W0120	5/24/2005	9/27/2005	5	990	5	2

Table 9-2. Indicator bacteria data by station, indicator, and date for Kimball Brook (MA92-21). Each sample date was designated as representing wet or dry weather conditions with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text in the Results column highlights criteria exceedances of 410 CFU/100 mL (applied to single-sample "Result" since there were no more than 10 samples in a year to calculate the STV; and red text in the Geomean column highlights exceedances of the 126 CFU/100 mL criterion (applied to rolling 90-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W0120	*E. coli*	5/24/2005	WET	990	990	
W0120	*E. coli*	6/21/2005	DRY	400	629	
W0120	*E. coli*	7/27/2005	DRY	71	304	
W0120	*E. coli*	8/24/2005	DRY	120	150	
W0120	*E. coli*	9/27/2005	DRY	450	157	
W0120	Fecal Coliform	5/24/2005	WET	4,000		
W0120	Fecal Coliform	6/21/2005	DRY	540		
W0120	Fecal Coliform	7/27/2005	DRY	65		
W0120	Fecal Coliform	8/24/2005	DRY	210		
W0120	Fecal Coliform	9/27/2005	DRY	700		

9.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information that can be used to focus pollutant reduction activities. Pathogen levels (as estimated by indicator bacteria) are usually higher in wet weather conditions as storm sewer systems overflow and/or stormwater runoff carries fecal matter that has accumulated on the landscape to the river via overland flow and stormwater conduits. Wet weather sources include wildlife and domesticated animal waste (including pets), urban stormwater runoff (including MS4 areas), CSOs, and sanitary sewer overflows (SSOs). In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants during dry weather, which then becomes diluted by precipitation. Dry weather sources include leaking sewer pipes, illicit connections of sanitary sewers to storm drains, failing septic systems, recreational use (such as swimmers), and direct wildlife and domesticated animal waste (including pets).

Indicator bacteria data for Kimball Brook (MA92-21) were elevated during both wet and dry weather. Elevated results during wet weather are consistent with urban stormwater, pet waste, and wildlife pathogen sources. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated levels of indicator bacteria during wet weather events. Elevated results during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens. Given the relatively small sample set, additional sampling under both wet and dry conditions, ideally at more than one location, would likely help identify pollutant sources.

Each potential pathogen source is described in further detail below.

Urban Stormwater: Portions of the watershed are moderately developed, with 88% of the land area subject to MS4 permit conditions; 11% of the land is classified as impervious area, and 7% as DCIA. Development within the watershed consists of low- to medium-density residential development with some industrial development in the lower watershed. Stormwater runoff from urban areas is likely a contributing source of pathogens to the downstream portion of the segment.

Illicit Sewage Discharges: Public sewer service may be available in the watershed within the Massachusetts town of Ipswich. Sewerage-related threats to water quality include leaking infrastructure (pipes, pump stations, etc.) and SSOs, which may be caused by undersized infrastructure, blockages, or excessive infiltration of groundwater or rainwater into pipes, exceeding system capacity. Illicit connections of wastewater to stormwater conveyances are also a potential source.

On-Site Wastewater Disposal Systems: Some development in the watershed utilizes on-site septic systems for wastewater treatment. It is likely that some septic systems are not properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Agricultural activities in the watershed account for 11% of the total land area. These agricultural lands primarily consist of large hayfields bordering the segment, with little or no wooded buffers; in one reach, the segment flows through one of these fields. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies. Stormwater runoff from agricultural land is likely a significant source of pathogens to the segment.

Pet Waste: In the lower watershed, the segment flows through multiple medium-density residential neighborhoods. Conservation lands, parks, ballfields, and residential neighborhoods popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent possible sources of pathogens.

Wildlife Waste: There are large open fields adjacent to most of the segment where wildlife might congregate. Large mowed areas, fields, or wetlands with a clear sightline to a waterbody may attract large congregations of waterfowl, resulting in elevated indicator bacteria counts in the water.

9.4. Existing Local Management

This section identifies the major municipalities immediately surrounding the impaired segment and its contributing watershed. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Ipswich. See Section 3.4

10. MA92-22 Labor in Vain Creek

10.1. Waterbody Overview

Labor in Vain Creek segment MA92-22 is 0.03 square miles (mi^2) in area and begins south of Argilla Road in Ipswich, MA. The segment is tidally influenced, but generally flows in a northerly direction to the Ipswich River segment MA92-02 in Ipswich, MA.

Tributaries to Labor in Vain Creek segment MA92-22 include a few unnamed tidal creeks that extend into wetland areas surrounding the segment. There are no sizable lakes or ponds within the segment watershed. Most of the stream flows within salt marsh.

Key landmarks in the watershed include Heartbreak Hill, Eagle Island, Maplecroft Farm Trail, Bradley Field, Hamlin Reservation, and Ascot Riding Center. From upstream to downstream, segment MA92-22 is crossed by Argilla Road and Labor in Vain Road, both in Ipswich.

Labor in Vain Creek (MA92-22) drains an area of 2.1 square miles, of which 0.05 mi^2 (2%) are impervious and 0.02 mi^2 (1%) are directly connected impervious area (DCIA). The watershed may be served by a public sewer system in Ipswich[22] and 21% is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are no NPDES permits on file governing point source discharges of pollutants to surface waters, MassDEP discharge-to-groundwater permits for on-site wastewater discharges, or combined sewer overflows (CSOs) within the watershed. There are no landfills or unpermitted land disposal dumping grounds within the segment watershed. See Figure 10-1.

Land cover in the watershed includes forest/natural areas (35%), agriculture (29%), and wetlands (32%). The watershed contains little development (4%), with a few low-density residential properties scattered around wetland areas. Agricultural activity is dominated by large hayfields and pastureland in the upper watershed, the majority of which is associated with horse farms.

In the Labor in Vain Creek (MA92-22) watershed, under the Natural Heritage and Endangered

Reduction from Highest Calculated Geomean: NA

Watershed Area (Acres): 1,334

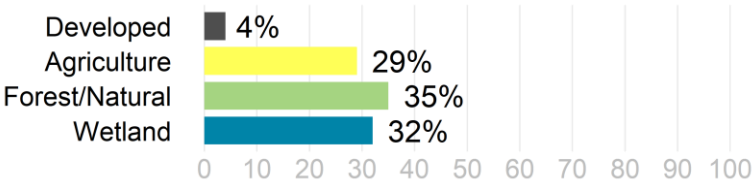
Segment Area (mi^2): 0.03

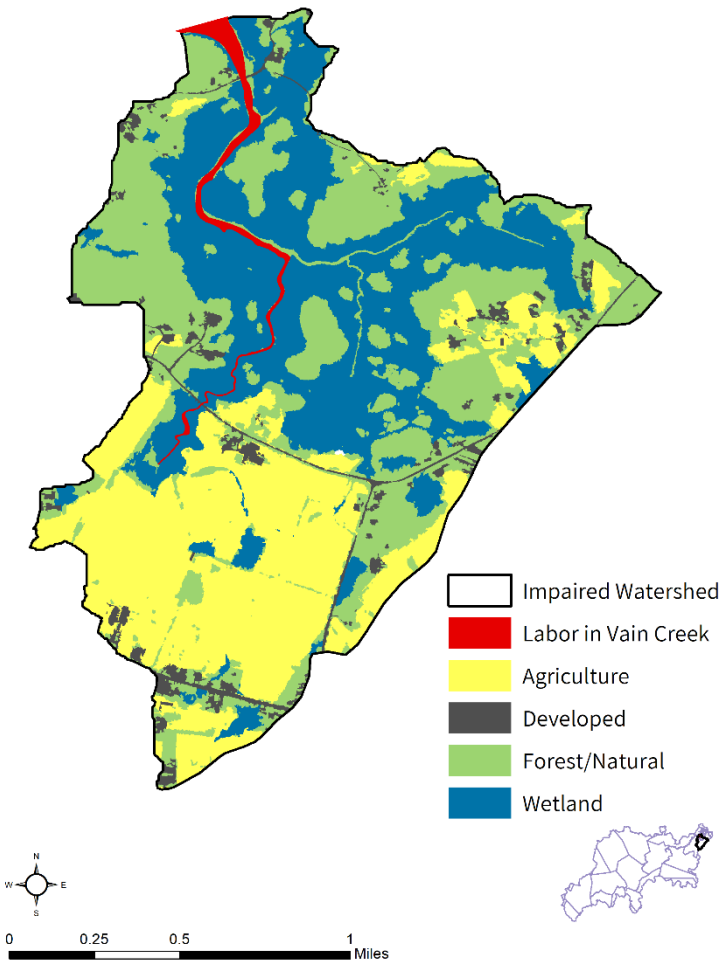
Impairment(s): Fecal coliform (Shellfish)

Class: SA (Shellfishing)

Impervious Area (Acres, %): 30 (2%)

DCIA Area (Acres, %): 11 (1%)





[22] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project (MassDEP, 2021b), MS4 reports, and local knowledge.

Species Program, there are 271 acres (20%) of Priority Habitats of Rare Species and 401 acres (30%) of Priority Natural Vegetation Communities. There are 522 acres (39%) within the Great Marsh Area of Critical Environmental Concern, no acres under Public Water Supply protection, and five acres (<1%) identified as Outstanding Resource Waters in the watershed. Over 448 acres (34%) of land within the segment watershed are protected in perpetuity[23], part of the total 501 acres (38%) of Protected and Recreational Open Space[24]. See Figure 10-1.

[23] Land protected in perpetuity includes conservation restrictions, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[24] All Protected and Recreational Open Space land is shown on the natural resources map.

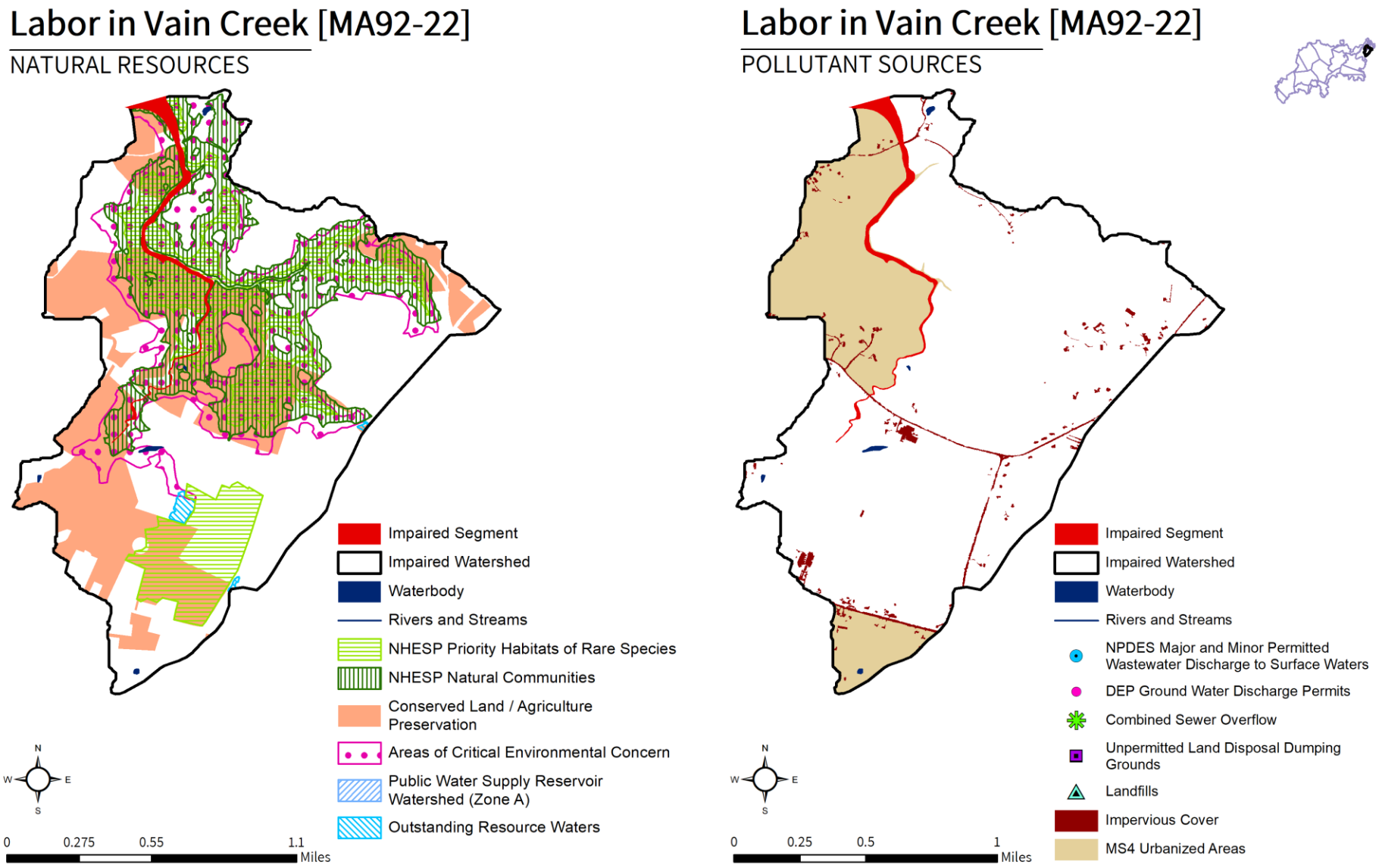


Figure 10-1. Natural resources and potential pollution sources draining to the Labor in Vain Creek segment MA92-22. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollutant sources, including impervious cover, MS4 areas, permitted facilities, etc.

10.2. Waterbody Impairment Characterization

Labor in Vain Creek (MA92-22) is a Class SA tidal estuary, with a Shellfishing qualifier (MassDEP, 2021a).

The Shellfish Harvesting use was assessed for attainment of SWQS using fecal coliform indicator bacteria at one shellfish growing area that covers 0.02 mi^2 (71% of the segment area; refer to Figure 10-2). MassDEP assessed the Shellfish Harvesting use as not supporting since the growing area normalized to the segment area is less than 100% approved for shellfishing by the Massachusetts Division of Marine Fisheries (Table 10-1).

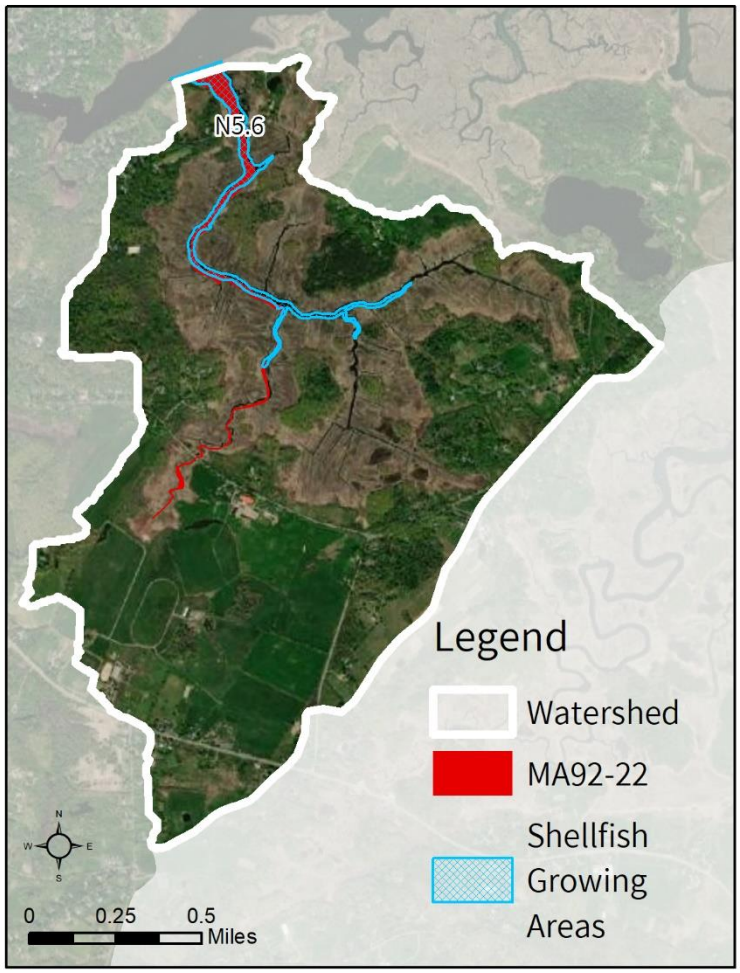


Figure 10-2. Location of the shellfish growing area associated with the impaired segment.

Table 10-1. Summary of MA DFG-Division of Marine Fisheries classification data from January 2014 for one shellfish growing area in Labor in Vain Creek segment MA92-22. Percentage indicates the relative area within the segment covered by the shellfish growing area. Shellfish Harvesting is classified as not supporting if the growing area normalized to the segment area is less than 100% approved for shellfishing by the Massachusetts Division of Marine Fisheries.

Name	Area Description	Class	Area (mi^2)	Percentage
N5.6	Labor-in-Vain Creek	Conditionally Approved	0.0212	71%

10.3. Potential Pathogen Sources

Each potential pathogen source is described in further detail below.

Urban Stormwater: The watershed is minimally developed, with 21% of the land area subject to MS4 permit conditions; 2% of the land is classified as impervious area, and 1% as DCIA. Stormwater runoff from urban areas is not likely to be a large contributing source of pathogens to the segment.

Illicit Sewage Discharges: Public sewer service may be available in the watershed within the town of Ipswich. Sewerage-related threats to water quality include leaking infrastructure (pipes, pump stations, etc.) and sanitary sewer overflows (SSOs), which may be caused by undersized infrastructure, blockages, or excessive infiltration

of groundwater or rainwater into pipes, exceeding system capacity. Illicit connections of wastewater to stormwater conveyances are also a potential source.

On-Site Wastewater Disposal Systems: Some development in the watershed utilizes on-site septic systems for wastewater treatment. It is likely that some septic systems are not properly maintained and are discharging untreated effluent to groundwater.

Illicit Boat Discharges: The segment is navigable by marine vessels. Vessels with onboard toilets are required to have a marine sanitation device (MSD) to treat or store wastewater. MSDs that treat wastewater may be improperly maintained or malfunctioning and therefore could discharge untreated sewage to coastal waterbodies. For MSDs that store wastewater, this sewage can either be pumped out at shore-based pump-out facilities or discharged directly into the water when the vessel is more than three miles offshore, beyond the designated No Discharge Zone (NDZ). Negligent boaters who ignore these laws and discharge untreated sewage to coastal waterbodies may be a source of pathogen pollution.

Vessel Pump-Out Facilities: There are no vessel sewage pump-out facilities directly adjacent to the Labor in Vain Creek segment MA92-22 (CZM, 2022b). Although pump-out facilities provide boaters with a means of disposing of onboard sewage without discharging it into coastal waters, these facilities are generally associated with high boating activity. Pump-out facilities which malfunction or leak also represent a potential pathogen source. As a result, waterbodies adjacent to pump-out facilities are likely at high risk of illicit boat (and facility) discharges.

Agriculture: Agricultural activities in the watershed account for 29% of the total land use. These areas are predominately hayfields and pastureland in the upper watershed, associated with horse farms. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: A large portion of the watershed is Protected and Recreational Open Space (38%), with numerous hiking trails and nature preserves. Conservation lands, parks, ballfields, and residential neighborhoods popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent possible sources of pathogens.

Wildlife Waste: In addition to the large agricultural fields in the upper watershed, the segment is surrounded by large wetland areas that may attract wildlife. Large mowed areas, fields, or wetlands with a clear sightline to a waterbody may attract large congregations of waterfowl, resulting in elevated indicator bacteria counts in the water.

10.4. Existing Local Management

This section identifies the major municipalities immediately surrounding the impaired segment and its contributing watershed. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Ipswich. See Section 3.4

11. MA92-23 Unnamed Tributary

11.1. Waterbody Overview

The unnamed tributary segment MA92-23 (locally known as Greenwood Creek) is 0.03 square miles (mi2) in area and begins east of Jeffrey's Neck Road and north of Newmarch Street in Ipswich, MA. The segment is tidally influenced but generally flows in an easterly direction to the confluence with the Ipswich River segment MA92-02 in Ipswich, MA.

Tributaries to the unnamed tributary segment MA92-23 include several unnamed tidal creeks within the salt marshes that largely surround the segment. There are no lakes or ponds within the segment watershed. The entire stream corridor lies within salt marsh wetlands.

Key landmarks in the watershed include Greenwood Farm, Daniel Boone Park, Dow Park, and Cuvilly Arts & Earth Center. The segment is not crossed by any roads, pedestrian bridges, etc.

The unnamed tributary (MA92-23) drains an area of 0.5 square miles (mi^2), of which 0.03 mi^2 (5%) are impervious and 0.01 mi^2 (2%) are directly connected impervious area (DCIA). The watershed may be served by a public sewer system in Ipswich[25] and 3% is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There is one additional NPDES permit on file governing the point source discharge of pollutants to surface waters, for a wastewater treatment facility (Table 10-1). There are no MassDEP discharge-to-groundwater permits for on-site wastewater discharges or combined sewer overflows (CSOs) within the watershed. There are no landfills or unpermitted land disposal dumping grounds within the segment watershed. See Figure 11-1.

The upper portion of the watershed is dominated by forest and natural areas that cover 46% of the total land area, while the lower watershed is dominated by wetlands that cover 35% of the land area. The watershed is moderately developed (10%), with medium density residential neighborhoods located in a few areas. Agricultural activities make up 9% of the land area, consisting

Reduction from Highest Calculated Geomean: NA

Watershed Area (Acres): 349

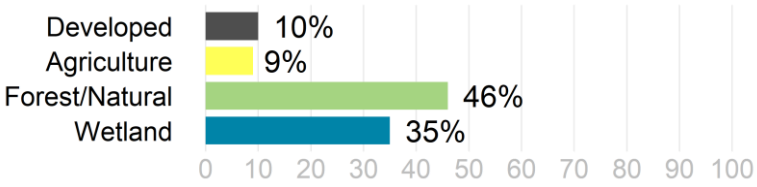
Segment Area (mi^2): 0.03

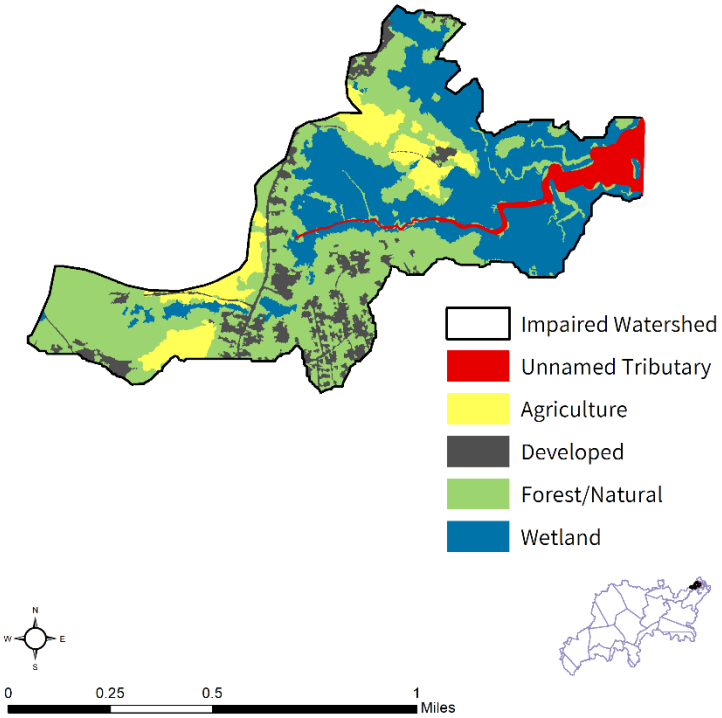
Impairment(s): Fecal coliform (Shellfish)

Class (Qualifier): SA (Shellfishing)

Impervious Area (Acres, %): 17 (5%)

DCIA Area (Acres, %): 7 (2%)





[25] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project (MassDEP, 2021b), MS4 reports, and local knowledge.

of hayfields and cultivated land. The segment itself flows exclusively through wetland areas.

In the unnamed tributary (MA92-23) watershed, under the Natural Heritage and Endangered Species Program, there are 81 acres (23%) of Priority Habitats of Rare Species and 124 acres (35%) of Priority Natural Vegetation Communities. There are 176 acres (50%) within the Great Marsh Area of Critical Environmental Concern and no acres under Public Water Supply protection or identified as Outstanding Resource Waters. Over 170 acres (49%) of land within the segment watershed are protected in perpetuity[26], which accounts for all of the Protected and Recreational Open Space [27]. See Figure 11-1.

Table 11-1. National Pollutant Discharge Elimination System (NPDES) permits for Wastewater Treatment Facilities (WWTF) in the segment watershed. WWTF are identified as either municipal (MUN) or other (OTH), if applicable.

NPDES ID	NAME	TOWN	WWTF
MA0100609	IPSWICH WWTF	IPSWICH	MUN

[26] Land protected in perpetuity includes conservation restrictions, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[27] All Protected and Recreational Open Space land is shown on the natural resources map.

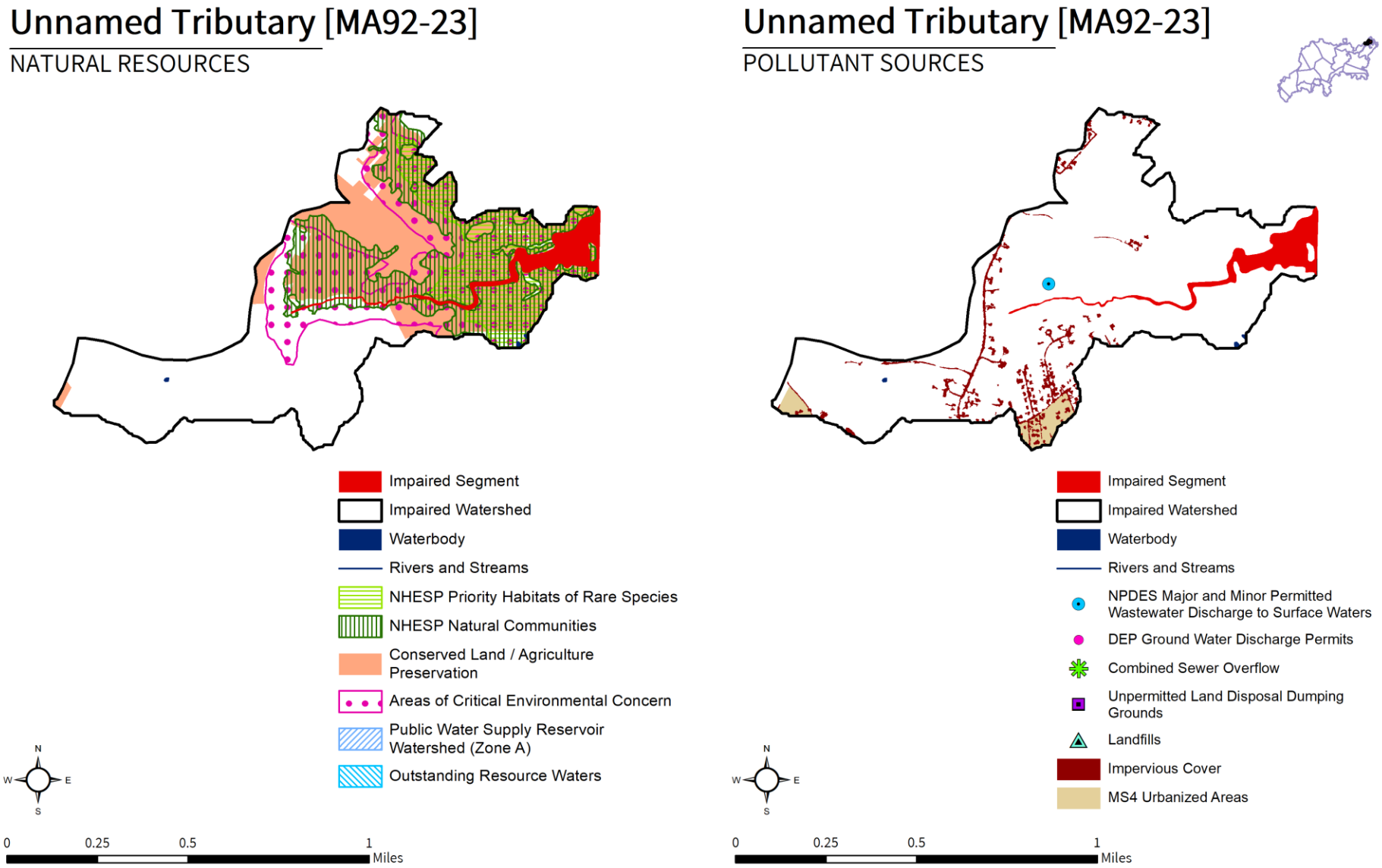


Figure 11-1. Natural resources and potential pollution sources draining to the unnamed tributary segment MA92-23. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollutant sources, including impervious cover, MS4 areas, permitted facilities, etc.

11.2. Waterbody Impairment Characterization

The unnamed tributary (MA92-23) is a Class SA tidal estuary, with a Shellfishing qualifier (MassDEP, 2021a).

The Shellfish Harvesting use was assessed for attainment of SWQS using fecal coliform indicator bacteria at one shellfish growing area that covers 0.02 mi^2 (76% of the segment area; refer to Figure 11-2). MassDEP assessed the Shellfish Harvesting use as not supporting since the growing area normalized to the segment area is less than 100% approved for shellfishing by the Massachusetts Division of Marine Fisheries (Table 11-2).

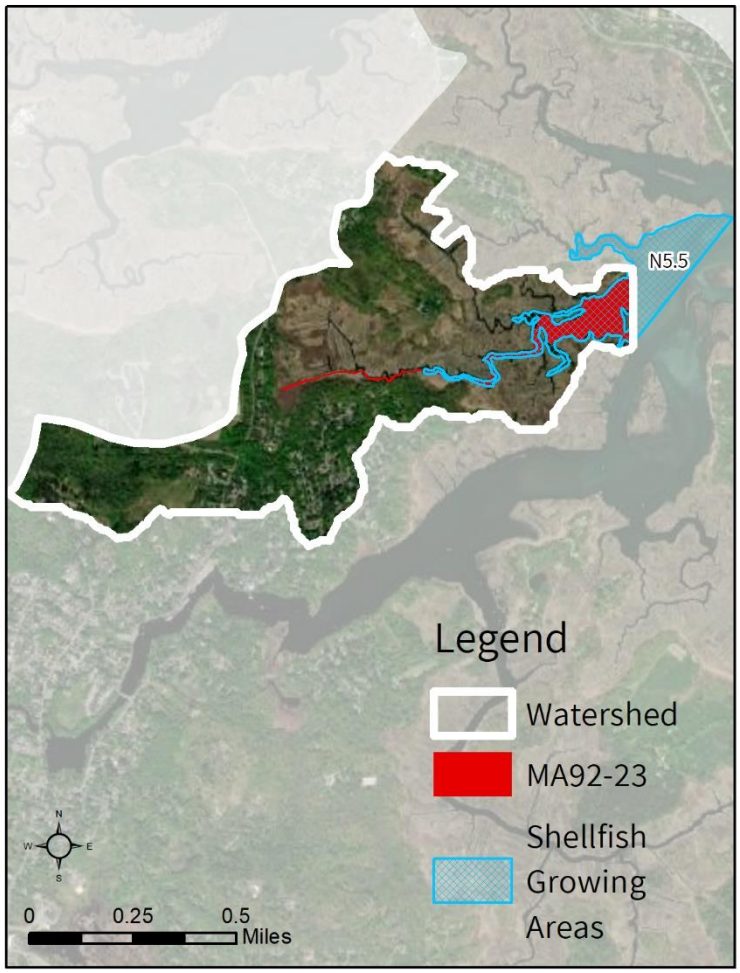


Figure 11-2. Location of the shellfish growing area associated with the impaired segment.

Table 11-2. Summary of MA DFG-Division of Marine Fisheries classification data from January 2014 for one shellfish growing area in the unnamed tributary segment MA92-23. Percentage indicates the relative area within the segment covered by each shellfish growing area. Shellfish Harvesting is classified as not supporting if the growing area normalized to the segment area is less than 100% approved for shellfishing by the Massachusetts Division of Marine Fisheries.

Name	Area Description	Class	Area (mi^2)	Percentage
N5.5	Greenwoods	Prohibited	0.0229	76%

11.3. Potential Pathogen Sources

Each potential pathogen source is described in further detail below.

Urban Stormwater: Portions of the watershed have minor development, with 3% of the land area subject to MS4 permit conditions; 5% of the land is classified as impervious area, and 2% as DCIA. Stormwater runoff from urban areas is likely a minor contributing source of pathogens to this segment.

Illicit Sewage Discharges: Public sewer service may be available in the watershed within the town of Ipswich. Sewerage-related sources include leaking infrastructure (pipes, pump stations, etc.) and sanitary sewer overflows (SSOs), which may be caused by undersized infrastructure, blockages, or excessive infiltration of

groundwater or rainwater into pipes, exceeding system capacity. Illicit connections of wastewater to stormwater conveyances are also a potential source.

On-Site Wastewater Disposal Systems: Some development in the watershed utilizes on-site septic systems for wastewater treatment. It is likely that some septic systems are not properly maintained and are discharging untreated effluent to groundwater.

Illicit Boat Discharges: The segment is navigable by marine vessels. Vessels with onboard toilets are required to have a marine sanitation device (MSD) to treat or store wastewater. MSDs that treat wastewater may be improperly maintained or malfunctioning and therefore could discharge untreated sewage to coastal waterbodies. For MSDs that store wastewater, this sewage can either be pumped out at shore-based pump-out facilities or discharged directly into the water when the vessel is more than three miles offshore, beyond the designated No Discharge Zone (NDZ). Negligent boaters who ignore these laws and discharge untreated sewage to coastal waterbodies may be a source of pathogen pollution.

Vessel Pump-Out Facilities: There are no vessel sewage pump-out facilities directly adjacent to the unnamed tributary segment MA92-23 (CZM, 2022b). Although pump-out facilities provide boaters with a means of disposing of onboard sewage without discharging it into coastal waters, these facilities are generally associated with high boating activity. Pump-out facilities which malfunction or leak also represent a potential pathogen source. As a result, waterbodies adjacent to pump-out facilities are likely at high risk of illicit boat discharges.

Agriculture: Agricultural activities in the watershed account for 9% of the total land area. These areas include cultivated fields in the upper watershed and large hayfields in the lower watershed closer to the segment. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: There is a residential neighborhood and a large area of conserved agricultural land near the segment. Conservation lands, parks, ballfields, and residential neighborhoods popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent possible sources of pathogens.

Wildlife Waste: In addition to the large hayfields in the lower watershed, the segment is surrounded by large wetland areas that may attract wildlife. Large mowed areas, fields, or wetlands with a clear sightline to a waterbody may attract large congregations of waterfowl, resulting in elevated indicator bacteria counts in the water.

11.4. Existing Local Management

This section identifies the major municipalities immediately surrounding the impaired segment and its contributing watershed. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Ipswich. See Section 3.4

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