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

Appendix T: Concord (SuAsCo) River Basin

Commonwealth of Massachusetts
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December 2024

CN 515.1.20

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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

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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 Total Maximum Daily Load (TMDL) for 17 pathogen-impaired river segments in the Concord River Basin, hereinafter referred to as the Sudbury, Assabet, and Concord (SuAsCo) River watershed (Figure 1-1). The core document and appendix together complete the TMDL for each of these pathogen-impaired river 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. For water quality data, the Method Detection Limit (MDL) is reported and used for values below the MDL when calculating geometric means.

This appendix 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 also 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. Refer to Table 1-1.

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 SuAsCo River Watershed Overview section.

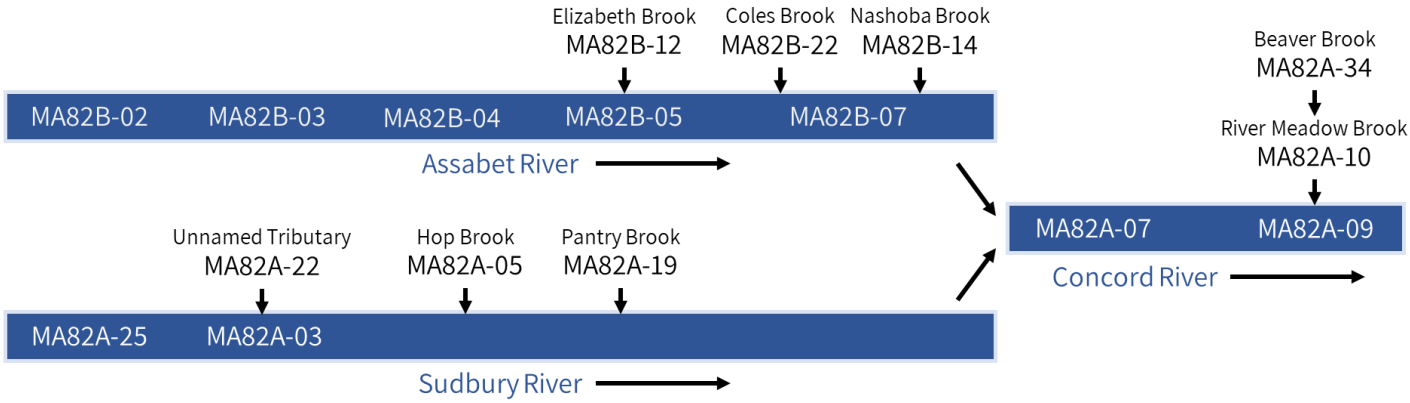


Figure 1.1. Conceptual diagram of water flow routing through the SuAsCo River watershed for the 17 pathogen-impaired river segments. Mainstem segments of major rivers (i.e., Assabet, Sudbury, and Concord Rivers) are highlighted in blue. Tributary segments to the major rivers are shown with arrows to the blue mainstem. Not to scale.

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 Concord (SuAsCo) River Basin

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)					
Sudbury River		R	126	866	85%	WLA (17%)	0.5	5.1	50.9	509.2	5,091.8	50,917.7
MA82A-03	B (AQL, HQW)			(90 day)		LA (83%)	2.6	25.7	257.4	2,573.5	25,735.0	257,350.3
Hop Brook		R	126	382	67%	WLA (12%)	0.4	3.6	35.8	358.5	3,584.5	35,845.1
MA82A-05	B (WW)			(30 day)		LA (88%)	2.7	27.2	272.4	2,724.2	27,242.3	272,422.9
Concord River		R	126	500	75%	WLA (13%)	0.4	4.0	39.6	396.2	3,961.7	39,616.8
MA82A-07	B (TWS, WW)			(30 day)		LA (87%)	2.7	26.9	268.7	2,686.5	26,865.1	268,651.3
Concord River		R	126	980	87%	WLA (14%)	0.4	4.2	41.6	416.4	4,163.7	41,636.9
MA82A-09	B (WW, CSO)			(30 day)		LA (86%)	2.7	26.7	266.6	2,666.3	26,663.1	266,631.1
River Meadow Brook		R	126	2,336	95%	WLA (19%)	0.6	5.9	59.0	589.9	5,898.6	58,986.3
MA82A-10	B			(90 day)		LA (81%)	2.5	24.9	249.3	2,492.8	24,928.2	249,281.7
Pantry Brook		R*	126	NA	-	WLA (9%)	0.3	2.7	27.1	271.3	2,713.5	27,134.9
MA82A-19	B					LA (91%)	2.8	28.1	281.1	2,811.3	28,113.3	281,133.1
Unnamed Tributary		R	126	307	59%	WLA (25%)	0.8	7.7	77.3	772.5	7,725.1	77,250.8
MA82A-22	B			(90 day)		LA (75%)	2.3	23.1	231.0	2,310.2	23,101.7	231,017.2
Sudbury River		R	126	270	53%	WLA (12%)	0.4	3.8	38.4	383.8	3,838.2	38,381.6
MA82A-25	B (WW, HQW)			(90 day)		LA (88%)	2.7	27.0	269.9	2,698.9	26,988.6	269,886.4
Beaver Brook		R	126	204	38%	WLA (16%)	0.5	4.9	48.9	488.7	4,887.4	48,873.6
MA82A-34	B			(90 day)		LA (84%)	2.6	25.9	259.4	2,593.9	25,939.4	259,394.5
Assabet River		R	126	2,800	96%	WLA (14%)	0.4	4.5	44.6	445.5	4,455.3	44,553.2
MA82B-02	B (WW)			(30 day)		LA (86%)	2.6	26.4	263.7	2,637.1	26,371.5	263,714.9
Assabet River		R	126	2,000	94%	WLA (14%)	0.4	4.3	42.7	427.3	4,273.3	42,733.4
MA82B-03	B (WW)			(30 day)		LA (86%)	2.7	26.6	265.5	2,655.3	26,553.5	265,534.6
Assabet River		R	126	8,000	98%	WLA (13%)	0.4	4.1	41.0	409.6	4,096.3	40,963.4
MA82B-04	B (WW)			(30 day)		LA (87%)	2.7	26.7	267.3	2,673.0	26,730.5	267,304.6
Assabet River		R	126	1,990	94%	WLA (13%)	0.4	4.0	39.8	398.1	3,981.4	39,814.2
MA82B-05	B (WW)			(30 day)		LA (87%)	2.7	26.8	268.5	2,684.5	26,845.4	268,453.8
Assabet River		R	126	1,400	91%	WLA (11%)	0.4	3.5	35.2	351.8	3,518.3	35,183.1
MA82B-07	B (WW)			(30 day)		LA (89%)	2.7	27.3	273.1	2,730.8	27,308.5	273,084.9
Elizabeth Brook		R	126	220	43%	WLA (6%)	0.2	1.9	19.5	194.9	1,948.7	19,486.8
MA82B-12	B			(90 day)		LA (94%)	2.9	28.9	288.8	2,887.8	28,878.1	288,781.2
Nashoba Brook		R	126	1,119	89%	WLA (12%)	0.4	3.7	36.6	365.7	3,656.6	36,565.7
MA82B-14	B			(90 day)		LA (88%)	2.7	27.2	271.7	2,717.0	27,170.2	271,702.3
Coles Brook		R	126	746	83%	WLA (18%)	0.5	5.5	54.9	548.6	5,486.0	54,859.5
MA82B-22	B			(90 day)		LA (82%)	2.5	25.3	253.4	2,534.1	25,340.8	253,408.5

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 Concord (SuAsCo) River Basin

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)					
Sudbury River		P	35	NA	-	WLA (17%)	0.1	1.4	14.1	141.4	1,414.4	14,143.8
MA82A-03	B (AQL, HQW)					LA (83%)	0.7	7.1	71.5	714.9	7,148.6	71,486.2
Hop Brook		P	35	NA	-	WLA (12%)	0.1	1.0	10.0	99.6	995.7	9,957.0
MA82A-05	B (WW)					LA (88%)	0.8	7.6	75.7	756.7	7,567.3	75,673.0
Concord River		P	35	NA	-	WLA (13%)	0.1	1.1	11.0	110.0	1,100.5	11,004.7
MA82A-07	B (TWS, WW)					LA (87%)	0.7	7.5	74.6	746.3	7,462.5	74,625.3
Concord River		P	35	NA	-	WLA (14%)	0.1	1.2	11.6	115.7	1,156.6	11,565.8
MA82A-09	B (WW, CSO)					LA (86%)	0.7	7.4	74.1	740.6	7,406.4	74,064.2
River Meadow Brook		P	35	NA	-	WLA (19%)	0.2	1.6	16.4	163.9	1,638.5	16,385.1
MA82A-10	B					LA (81%)	0.7	6.9	69.2	692.4	6,924.5	69,244.9
Pantry Brook		P	35	NA	-	WLA (9%)	0.1	0.8	7.5	75.4	753.7	7,537.5
MA82A-19	B					LA (91%)	0.8	7.8	78.1	780.9	7,809.3	78,092.5
Unnamed Tributary		P	35	NA	-	WLA (25%)	0.2	2.1	21.5	214.6	2,145.9	21,458.5
MA82A-22	B					LA (75%)	0.6	6.4	64.2	641.7	6,417.1	64,171.5
Sudbury River		P	35	NA	-	WLA (12%)	0.1	1.1	10.7	106.6	1,066.2	10,661.6
MA82A-25	B (WW, HQW)					LA (88%)	0.7	7.5	75.0	749.7	7,496.8	74,968.4
Beaver Brook		P	35	NA	-	WLA (16%)	0.1	1.4	13.6	135.8	1,357.6	13,576.0
MA82A-34	B					LA (84%)	0.7	7.2	72.1	720.5	7,205.4	72,054.0
Assabet River		P	35	NA	-	WLA (14%)	0.1	1.2	12.4	123.8	1,237.6	12,375.9
MA82B-02	B (WW)					LA (86%)	0.7	7.3	73.3	732.5	7,325.4	73,254.1
Assabet River		P	35	NA	-	WLA (14%)	0.1	1.2	11.9	118.7	1,187.0	11,870.4
MA82B-03	B (WW)					LA (86%)	0.7	7.4	73.8	737.6	7,376.0	73,759.6
Assabet River		P	35	NA	-	WLA (13%)	0.1	1.1	11.4	113.8	1,137.9	11,378.7
MA82B-04	B (WW)					LA (87%)	0.7	7.4	74.3	742.5	7,425.1	74,251.3
Assabet River		P	35	NA	-	WLA (13%)	0.1	1.1	11.1	110.6	1,106.0	11,059.5
MA82B-05	B (WW)					LA (87%)	0.7	7.5	74.6	745.7	7,457.0	74,570.5
Assabet River		P	35	NA	-	WLA (11%)	0.1	1.0	9.8	97.7	977.3	9,773.1
MA82B-07	B (WW)					LA (89%)	0.8	7.6	75.9	758.6	7,585.7	75,856.9
Elizabeth Brook		P	35	NA	-	WLA (6%)	0.1	0.5	5.4	54.1	541.3	5,413.0
MA82B-12	B					LA (94%)	0.8	8.0	80.2	802.2	8,021.7	80,217.0
Nashoba Brook		P	35	NA	-	WLA (12%)	0.1	1.0	10.2	101.6	1,015.7	10,157.1
MA82B-14	B					LA (88%)	0.8	7.5	75.5	754.7	7,547.3	75,472.9
Coles Brook		P	35	NA	-	WLA (18%)	0.2	1.5	15.2	152.4	1,523.9	15,238.8
MA82B-22	B					LA (82%)	0.7	7.0	70.4	703.9	7,039.1	70,391.2

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).*
AQL *= Aquatic Life Use; waters with natural background conditions that prevent the attainment of Class B criteria and thus Class C dissolved oxygen and temperature criteria apply*
CSO *= Combined Sewer Overflow; waters identified as impacted by the discharge of CSOs without a long-term control plan approved or fully implemented*
CW *= Cold Water; waters that meet the cold water fisheries (CWF) definition at 314 CMR 4.02 and are subject to CWF dissolved oxygen and temperature criteria*

HQW *= High Quality Water; waters designated for protection under 314 CMR 4.04(2)*
ORW *= Outstanding Resource Waters; waters designated for protection under 314 CMR 4.04(2);*
PWS *=Public Water Supply; may be subject to more stringent criteria in accordance with 310 CMR 22.00, and may have restricted use;*
SF *= Shellfishing; waters subject to more stringent regulation by Massachusetts Division of Marine Fisheries (DMF) pursuant to M.G.L. c. 130, § 75*
TWS *= Treated Water Supply; Class B waters used as a source of public water supply after treatment and that may be subject to more stringent site-specific criteria*
WW *= Warm Water; waters that meet the warm water fisheries (WWF) definition at 314 CMR 4.02 and are subject to WWF dissolved oxygen and temperature criteria*

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 use.*
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 TMD*L 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. SuAsCo River Watershed Overview

The SuAsCo River watershed covers an area of approximately 400 square miles in eastern Massachusetts (Figure 1-1). It includes the Concord River, formed by the confluence of the Sudbury and Assabet Rivers in the town of Concord at Egg Rock. There are 82 named rivers, approximately 266 named river miles, many smaller unnamed rivers, and 129 lakes, ponds, and impoundments in the watershed (MassDEP, 2005).

Both the Assabet and Sudbury rivers begin in Westborough, then flow generally northeast. The Assabet River drains 131 square miles, flowing about 31 miles before meeting the Sudbury River. The river course is slowed and altered by many dams and receives effluent from four major wastewater treatment facilities (WWTF) (MassDEP, 2016). There are eight pathogen-impaired river segments in the Assabet River watershed, including nearly the full length of the mainstem.

The Sudbury River drains 162 square miles and flows northeast for about 28 miles to meet the Assabet River. Water supply reservoirs in Hopkinton, Southborough, Ashland, and Framingham are used as emergency drinking water sources (MassDEP, 2016). The Sudbury River watershed contains five pathogen-impaired river segments.

The Concord River watershed, excluding the upstream Assabet and Sudbury watersheds, is 107 square miles and the river flows about 15 miles to the Merrimack River in Lowell. The downstream portion of the Concord River watershed is the most developed and includes four pathogen-impaired river segments.

The SuAsCo River watershed has been characterized by its many dams (eight on the Assabet, six on the Sudbury, and two on the Concord, counting only those on the mainstems) and consequent flow alterations. There are two National Wildlife Refuges (NWR) in the Concord River watershed, the Great Meadows NWR in and around Sudbury and the Assabet NWR mostly in Stow. In addition, the watershed contains the state's first Area of Critical Environmental Concern (ACEC), the Great Cedar Swamp (MassDEP, 2001).

A total of 29 miles of the Sudbury, Assabet, and Concord rivers have been classified by the National Park Service as scenic or recreational under the Wild and Scenic Rivers Act. The designation was based on ecological and recreational values, and historical and literary importance (NWSRS, 2019). See Sudbury, Assabet, and Concord Wild and Scenic River Act (USGPO, 1999).

The SuAsCo River watershed overlaps at least partially with 37 municipalities. Of these, 23 were identified as being direct sources of pathogen loading to the impaired river segments in this TMDL. The efforts of these municipalities contributing to pollutant loading are described in the segment-specific sections below. For each segment, the cities and towns that contain or border the impaired segment were identified. Towns comprising more than 10% of the impaired stream segment's sub-basin (that portion of its watershed not shared with upstream segments) were also included. In addition, towns which may not meet the above characteristics, but which have land area in the sub-basin near the impaired segment (e.g., Town of Littleton for Nashoba Brook MA82B-14), were included on a case-by-case basis. See Figure 2-1 for a map showing impaired segments and municipalities.

Many municipalities 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 July 1, 2018. 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 requirement to reduce pollutants to the Maximum Extent Practicable (USEPA, 2020, Appendix F).

In addition to municipalities, there are four Regional Planning Agencies (RPAs) in the SuAsCo River watershed. These are public organizations advising municipalities, private business groups, and state and federal

governments on a range of matters. Their research, coordination, and technical assistance is especially valuable on watershed issues such as pathogen pollutants and stormwater that cross town boundaries.

- Central Massachusetts Regional Planning Commission (CMRPC), http://www.cmrpc.org/ (CMRPC, 2021)
- Metropolitan Area Planning Council (MAPC), http://www.mapc.org/ (MAPC, 2021)
- Montachusett Regional Planning Commission (MRPC), http://www.mrpc.org/ (MRPC, 2021)
- Northern Middlesex Council of Governments (NMCOG), http://www.nmcog.org/ (NMCOG, 2021)

The following RPA initiatives and tools are especially noteworthy:

- There are regional stormwater coalitions within some RPAs, and these are noted in the segment-specific sections below.
- MAPC created a Stormwater Utility/Funding Starting Kit (Metropolitan Area Planning Council, MAPC, 2014).
- MAPC and the Neponset River Watershed Association created a GIS toolkit to calculate MS4 outfall catchments, which is a requirement under the MS4 General Permit (Metropolitan Area Planning Council, MAPC, 2018).
- NMCOG formed the Northern Middlesex Stormwater Collaborative (NMSC) (Stormwater Collaborative, n.d.).

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 in the “Think Blue” campaign (Think Blue Massachusetts, 2019).

There are several non-profit active stewards of the Concord River watershed. The largest is OARS, established in 1986 as the Organization for the Assabet River by a group of concerned citizens, OAR added the Sudbury and Concord Rivers to its mission in 2011, becoming OARS. OARS’ has a three-pronged approach to its mission. The goals are to:

- **Raise awareness** of the rivers’ natural beauty, habitat value, and physical importance to the watershed communities, governments and other stakeholders as well as bringing attention to the threats to the rivers’ water and habitat quality;
- **Collect data and advocate for additional information gathering** in order to ensure that decisions affecting the rivers are based on scientific research; and
- **Work collaboratively with local and state governmental officials, community members, and others** toward solutions that will help the rivers achieve their “fishable and swimmable” state standard. (OARS, 2022)

The following actions will help reduce pathogen loads to the streams. The list is a starting point and is not comprehensive. For a more detailed discussion of pollutant reduction actions, see Section 5 “Implementation” of the core TMDL document.

- Removal of the CSO in the watershed is a top priority.
- **Municipalities:** Continue to implement requirements of the MS4 permit, which includes specific requirements for waterbodies with an approved Bacteria/Pathogen TMDL, such as prioritization and reporting, enhanced BMPs, IDDE work, and education (USEPA, 2020).
- **Regional Planning Agencies (RPAs) and municipalities:** Continue and expand collaboration on MS4 and stormwater issues. Cooperatively developing tools and sharing knowledge has many advantages, including reduced costs, increased innovation, and more consistent and effective stream restoration efforts at the watershed scale.
    - Two tools developed by MAPC are potentially valuable in all MS4 communities in the state. Municipalities and other RPAs (with permission from MAPC) should consider adapting and/or expanding on these tools in their area:
        - Stormwater Utility/Funding Starting Kit (Metropolitan Area Planning Council, 2014).

    - MAPC and the Neponset River Watershed Association created a GIS toolkit to calculate MS4 outfall catchments, which is a requirement under the MS4 General Permit (Metropolitan Area Planning Council, MAPC, 2018).
- **USDA NRCS and landowners:** Develop comprehensive nutrient management plans for agriculture, using local connections to farmers for outreach.
- **Parks departments, schools, private landowners, and others** who maintain large, mowed fields with direct access to water should consider maintaining a vegetative buffer along the water's edge. Buffers slow and filter stormwater runoff, provide a visual screen that can reduce large aggregations of waterfowl, and have many other water quality benefits at low cost.

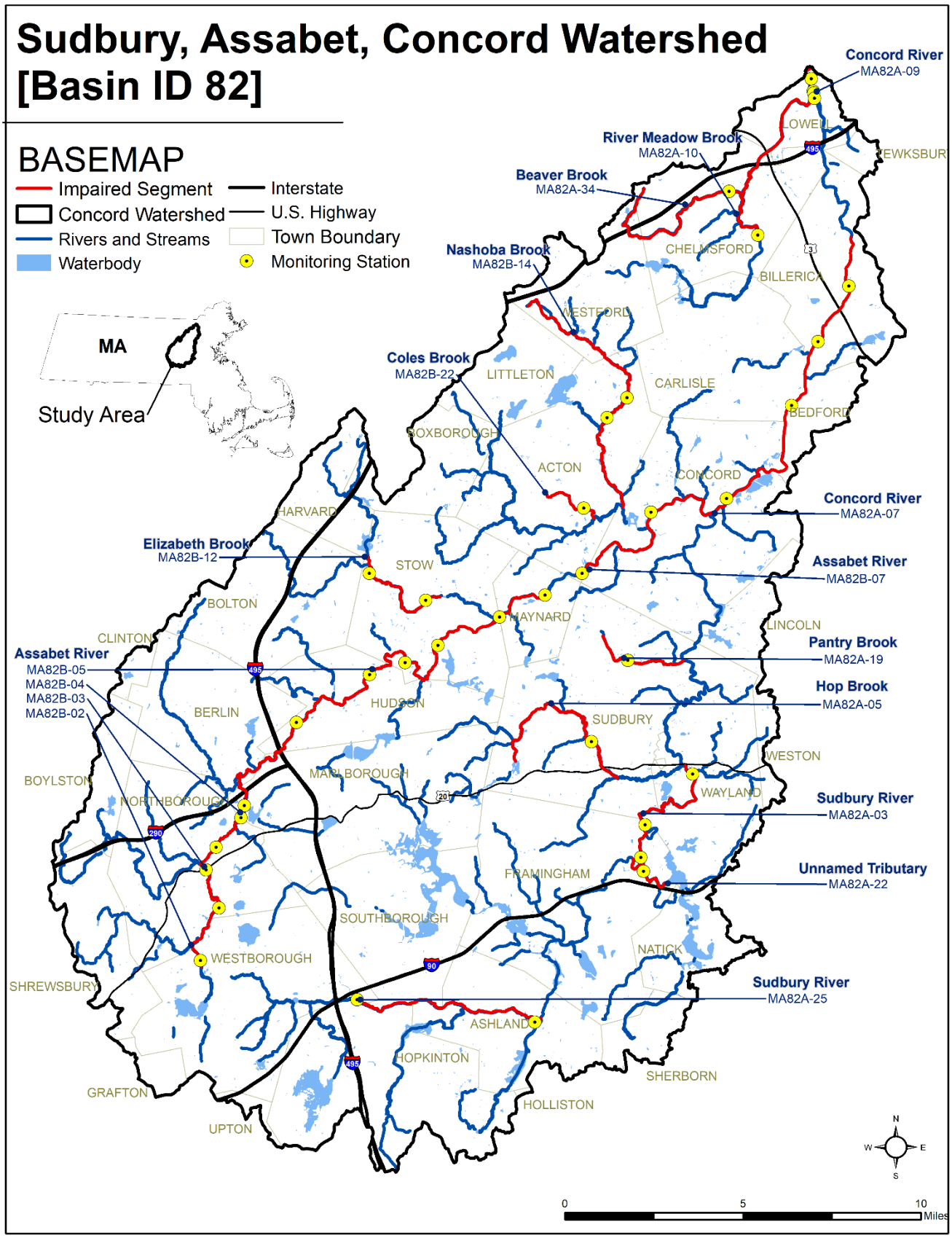


Figure 2-1: Overview map of all pathogen-impaired river segments, water quality monitoring stations, municipal borders, waterbodies, and roads in the SuAsCo River watershed.

3. MA82A-03 Sudbury River

3.1. Waterbody Overview

The Sudbury River segment MA82A-03 is 5.5 miles long and begins about one mile northwest of I-90 exit 13 in Framingham. It begins at the outlet of Saxonville Pond (MA82097, an impoundment of the Sudbury River) near the intersection on Central Street and Water Street in Framingham. It flows north, forming a short section of the Framingham-Wayland municipal border, then the Wayland-Sudbury border, before flowing northeast into Wayland, ending at its confluence with Hop Brook (formerly named Wash Brook on USGS quads prior to 1987), just upstream from the US Route 20 bridge in Wayland. The segment is bound at the downstream end by the Sudbury River segment MA82A-04, which is not impaired.

Tributaries to this section of the Sudbury River include the unnamed tributary MA82A-22, also pathogen-impaired (labeled as Cochituate Brook on USGS maps) draining Lake Cochituate, Pod Meadow wetland, Dudley Pond, Heard Pond, and Pine Brook.

Major landmarks in the watershed include the small downtown area of Saxonville Village (part of Framingham), Carol Getchell Reservation (nature preserve with streamside trails), Wayland High School which has ballfields abutting the river, Heard Pond, Heard Farm (managed by the Town of Wayland Conservation Commission and with fields popular for dog-walking), a large golf course, and portions of the Great Meadows National Wildlife Refuge.

Road crossings are concentrated in the Saxonville area, with bridges at Central Street, Concord Street, Danforth Street, and a pedestrian bridge at the end of Hillside Street. Downstream crossings are at Stonebridge Road, Pelham Island Road, and a small railroad bridge of the abandoned Central Massachusetts Branch next to the US Route 20 bridge.

The Sudbury River (MA82A-03) drains an area of 117 square miles, of which 19 mi^2 (17%) is impervious and 12 mi^2 (10%) is directly connected impervious area (DCIA). The watershed is served

Reduction from Highest Calculated Geomean: 85%

Watershed Area (Acres): 74,671

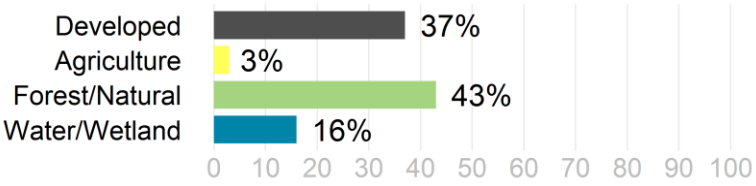
Segment Length (Miles): 5.5

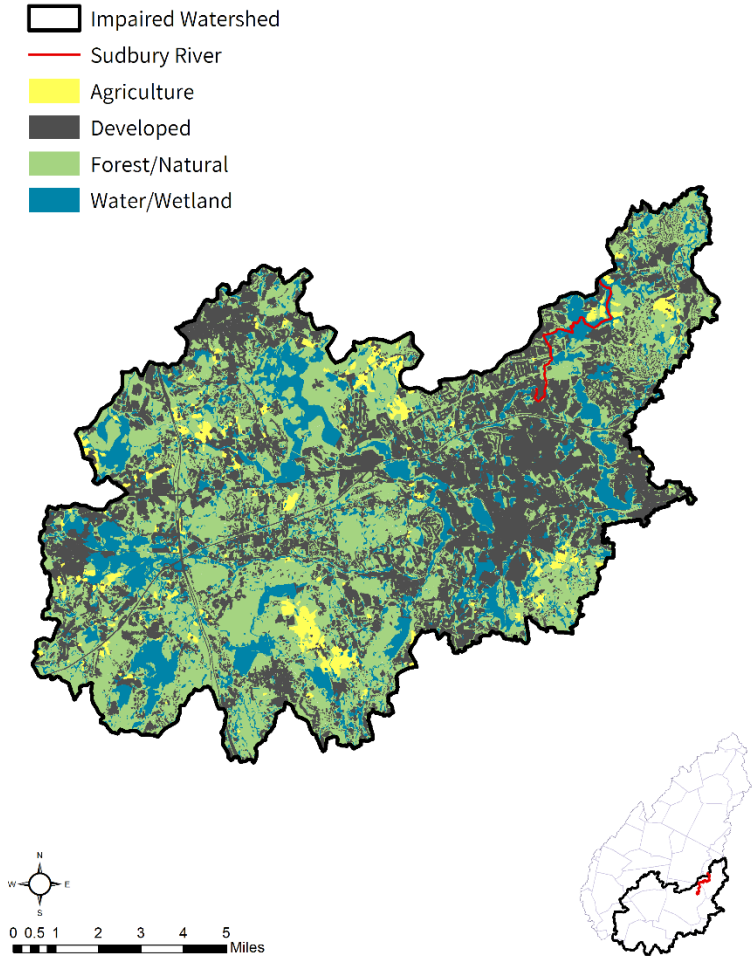
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifiers): B (Aquatic Life, High Quality Water)

Impervious Area (Acres, %): 12,334 (17%)

DCIA Area (Acres, %): 7,693 (10%)





partially[1] by public sewer and 81% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are 11 groundwater discharge permits for on-site wastewater discharge within this watershed (five of which are within the immediate drainage area to the impaired segment) (Table 3-1). See Figure 3-1.

Table 3-1. 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)
499-4	ST. MARK'S SCHOOL	SOUTHBOROUGH	Sanitary Discharge	35,000
869-0	FAY SCHOOL	SOUTHBOROUGH	Sanitary Discharge	21,000
925-0M1	MADISON PLACE	SOUTHBOROUGH	Sanitary Discharge	27,920
638-2	TRADITIONS WWTF	WAYLAND	Sanitary Discharge	27,120
906-0	WAYLAND HIGH SCHOOL	WAYLAND	Sanitary Discharge	12,154

Approximately the first 1000 feet of the river segment, above Danforth Street Bridge in Framingham, flows through a densely developed commercial and residential development and the river's right bank is extensively armored with riprap, which is further topped by a cement wall near Concord Street. Below Danforth Street, the river segment is designated as "scenic" under the Sudbury, Assabet, and Concord Wild and Scenic River Act (USGPO, 1999). Here, the river flows through medium then low density development and has a largely intact vegetative buffer along the banks, widening into forested and marshy wetlands at the lower end of the segment. U.S. Army Corps of Engineers constructed a flood control project in this area in 1979 to reduce flooding in Saxonville (MassDEP, 2016).

The watershed of the Sudbury River (MA82A-03) contains two Areas of Critical Environmental Concern, "Cedar Swamp" (1,650 acres) and "Miscoe, Warren and Whitehall Watersheds" (771 acres), which combined cover 2,421 acres (3%) of the land area. Under the Natural Heritage and Endangered Species Program, there are 132 acres (0.2%) of Priority Natural Vegetation Communities and 1,508 acres (2%) of Priority Habitats of Rare Species. There are 18,702 acres (25%) under Public Water Supply protection and 1,520 acres (2%) identified as Outstanding Resource Waters. Over 1,989 acres (3%) of land protected in perpetuity[2] exist within the segment watershed, which is part of a total of 20,148 acres (27%) of Protected and Recreational Open Space[3]. Only a small conservation area directly touches the impaired segment. See Figure 3-1.

[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 https://www.mass.gov/guides/water-utility-resilience-program(MassDEP, 2020), MS4 reports, and local knowledge.

[2] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetlands restrictions, aquifer protection, historic preservation, etc. Refer to MassGIS metadata for the Protected and Recreational Open Space data layer. Land protected in perpetuity reflect watershed-wide estimates (including for watersheds that extend outside of the State of Massachusetts).

[3] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside of the State of Massachusetts).

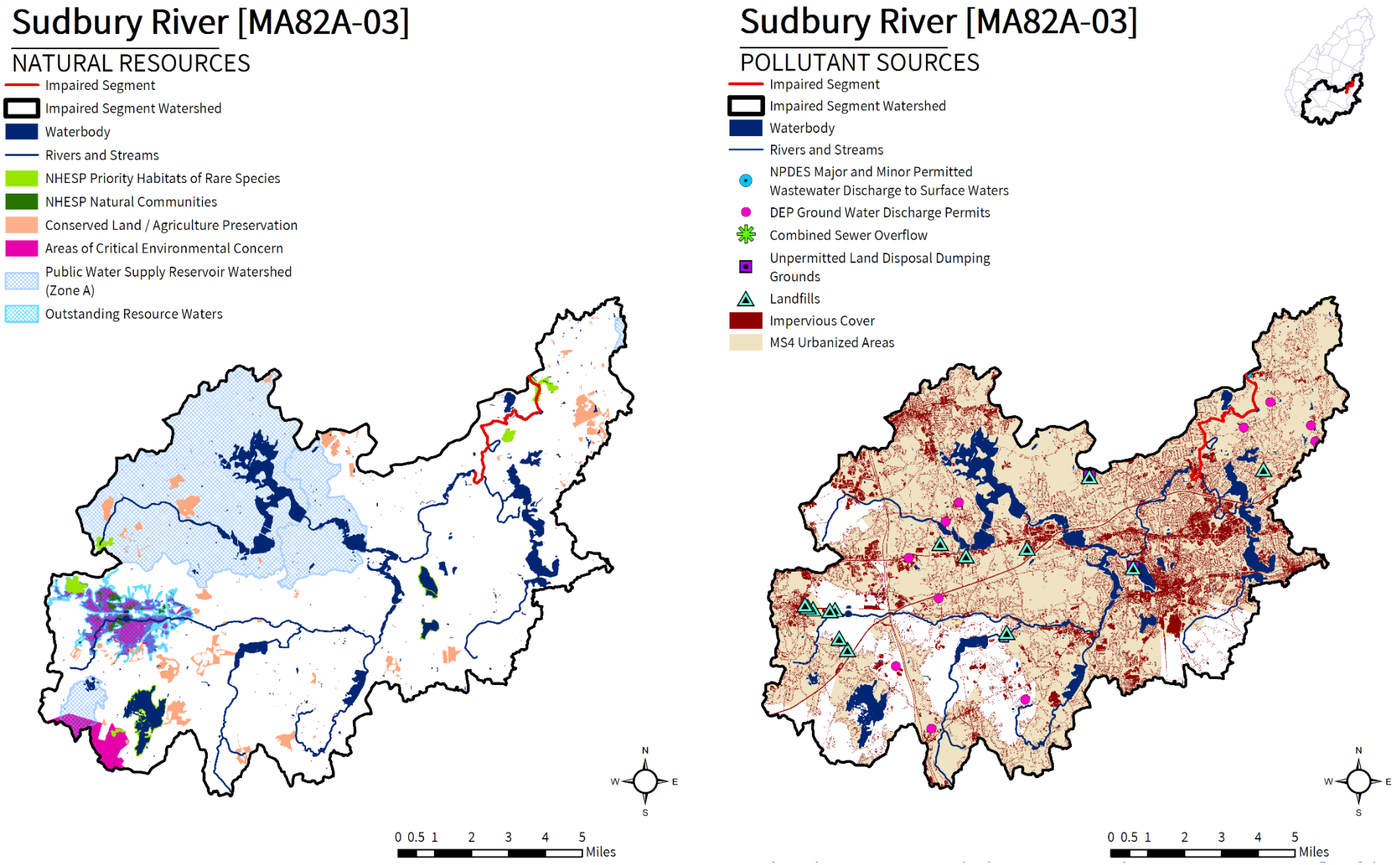


Figure 3-1. Natural resources and potential pollution sources draining to the Sudbury River segment MA82A-03. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, permitted facilities.

3.2. Waterbody Impairment Characterization

The Sudbury River (MA82A-03) is a Class B, Aquatic Life Use and High Quality Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* at the stations listed below (refer to Tables 3-2, 3-3; Figure 3-2). 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.

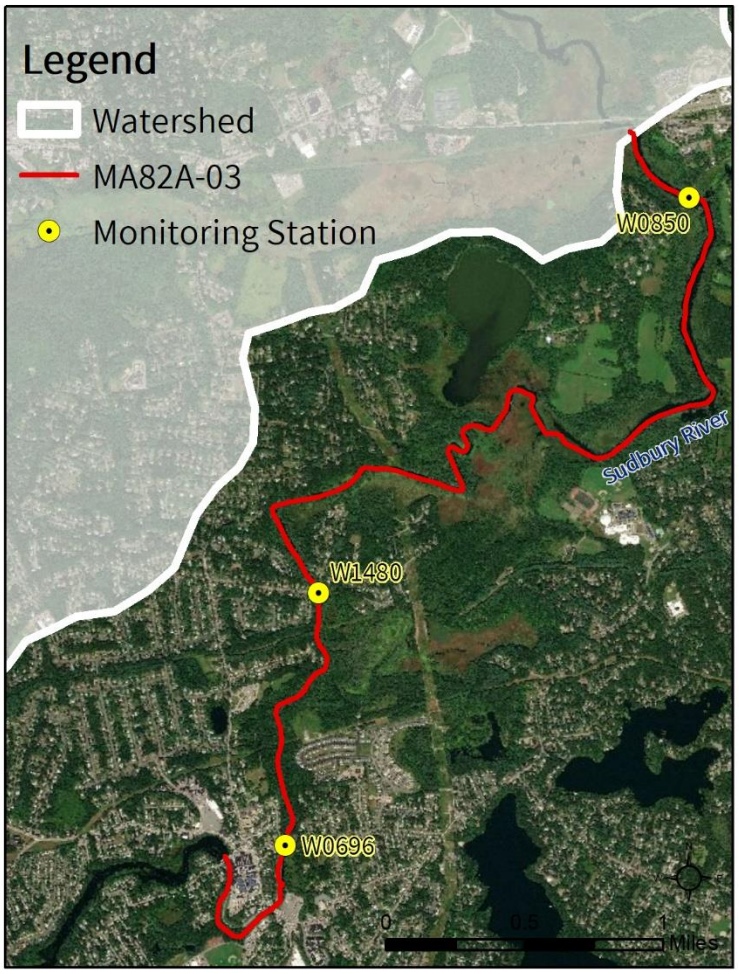


Figure 3-2. Location of monitoring station(s) along the impaired river segment.

- From 2006-2013, 38 samples were collected at W0696, resulting in 14 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 38 samples, four exceeded the STV criterion in 2006, 2007, 2009, and 2010 during wet weather only.
- In 2006, five samples were collected at W0850, resulting in 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 wet weather only.
- In 2006, five samples were collected at W1480, 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. Out of five samples, one exceeded the STV criterion during wet weather only.

Table 3-2. Summary of indicator bacteria sampling results by station for the Sudbury River (MA82A-03). 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 Statistical Threshold Value (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
W0696	5/4/06	9/25/13	38	866	14	4
W0850	5/4/06	9/26/06	5	427	5	1
W1480	5/4/06	9/26/06	5	217	3	1

Table 3-3. Indicator bacteria data by station, indicator, and date for the Sudbury River (MA82A-03). Each sample date was designated wet or dry weather with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text 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 Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 90-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W0696	*E. coli*	5/4/06	WET	160	160	
W0696	*E. coli*	6/8/06	WET	670	327	
W0696	*E. coli*	7/20/06	DRY	310	322	
W0696	*E. coli*	8/24/06	DRY	140	308	
W0696	*E. coli*	9/26/06	DRY	140	182	
W0696	*E. coli*	7/18/07	DRY	109	109	
W0696	*E. coli*	9/12/07	WET	1730	434	
W0696	*E. coli*	11/7/07	WET	152	513	
W0696	*E. coli*	2/27/08	WET	64	64	
W0696	*E. coli*	4/23/08	DRY	5	18	
W0696	*E. coli*	6/18/08	WET	155	28	
W0696	*E. coli*	8/20/08	DRY	124	139	
W0696	*E. coli*	10/22/08	DRY	22	52	
W0696	*E. coli*	1/21/09	DRY	33	33	
W0696	*E. coli*	3/18/09	DRY	7	15	
W0696	*E. coli*	5/20/09	DRY	145	32	
W0696	*E. coli*	7/22/09	WET	435	251	
W0696	*E. coli*	9/29/09	WET	116	225	
W0696	*E. coli*	11/17/09	DRY	75	93	
W0696	*E. coli*	2/18/10	DRY	12	12	
W0696	*E. coli*	8/25/10	WET	866	866	
W0696	*E. coli*	10/20/10	DRY	32	166	
W0696	*E. coli*	1/19/11	WET	91	91	
W0696	*E. coli*	3/15/11	DRY	29	51	
W0696	*E. coli*	5/17/11	WET	199	76	
W0696	*E. coli*	7/20/11	DRY	365	270	
W0696	*E. coli*	9/21/11	DRY	54	140	
W0696	*E. coli*	11/16/11	DRY	38	45	
W0696	*E. coli*	2/22/12	DRY	4	4	
W0696	*E. coli*	4/11/12	DRY	4	4	
W0696	*E. coli*	6/20/12	DRY	45	13	
W0696	*E. coli*	8/22/12	DRY	16	27	
W0696	*E. coli*	10/24/12	DRY	13	14	
W0696	*E. coli*	1/28/13	DRY	30	30	
W0696	*E. coli*	3/20/13	WET	30	30	
W0696	*E. coli*	5/20/13	DRY	20	24	
W0696	*E. coli*	8/28/13	DRY	72	72	
W0696	*E. coli*	9/25/13	DRY	27	44	
W0850	*E. coli*	5/4/06	WET	240	240	
W0850	*E. coli*	6/8/06	WET	760	427	
W0850	*E. coli*	7/20/06	DRY	350	400	
W0850	*E. coli*	8/24/06	DRY	100	299	
W0850	*E. coli*	9/26/06	DRY	130	166	
W1480	*E. coli*	5/4/06	WET	77	77	
W1480	*E. coli*	6/8/06	WET	610	217	
W1480	*E. coli*	7/20/06	DRY	65	145	
W1480	*E. coli*	8/24/06	DRY	77	145	
W1480	*E. coli*	9/26/06	DRY	190	98	

3.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present and 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 SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants, which then becomes diluted during periods of 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).

The indicator bacteria data for the Sudbury River (MA82A-03) were elevated during wet weather at all three sample stations, a result which is 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 wet weather indicator bacteria levels.

Each potential pathogen source is described in further detail below.

Urban Stormwater: Portions of the Sudbury River (MA82A-03) watershed are highly developed, with 81% of the land area in MS4, 10% as DCIA, and a dense urban fabric which has hardened the riverbanks in the upper segment in Saxonville Village. There is a large portion of the watershed that extends far upstream of the segment, and about 37% is developed land use. Stormwater runoff from urban areas is likely the most significant source of pathogens.

Illicit Sewage Discharges: With some of the watershed serviced by sewer and most (81%) of the watershed designated as MS4 area, illicit storm drain connections and/or illicit discharges from failing infrastructure such as leaky sewer lines or SSOs are likely a significant source of pathogen pollutants.

On-Site Wastewater Disposal Systems: There are 11 groundwater discharge permits for on-site wastewater discharge, which are large-capacity septic systems (non-residential). Most of the residential development in the watershed uses septic systems for wastewater treatment; it is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: While there is relatively little agriculture (3% of land area), this is also a potential source of pathogen pollutant loading. Some agricultural lands are adjacent to the lower portion of the river segment. Additionally, any areas adjacent to upstream tributaries or storm drains could also provide a direct conduit to the river.

Pet Waste: Conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: There are large conservation lands and wetlands in the lower portion of the river. Large open mowed areas with a clear sightline to a waterbody may attract excessive waterfowl and elevate pathogen counts in the water.

3.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Framingham

All of Framingham is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). Framingham (Permit ID#MAR0411160) has an EPA approved Notice of Intent (NOI). Framingham has a Stormwater Management Plan filed with its Department of Public Works Operations Center. The town has mapped all of its MS4 stormwater system and has submitted the map electronically with the NOI.

It adopted IDDE, ESC, and post-construction stormwater regulations in 2008. According to the NOI, there are 85 stormwater outfalls into the Sudbury River, although none are reported to flow into waterbodies listed as impaired for pathogens.

Framingham has the following ordinances and bylaws:

- Stormwater Management component to Zoning, page 137: https://webapps.framinghamma.gov/WebLink/ElectronicFile.aspx?docid=1247234&dbid=0&repo=Framingham (City of Framingham, 2019)
- Wetlands Protection Bylaw: https://www.framinghamma.gov/DocumentCenter/View/421/Wetlands-Protection-Bylaw?bidId= (City of Framingham, 2005)

Framingham's Master Plan also includes sections on Natural Resources and Environmental Protection (Part 1, p. 165) with a detailed description of the Sudbury River, NPDES Phase II program (Part 1, p. 161), and wastewater (Part 1, p. 154). The Master Plan cites past efforts to improve water quality outside of the impaired segment, including structural BMPs to reduce pathogen pollutant loading and collaboration on EPA Section 319 grants with neighboring Town of Ashland. https://www.framinghamma.gov/294/framingham-master-plan (City of Framingham, 2014)

Open space plan being updated in 2020: https://www.framinghamma.gov/DocumentCenter/View/12753/Final-OSRP-2013-Complete?bidId= (City of Framingham, 2015)

Framingham is part of the MetroWest Regional Collaborative (MWRC) within the Metropolitan Area Planning Council (MAPC, http://www.mapc.org/). (MAPC, 2021).

Town of Sudbury

Most of Sudbury is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (Permit ID#MAR041224), with an EPA approved Notice of Intent (NOI). Sudbury has a draft hardcopy Stormwater Management Plan on file with its Department of Public Works. The town has mapped all of its MS4 stormwater system, with an online map at https://www.mapsonline.net/sudburyma/stormwater.html. (Town of Sudbury, N.d.) The town also adopted IDDE, ESC, and post-construction stormwater regulations in 2009-10. In its NOI, it reports no stormwater outfalls to the Sudbury River, and the online map shows the closest discharge point to the impaired segment is about 100 feet away, with another 2-3 outfalls within about 250 feet, discharging to a wooded riparian buffer of the impaired segment.

Sudbury has the following ordinances and bylaws:

- Stormwater Management Bylaw Regulation: https://sudbury.ma.us/planning/wp-content/uploads/sites/328/2014/08/SudburySWRegsRevised2013.pdf?version=abc2458ab7a235e57cc5f137ba179ce7 (Town of Sudbury, 2013)
- Wetlands Administration Bylaw Regulations: https://s3-us-west-2.amazonaws.com/cdn.sudbury.ma.us/wp-content/uploads/sites/272/2017/10/Wetlands-Bylaw-Regulation-Amendment-170925.pdf?version=18d2af56918f837c61fd50801a467313 (Town of Sudbury, 2017)
- Pet waste regulations in Bylaws, Art. 5, Section 3-14: https://s3-us-west-2.amazonaws.com/cdn.sudbury.ma.us/wp-content/uploads/sites/270/2018/07/2018-General-Bylaws-Articles-I-%E2%80%93-XXXII.pdf?version=7dfdc5a23807d729792a24131acdd6b8 (Town of Sudbury, 2018)
- IDDE regulations in Bylaws, Art. 32, link above.

In addition, Sudbury's Master Plan describes the watershed approach to water quality protection (p. 51), sets a stormwater management goal, with pathogen-impaired Pantry Brook cited as "special and worth protecting or acquiring for conservation, recreation, scenic views or wildlife protection" (p. 118). https://sudbury.ma.us/pcd/substainable-sudbury-master-plan-acrobat/ (Town of Sudbury, 2019)

Sudbury's 2009-2013 Open Space and Recreation Plan: https://s3-us-west-2.amazonaws.com/cdn.sudbury.ma.us/wp-content/uploads/sites/326/2014/08/OSRPCFINALJune2009nomaps.pdf?version=2747a707d5240ebc37e394b0fcba20ba (Town of Sudbury, 2009)

Most residents of Sudbury are served by on-site septic systems. A small sewer network has been considered in the Route 20 commercial area. See https://sudbury.ma.us/sewertechcommittee/route-20-sewer-frequently-asked-questions/ (Town of Sudbury, 2015)

Sudbury is part of the Minuteman Advisory Group on Interlocal Coordination within the Metropolitan Area Planning Council (MAPC, http://www.mapc.org/). (MAPC, 2021).

Town of Wayland

Most of Wayland is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (Permit MAR041169), with an EPA approved Notice of Intent (NOI). Wayland has a Stormwater Management Plan on file and has mapped all its MS4 stormwater system. It adopted IDDE, ESC, and post-construction stormwater regulations in 2008. There are no stormwater outfalls reported to the impaired segment, although there are a few to some upstream tributaries which are not listed as pathogen-impaired.

Wayland has the following ordinances and bylaws:

- Stormwater: https://www.wayland.ma.us/department-public-works/pages/stormwater-management (Town of Wayland, 2020)
- Wetlands: https://ecode360.com/12285685 (Town of Wayland, 2002)
- Pet waste: Town of Wayland Codes, section 91-5-F: https://ecode360.com/12285287 (Town of Wayland, N.d.)

In addition, the Town of Wayland's Master Plan dedicates a section to nonpoint source pollutants, including pathogens, in Chapter 5, section 5.4.5. In addition, Lake Cochituate (an upstream tributary to the Sudbury River), is described in Chapter 15 as a town beach. https://www.wayland.ma.us/planning-board-department/pages/master-plans (Town of Wayland, 2004)

Wayland's Open Space and Recreation Plan: http://waylandrec.com/wp-content/uploads/2016/06/Wayland-DRAFT-OSRP-2016-Submission-low-1-1.pdf (Town of Wayland, 2016)

Wayland is part of the MetroWest Regional Collaborative (MWRC) within the Metropolitan Area Planning Council (MAPC, http://www.mapc.org/). (MAPC, 2021)

4. MA82A-05 Hop Brook

4.1. Waterbody Overview

Hop Brook segment MA82A-05 is 6.7 miles long, located entirely within the Town of Sudbury in inland eastern Massachusetts, between the I-95 and I-495 corridors. It begins at the Carding Mill Pond (MA82015) outlet, flows north through the wetlands in Sudbury Valley Trustees (SVT) Dutton Road and Hopbrook Marsh Conservation Land, then turns northeast to flow into Stearns Millpond (formerly segment MA82104). It then curves southeast, then south, ending at its confluence with Allowance Brook (MA82A-06), formerly Landham Brook on USGS quads prior to 1987.

The largest tributary is Dudley Brook, flowing north to join the brook in the middle of the segment. Smaller tributaries include the stream draining Blanford Pond (enclosed within a greenhouse and plant nursery complex) and Run Brook which drains a wetland north of the segment.

Major landmarks in the watershed include Ephraim Curtis Middle School (ballfields are on the opposite side away from the brook), the Town of Sudbury Department of Public Works, and a large greenhouse and plant nursery complex directly abutting portions of the lower reaches of the brook. Boston Road/US Route 20 crosses the segment just above its end point, and other crossings include Union Avenue, Peakham Road, and Dutton Road.

Hop Brook (MA82A-05) drains an area of 15.6 square miles, of which 1.8 mi^2 (12%) is impervious and 0.8 mi^2 (5%) is directly connected impervious area (DCIA). The watershed is partially[4] served by public sewer, and 95% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There is one NPDES wastewater treatment facility permit on file governing point source discharges of pollutants to surface waters (Table 4-1). There is also one MassDEP discharge to groundwater permits for on-site wastewater discharge within this watershed (Table 4-2). See Figure 4-1.

Reduction from Highest Calculated Geomean: 67%

Watershed Area (Acres): 9,980

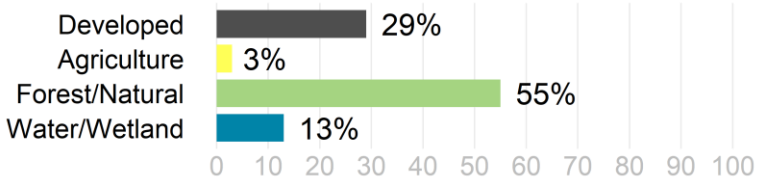
Segment Length (Miles): 6.7

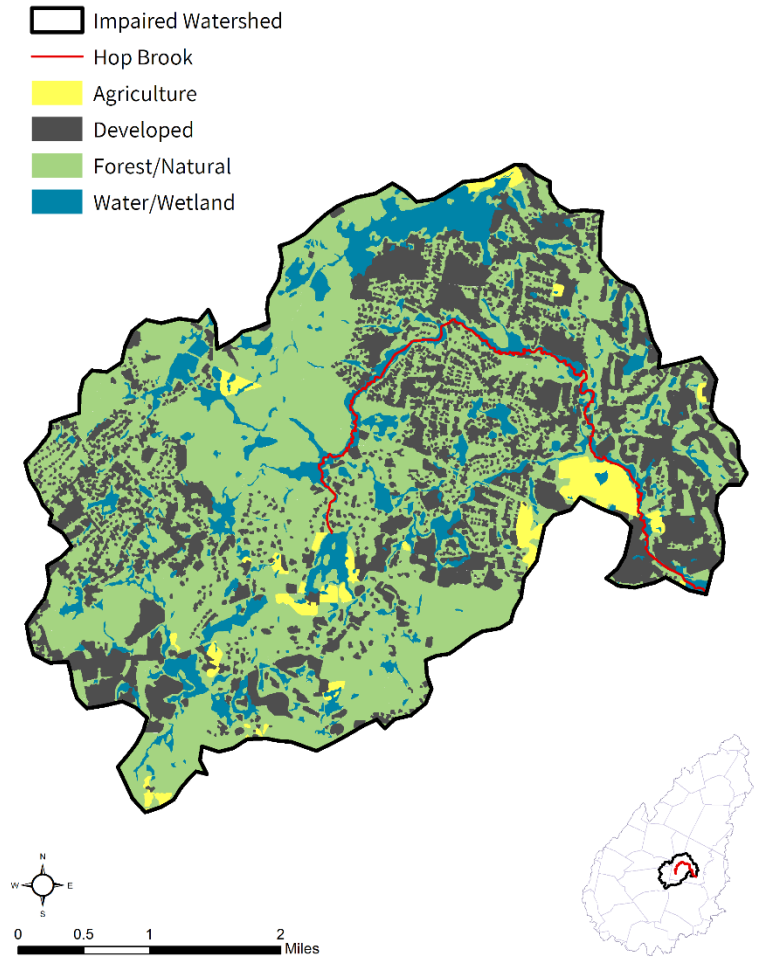
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifier): B (Warm Water)

Impervious Area (Acres, %): 1,160 (12%)

DCIA Area (Acres, %): 501 (5%)





[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 https://www.mass.gov/guides/water-utility-resilience-program(MassDEP, 2020), MS4 reports, and local knowledge.

Table 4-1. National Pollutant Discharge Elimination System (NPDES) permits for Wastewater Treatment Facilities (WWTF) in the segment watershed. Only permits unique to this segment watershed are shown. WWTF are identified as either municipal (MUN) or other (OTH), if applicable.

NPDES ID	NAME	TOWN	WWTF
MA0100498	MARLBOROUGH EASTERLY WWTP	MARLBOROUGH	MUN

Table 4-2. 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)
904-0	PRI LONGFELLOW GLEN	SUDBURY	Sanitary Discharge	25,000

Development density is low in the upper portion of the segment, then gradually becoming medium density residential in the middle portion, then medium density commercial in the lower reaches. In the lower reaches of the brook, there are several areas near road crossings with minimal vegetative cover along the banks. Hop Brook flows through numerous conservation lands, including the woods and wetlands of SVT Dutton Road; the Town of Sudbury's Hopbrook Marsh Conservation Land, Atkinson Parcel, and Haynes Meadow; and protected areas of Maple Meadows at its confluence with Allowance Brook. There are many foot and bike trails along the river in the upper watershed conservation lands, as well as next to the middle school. An abandoned railroad also crosses the segment near the downstream end.

In the watershed of Hop Brook (MA82A-05), under the Natural Heritage and Endangered Species Program, there are 11 acres (0.1%) of Priority Natural Vegetation Communities and 2,010 acres (20%) of Priority Habitats of Rare Species. There are 32 acres (0.3%) under Public Water Supply protection, but no Areas of Critical Environmental Concern or Outstanding Resource Waters identified in this watershed. Over 380 acres (4%) of land protected in perpetuity[5] exist within the segment watershed, which is part of a total of 2,601 acres (26%) of Protected and Recreational Open Space[6]. Only a small conservation area directly touches the impaired segment. See Figure 4-1.

[5] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetlands restrictions, aquifer protection, historic preservation, etc. Refer to MassGIS metadata for the Protected and Recreational Open Space data layer. Land protected in perpetuity reflect watershed-wide estimates (including for watersheds that extend outside of the State of Massachusetts).

[6] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside of the State of Massachusetts).

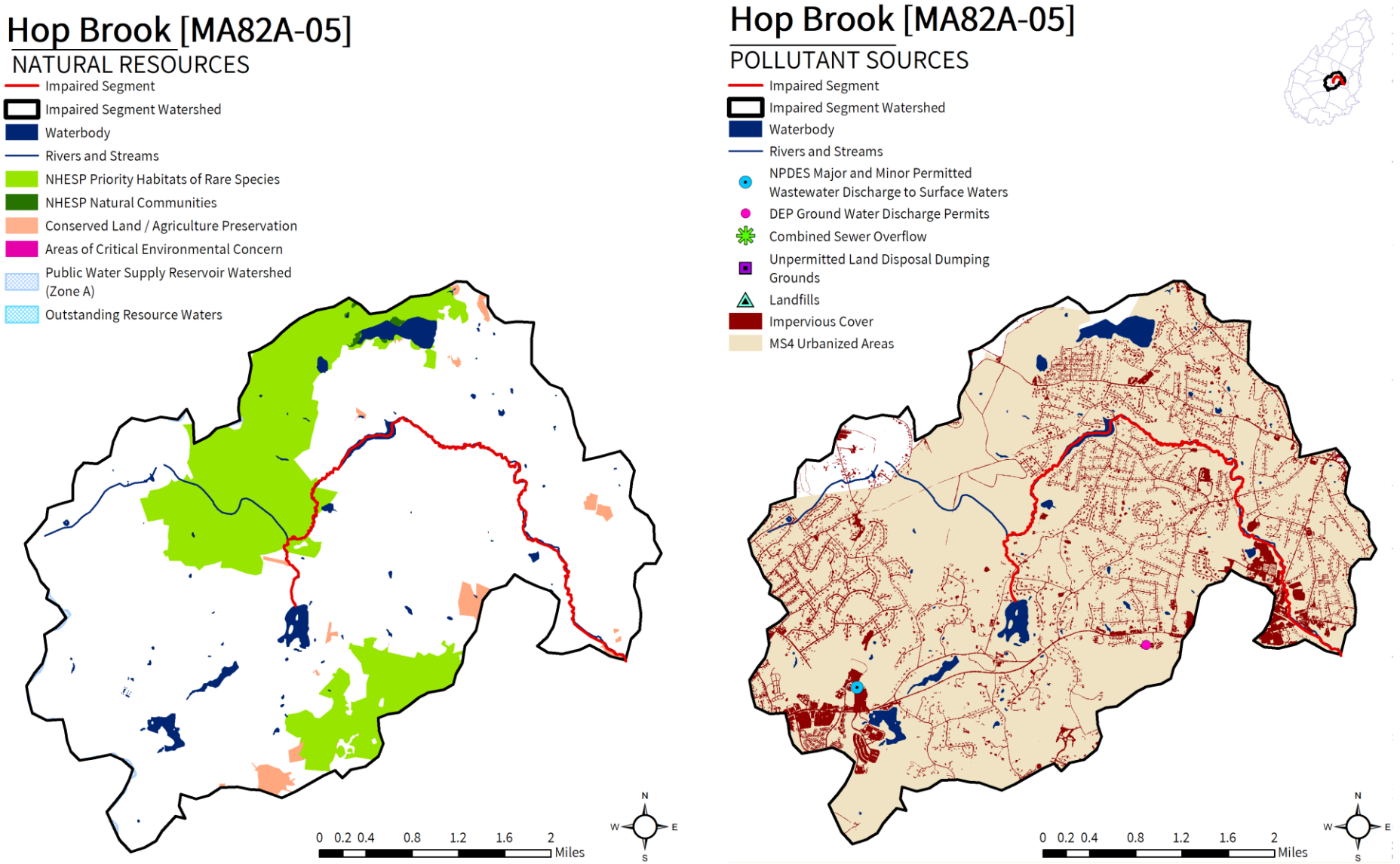


Figure 4-1. Natural resources and potential pollution sources draining to the Hop Brook segment MA82A-05. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, permitted facilities.

4.2. Waterbody Impairment Characterization

Hop Brook (MA82A-05) is a Class B, Warm Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* at the station listed below (refer to Tables 4-3, 4-4; Figure 4-2). 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, 30-day rolling basis.

- In 2010, six samples were collected at W2136, resulting in five days when the 30-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 six samples, one exceeded the STV criterion during dry weather.

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

Table 4-3. Summary of indicator bacteria sampling results by station for Hop Brook (MA82A-05). The maximum 30-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 Statistical Threshold Value (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 30-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 30-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
W2136	5/4/10	9/13/10	6	382	5	1

Table 4-4. Indicator bacteria data by station, indicator, and date for Hop Brook (MA82A-05). Each sample date was designated wet or dry weather with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text 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 Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 30-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
W2136	*E. coli*	5/4/10	DRY	85	85	
W2136	*E. coli*	6/8/10	DRY	220	220	
W2136	*E. coli*	6/24/10	WET	270	244	
W2136	*E. coli*	7/13/10	DRY	430	341	
W2136	*E. coli*	8/9/10	DRY	340	382	
W2136	*E. coli*	9/13/10	WET	380	380	

4.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present and 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 SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants, which then becomes diluted during periods of 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).

The indicator bacteria data for Hop Brook (MA82A-05) were elevated during wet weather, a result which is 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 wet weather indicator bacteria levels.

Indicator bacteria levels were also elevated during dry weather suggesting that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, may also be a factor.

Given the relatively small sample set, additional sampling under both wet and dry conditions, ideally at more than one location, would likely help in identifying pollutant sources.

Each potential pathogen source is described in further detail below.

Urban Stormwater: Portions of the Hop Brook (MA82A-05) watershed are highly developed, with 95% of the land area in MS4, 5% as DCIA, the lower part of the segment surrounded by mixed commercial and industrial land uses, and much of the rest of the watershed in residential land use. Stormwater runoff from urban areas is likely the most significant source of pathogens.

Illicit Sewage Discharges: With a portion of the watershed in sewer service and most of the watershed (95%) designated as MS4 area, illicit storm drain connections and/or illicit discharges from failing infrastructure such as leaky sewer lines or SSOs are likely a significant source of pathogen pollutants.

On-Site Wastewater Disposal Systems: There is one groundwater discharge permit for on-site wastewater discharge, which is a large-capacity septic system (non-residential). Given the large portion of the watershed not covered by sewer service, malfunctioning septic systems are also a possible source. It is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: There are substantial agricultural activities in the watershed, including large greenhouses and plant nurseries abutting the river. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: There are extensive conservation lands and trails in the upper portion of the river. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: Conservation lands with large open mowed areas with a clear sightline to a waterbody, along with open meadow wetlands, may attract large amounts waterfowl and elevate indicator bacteria counts in the water.

4.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Sudbury. see Section 3.4.

In addition to municipal activities, the **Hop Brook Protection Association** is also active in water quality issues. Past actions have included supporting the Marlborough Easterly Wastewater Treatment Plant upgrade (completed in 2015) and harvesting aquatic overgrowth from three ponds (Grist Mill, Carding Mill, and Stearns Mill) in 2018. The association is currently active, with a new board elected in May 2019. See: http://www.hopbrook.org/ (Hop Brook Protection Association, 2020)

5. MA82A-07 Concord River

5.1. Waterbody Overview

The Concord River segment MA82A-07 is 10.4 miles long, located about 5 miles northwest of the junction of I-95 and MA-3. It begins at the confluence of the Assabet (MA82B-07, pathogen-impaired) and Sudbury (MA82A-04) rivers in the town of Concord near Egg Rock, flows northeast forming the municipal border between Concord and Bedford, then Carlisle and Bedford, then Carlisle and Billerica. Then it flows into the Town of Billerica, where it ends at the Billerica Water Supply intake in the north central part of the town. The immediate connecting downstream Concord River segment is not pathogen-impaired, though the Concord River segment MA82A-09 at the outlet is pathogen-impaired.

Tributaries include the pathogen-impaired Assabet River (MA82B-07), a portion of the Sudbury River which is not pathogen-impaired, Sawmill Brook, Mill Brook, Pages Brook (which drains Greenough Pond), and numerous small streams draining wetlands adjacent to the river. Most of the river segment is designated a Wild and Scenic River, from its beginning to the US Route 3 crossing (USGPO, 1999). Great Meadows National Wildlife Refuge, containing Great Meadows Lake, also straddles most of this portion of the river.

Other landmarks in the watershed include, at the upper end of the segment - Concord Battleground, Minute Man National Historical Park which straddles the river, and the North Bridge Visitor Center - and further downstream - Governor Thomas Dudley Park, then Minnie Reed Conservation Area and Ralph Hill Conservation Area. At the end of the segment is Virginia Park Conservation Land, opposite the water intake. Road crossings include Lowell Road in Concord, then Carlisle Road/MA-225 at the Bedford-Carlisle border near the Bedford Boat Ramp. In Billerica, crossings include Nashua Road/MA-4, and US Route 3 (divided highway), then River Street and Boston Road near the segment's end. See Figure 5-1.

The Concord River (MA82A-07) drains an area of 367 square miles, of which 47 mi^2 (13%) is impervious and 27 mi^2 (8%) is directly connected impervious area (DCIA). The watershed is

Reduction from Highest Calculated Geomean: 75%

Watershed Area (Acres): 234,601

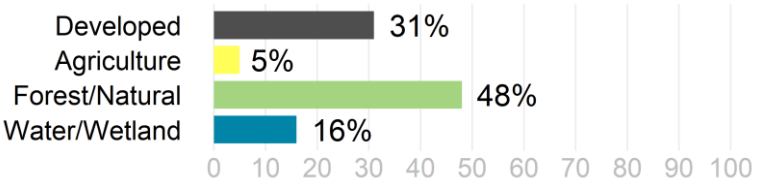
Segment Length (Miles): 10.4

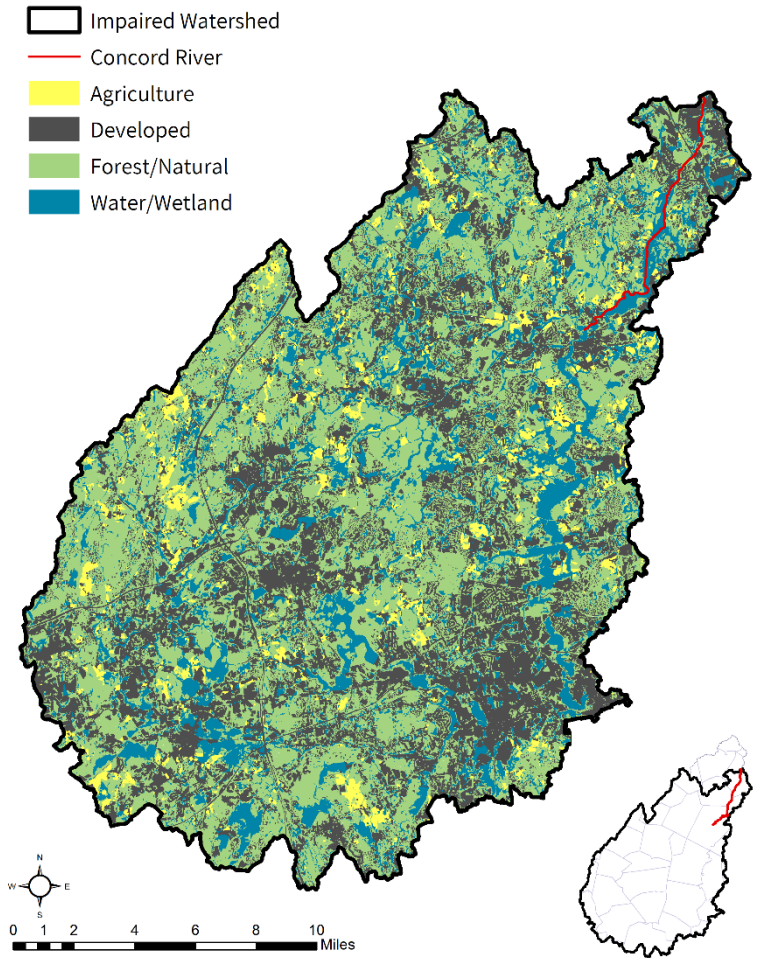
Impairment(s): *E. coli*, fecal coliform (Primary Contact Recreation)

Class (Qualifier): B (Treated Water Supply, Warm Water)

Impervious Area (Acres, %): 30,149 (13%)

DCIA Area (Acres, %): 17,589 (8%)





partially[7] served by public sewer, and 68% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater permit (USEPA, 2020). There are two NPDES wastewater treatment facility permits on file governing point source discharges of pollutants to surface waters within the immediate drainage area to the impaired segment (Table 5-1). There is one Industrial stormwater discharge in the segment watershed (Table 5.2). There are also four MassDEP discharge to groundwater permits for on-site wastewater discharge within the immediate drainage area to the impaired segment (Table 5-3). See Figure 5-1.

Table 5-1. National Pollutant Discharge Elimination System (NPDES) permits for Wastewater Treatment Facilities (WWTF) in the segment watershed. Only permits unique to this segment watershed are shown. WWTF are identified as either municipal (MUN) or other (OTH), if applicable.

NPDES ID	NAME	TOWN	WWTF
MA0039853	WAYLAND WW MGT. DIST. COMM.	WAYLAND	MUN
MA0100668	CONCORD WWTF	CONCORD	MUN

Table 5-2. National Pollutant Discharge Elimination System (NPDES) permits for Industrial Stormwater discharge in the segment watershed. Only permits unique to this segment watershed are listed.

NPDES ID	NAME	TOWN
MA0040339	ENTEGRIS INC	BILLERICA

Table 5-3. 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)
689-2	NASHAWTUC COUNTRY CLUB	CONCORD	Sanitary Discharge	14,955
776-1	CONCORD COUNTRY CLUB	CONCORD	Sanitary Discharge	17,303
855-1	THE COMMONS IN LINCOLN	LINCOLN	Sanitary Discharge	29,550
23-4M1	RAYTHEON	SUDBURY	Sanitary Discharge	50,000

For most of the river's length, there is wide vegetated riparian buffer consisting of open and forested wetlands, while the downstream portion of the watershed contains medium to high density residential development, and medium density commercial development in Billerica.

The watershed of the Concord River (MA82A-07) contains two Areas of Critical Environmental Concern, "Cedar Swamp" (1,650 acres) and "Miscoe, Warren and Whitehall Watersheds" (773 acres), which combined cover 2,423 acres (1%) of the land area. Under the Natural Heritage and Endangered Species Program, there are 308 acres (0.1%) of Priority Natural Vegetation Communities and 20,354 acres (9%) of Priority Habitats of Rare Species. Over 11,158 acres (5%) of land protected in perpetuity[8] exist within the segment watershed, which is part of a total of 64,365 acres (27%) of Protected and Recreational Open Space[9]. There are 22,560 acres (10%) under Public Water Supply protection and 1,520 acres (1%) identified as Outstanding Resource Waters. See Figure 5-1.

[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 https://www.mass.gov/guides/water-utility-resilience-program(MassDEP, 2020), MS4 reports, and local knowledge.

[8] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetlands restrictions, aquifer protection, historic preservation, etc. Refer to MassGIS metadata for the Protected and Recreational Open Space data layer. Land protected in perpetuity reflect watershed-wide estimates (including for watersheds that extend outside of the State of Massachusetts).

[9] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside of the State of Massachusetts).

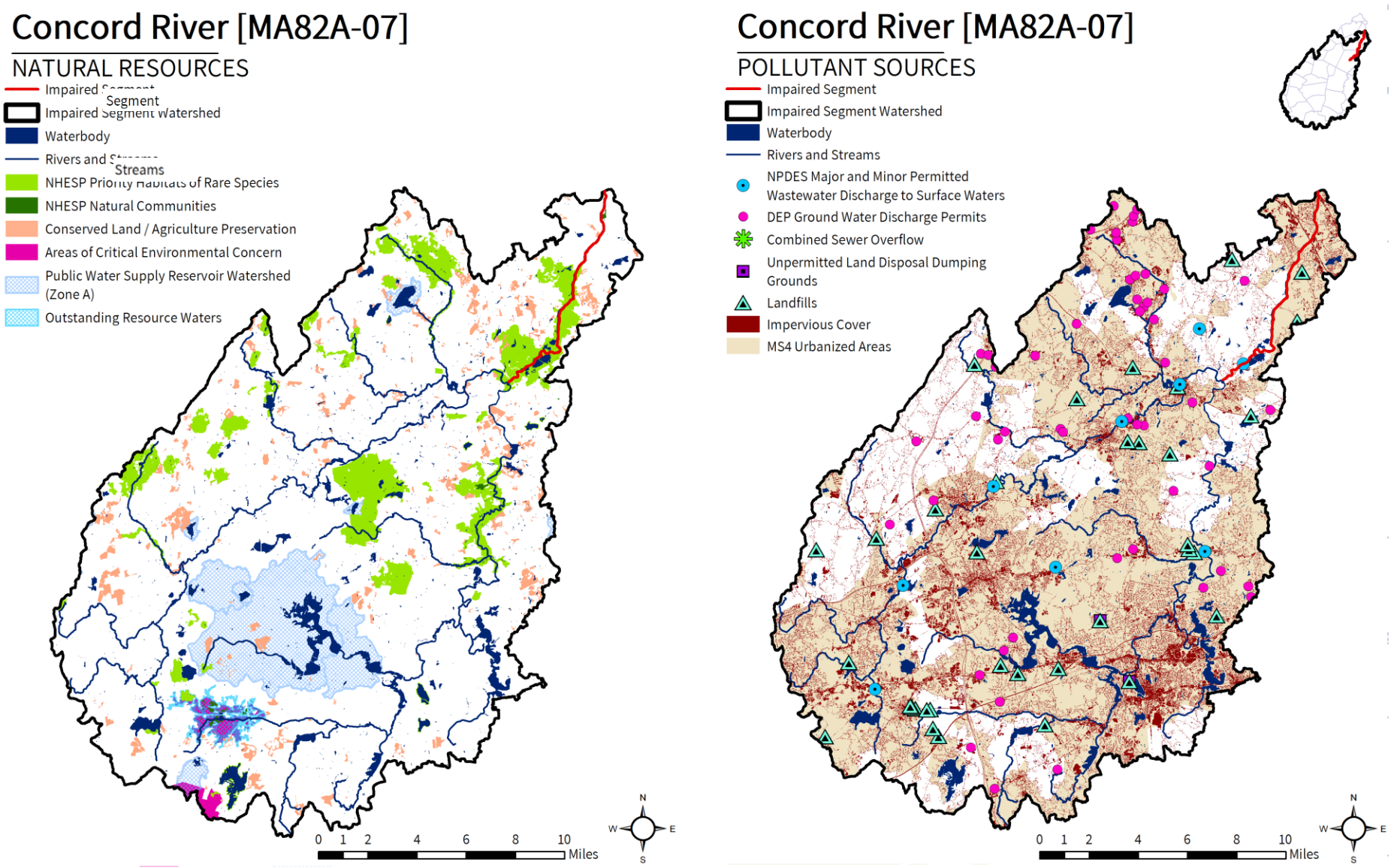


Figure 5-1. Natural resources and potential pollution sources draining to the Concord River segment MA82A-07. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, permitted facilities.

5.2. Waterbody Impairment Characterization

The Concord River (MA82A-07) is a Class B, Treated Water Supply and Warm Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* and fecal coliform at the stations listed below (refer to Tables 5-4, 5-5; Figure 5-2). 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, 30-day rolling basis.

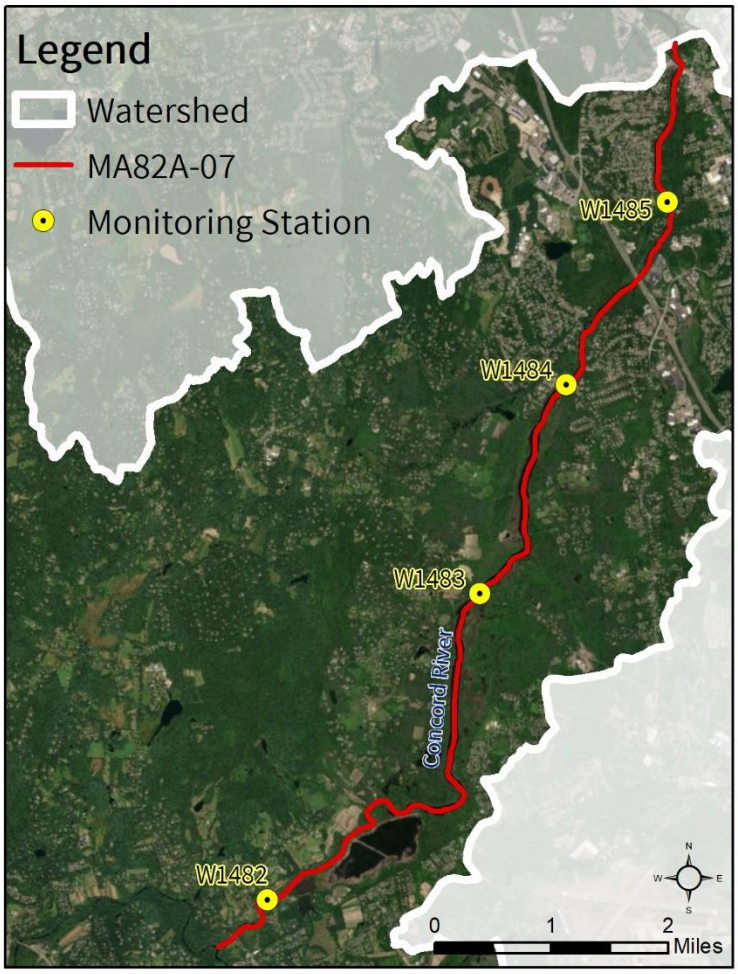


Figure 5-2. Location of monitoring station(s) along the impaired river segment.

- In 2006, five samples were collected at W1482, resulting in four days when the 30-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 wet weather.
- In 2006, five samples were collected at W1483, resulting in one day when the 30-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, none exceeded the STV criterion.
- In 2006, five samples were collected at W1484, resulting in one day when the 30-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, none exceeded the STV criterion.
- In 2006, five samples were collected at W1485, resulting in one day when the 30-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, none exceeded the STV criterion.

Table 5-4. Summary of indicator bacteria sampling results by station for the Concord River (MA82A-07). The maximum 30-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 Statistical Threshold Value (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 30-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 30-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
W1482	5/4/06	9/26/06	5	500	4	1
W1483	5/4/06	9/26/06	5	350	1	0
W1484	5/4/06	9/26/06	5	390	1	0
W1485	5/4/06	9/26/06	5	330	1	0

Table 5-5. Indicator bacteria data by station, indicator, and date for the Concord River (MA82A-07). Each sample date was designated wet or dry weather with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text 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 Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 30-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
W1482	*E. coli*	5/4/06	WET	65	65	
W1482	*E. coli*	6/8/06	WET	500	500	
W1482	*E. coli*	7/20/06	DRY	300	300	
W1482	*E. coli*	8/24/06	DRY	210	210	
W1482	*E. coli*	9/26/06	DRY	190	190	
W1482	Fecal Coliform	5/4/06	WET	130		
W1482	Fecal Coliform	6/8/06	WET	590		
W1482	Fecal Coliform	7/20/06	DRY	180		
W1482	Fecal Coliform	8/24/06	DRY	200		
W1482	Fecal Coliform	9/26/06	DRY	100		
W1483	*E. coli*	5/4/06	WET	39	39	
W1483	*E. coli*	6/8/06	WET	350	350	
W1483	*E. coli*	7/20/06	DRY	58	58	
W1483	*E. coli*	8/24/06	DRY	45	45	
W1483	*E. coli*	9/26/06	DRY	65	65	
W1483	Fecal Coliform	5/4/06	WET	65		
W1483	Fecal Coliform	6/8/06	WET	370		
W1483	Fecal Coliform	7/20/06	DRY	52		
W1483	Fecal Coliform	8/24/06	DRY	45		
W1483	Fecal Coliform	9/26/06	DRY	32		
W1484	*E. coli*	5/4/06	WET	71	71	
W1484	*E. coli*	6/8/06	WET	390	390	
W1484	*E. coli*	7/20/06	DRY	20	20	
W1484	*E. coli*	8/24/06	DRY	19	19	
W1484	*E. coli*	9/26/06	DRY	6	6	
W1484	Fecal Coliform	5/4/06	WET	71		
W1484	Fecal Coliform	6/8/06	WET	380		
W1484	Fecal Coliform	7/20/06	DRY	13		
W1484	Fecal Coliform	8/24/06	DRY	6		
W1484	Fecal Coliform	9/26/06	DRY	6		
W1485	*E. coli*	5/4/06	WET	13	13	
W1485	*E. coli*	6/8/06	WET	330	330	
W1485	*E. coli*	7/20/06	DRY	29	29	
W1485	*E. coli*	8/24/06	DRY	19	19	
W1485	*E. coli*	9/26/06	DRY	32	32	
W1485	Fecal Coliform	5/4/06	WET	19		
W1485	Fecal Coliform	6/8/06	WET	250		
W1485	Fecal Coliform	7/20/06	DRY	13		
W1485	Fecal Coliform	8/24/06	DRY	39		
W1485	Fecal Coliform	9/26/06	DRY	19		

5.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present and 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 SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants, which then becomes diluted during periods of 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).

The indicator bacteria data for the Concord River (MA82A-07) were elevated during wet weather, a result which is 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 wet weather indicator bacteria levels.

The highest geometric means in all conditions (e.g., wet, dry) and single samples were found at the upstream-most sample station (W1482). This may indicate that the major pathogen pollutant sources originate upstream near that sample station and that pollutants are diluted downstream. The location of the sample station is just downstream of the villages of Concord and West Concord, suggesting that future sampling and pathogen source investigation focus there.

Each potential pathogen source is described in further detail below.

Urban Stormwater: Portions of the Concord River (MA82A-07) watershed are well developed, with 68% of the land area in MS4, 8% as DCIA, and medium density residential development predominant in the lower reaches of the segment. There is a large portion of the watershed that extends far upstream of the segment, with large areas of developed land use. Stormwater runoff from urban areas is likely the most significant source of pathogens.

Illicit Sewage Discharges: With a portion of the watershed in sewer service and most of the watershed (68%) designated as MS4 area, both sanitary sewers and septic systems are possible source categories. Sewer related risks include leaking infrastructure (pipes, pump stations, etc.), and sanitary sewer overflows 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 drains are also a risk.

On-Site Wastewater Disposal Systems: There are 51 (4 in the immediate drainage area) groundwater discharge permits for on-site wastewater discharge, which are large-capacity septic systems (non-residential). Given the large portion of the watershed not covered by sewer service, malfunctioning septic systems are also a possible source. It is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: There are some orchards, row crops, and fields, mostly along the upper portions of the segment. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies. Additionally, any agricultural lands adjacent to upstream tributaries or storm drains could also provide a direct conduit to the river.

Pet Waste: There are parks, large conservation lands, and wetlands along much of the river segment. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: Conservation and recreational lands having large open mowed areas with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water.

5.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Bedford

All of Bedford is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Bedford (Permit ID#MAR041028) has an EPA approved Notice of Intent (NOI). It has mapped all of its MS4 stormwater system, with a map attached to its NOI. It adopted IDDE, ESC, and post-construction stormwater regulations in 2012. An MS4 report for 2018 was not found. There were seven reported outfalls to the Concord River MA82A-07.

Stormwater page: https://www.bedfordma.gov/department-of-public-works/webforms/stormwater-management-program (Town of Bedford, 2020)

SWMP: NOI anticipates completion by end of first year of 2016 MS4 General Permit (2019).

Bedford has the following ordinances and bylaws:

- Stormwater Management: Bylaws > Article 55, page 109: https://www.bedfordma.gov/sites/g/files/vyhlif2781/f/uploads/charter_and_bylaws_updated_thru_stm_2018.pdf (Town of Bedford, 2018b)
- Title 5 / Sewer System: Bylaws > Article 51, page 85: https://www.bedfordma.gov/sites/bedfordma/files/uploads/charter_and_bylaws_updated_thru_stm_2018.pdf (Town of Bedford, 2018a)
- Parks and Open Space: https://www.bedfordma.gov/conservation-commission/pages/open-space-and-recreation-plan (Town of Bedford, 2004)
- Wetlands Protection Bylaw: https://www.bedfordma.gov/sites/bedfordma/files/u80/approved_wetlands_bylaw_2016.pdf (Town of Bedford, 2016)
- Pet Waste:: https://www.bedfordma.gov/sites/g/files/vyhlif2781/f/uploads/pet_waste_flyer.pdf (Town of Bedford, n,d.)
- Stormwater Utility (or similar): None found.

In *The Bedford We Want: Shaping Our Future Comprehensive Plan* from 2013, stormwater is cited in sections on land use (page 4-1) and natural resources (page 6-1). The plan mentions the Concord and Shawsheen rivers in Natural and Cultural Resources, pages 6-4. It also indicates most of the town is served by sewer lines leading to the MWRA treatment plant at Dee Island in Boston Harbor, includes a map of sewer and public water areas, and sets as a land use priority for the Department of Public Works to upgrade and repair sanitary sewer and wastewater pipes in the business area.

Bedford's 2013 Comprehensive Plan: https://www.bedfordma.gov/planning/pages/comprehensive-plan-2013 (Town of Bedford, 2013)
Bedford's 2004 Open Space and Recreation Plan: https://www.bedfordma.gov/conservation-commission/pages/open-space-and-recreation-plan (Town of Bedford, 2004)

Bedford is within the service area of Metropolitan Area Planning Council (MAPC, http://www.mapc.org/). (MAPC, 2021).

Town of Billerica

Almost all of Billerica is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Billerica (Permit ID#MAR041182) has an EPA approved Notice of Intent (NOI). Billerica has mapped all of its MS4 stormwater system, with a map found here: https://www.mapsonline.net/billericama/public.html. (Town of Billerica, 2013) It adopted IDDE, ESC, and post-construction stormwater regulations in 2007. The 2018 MS4

report states that the Town has responded to several stormwater related complaints, including pet waste dumping into the MS4 system, by informing those involved that the activity was prohibited. It also developed a template for Inspection and Maintenance Agreements and an example Annual O&M Inspection Report for private stormwater systems. Three illicit discharges were reported as discovered in the recent reporting period. Billerica reports 12 outfalls to Concord River MA82A-07, and a further 16 outfalls to its tributaries/wetlands.

Stormwater page: https://www.town.billerica.ma.us/214/Stormwater-Management (Town of Billerica, 2018c)

SWMP: https://www.town.billerica.ma.us/DocumentCenter/View/8035/2018-Billerica-Stormwater-Management-Plan (Town of Billerica, 2020b)

Billerica has the following ordinances and bylaws:

- Stormwater: https://www.town.billerica.ma.us/246/Stormwater-Bylaws, (Town of Billerica, 2007)
- Stormwater: Article XXV - Stormwater Management Bylaw, https://www.town.billerica.ma.us/DocumentCenter/View/315 (Town of Billerica, n.d.)
- Stormwater: General Bylaws Article XXVI - Bylaw Governing Discharges to MS4, https://www.town.billerica.ma.us/DocumentCenter/View/314 (Town of Billerica, 2008a)
- Wetlands: https://www.town.billerica.ma.us/DocumentCenter/View/2973/Wetland-Protection-Regulations-Adopted-6-25-08 (Town of Billerica, 2008b)
- Sanitary Sewer Rules and Regulations: https://www.town.billerica.ma.us/documentcenter/view/294 (Town of Billerica, 2020a)
- Pet Waste: https://www.town.billerica.ma.us/ArchiveCenter/ViewFile/Item/528 (Town of Billerica, 2015)
- Stormwater Utility (or similar): None found.

The Town of Billerica's 2018 Master Plan deals with rivers, including specifically the Concord River, under Natural Resources > Water Resources, p. 43. Stormwater is discussed in Public Facilities and Services section, and Cultural and Natural Resources Section. It mentions that 75% of the town is currently served by sewer, and Billerica is pursuing a multimillion-dollar program to serve the entire town by 2035. https://www.town.billerica.ma.us/DocumentCenter/View/7658/Master-Plan_FINAL_04_4-18pdf (Town of Billerica, 2018b)

Billerica also has a 2018 Open Space and Recreation Plan, in which stormwater and on-site wastewater system issues are discussed. It states the Town Planning Board could adopt MassDEP Stormwater Standards for all new development, which would help mitigate environmental impacts from development. See: https://www.town.billerica.ma.us/DocumentCenter/View/7505/Open-Space-Recreation-Plan (Town of Billerica, 2018a)

Billerica is within the service area of Northern Middlesex Council Of Governments (NMCOG, http://www.nmcog.org/). (NMCOG, 2021).

Town of Carlisle

The Town of Carlisle contains very little "Urban Area" as defined by the US Census and is covered by an MS4 General Permit waiver from NPDES II / MS4 program.

Carlisle has the following ordinances and bylaws:

- Title 5 / Supplementary Regulations for sewage disposal systems: https://www.carlislema.gov/DocumentCenter/View/723/Septic-Regulations-PDF (Town of Carlisle, 2019b)
- Non-zoning Wetland Bylaw: https://www.carlislema.gov/DocumentCenter/View/922/Carlisle-NonZoning-Wetland-Bylaw-PDF?bidId= (Town of Carlisle, 2015)
- Pet Waste: General Bylaws > Animal Control Bylaw > Section 14.6.2.2, page 52: https://www.carlislema.gov/DocumentCenter/View/205/General-Bylaws-PDF?bidId= (Town of Carlisle, 2019a)

Carlisle is currently writing a Master Plan. It has a 2013 Open Space and Recreation Plan, approved through September 2020, which states the town is entirely served by on-site wastewater systems and private wells, and

that Board of Health's primary focus is on protecting groundwater. The Board created a Community Septic Loan Program funded through the State Revolving Fund to facilitate repairs of failed systems. The Planning Board set a goal of mapping septic systems in GIS. The plan also briefly mentions impervious surfaces as a source of stormwater pollutants.

Carlisle's 2013 Open Space and Recreation Plan: https://www.carlislema.gov/DocumentCenter/View/929/Carlisle-2013-Open-Space-and-Recreation-Plan---Entire-Document-PDF (Town of Carlisle, 2013)

Carlisle is part of the Minuteman Advisory Group on Interlocal Coordination within the Metropolitan Area Planning Council (MAPC, http://www.mapc.org/). (MAPC, 2021).

Town of Concord

About half of Concord is US Census defined "Urban Area," and is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (Permit ID#MAR041187) has an EPA approved Notice of Intent (NOI). Concord has mapped all of its MS4 stormwater system and has submitted a paper map with its NOI. It adopted IDDE, ESC, and post-construction stormwater regulations in 2011. Concord reports 13 outfalls to the Assabet River MA82B-07. In the most recent MS4 report, it states four illicit discharges (dumping) were identified and indicates that 35% of the population is on sewer, 65% on septic systems.

Stormwater page: https://concordma.gov/175/Stormwater-Management (Town of Concord, 2011a)

SWMP: see stormwater page link.

Concord has the following ordinances and bylaws:

- Stormwater Regulations: https://concordma.gov/DocumentCenter/View/96/Concord-Storm-Water-Regulations-PDF (Town of Concord, 2011b)
- Title 5 Supplemental Regulations: https://concordma.gov/DocumentCenter/View/1960/Title-5-Regulations-PDF?bidId= (MADEP, N.d.)
- Wetland Bylaws: https://concordma.gov/DocumentCenter/View/2233/Concord-Wetlands-Bylaw?bidId= (Town of Concord, 2013)
- Pet Waste: https://concordma.gov/DocumentCenter/View/4173/Dog-Bylaw-PDF (Town of Concord, 2007)

Concord's 2018 *Envision Concord: Bridge to 2030 Plan* has a Natural Resources section, starting on page 194, a stormwater section on page 45, and discusses the Assabet River as a recreational asset on page 135, and elsewhere. Sewer and Septic are mentioned in the wastewater section, page 212.

Master Plan / Comprehensive Plan: https://www.concordma.gov/2281/Long-Range-Plan (Town of Concord, 2018)

Concord's 2015 Open Space and Recreation Plan is at: https://concordma.gov/738/Open-Space-Recreation-Plan (Town of Concord, 2015)

Concord is part of the Minuteman Advisory Group on Interlocal Coordination within the Metropolitan Area Planning Council (MAPC, http://www.mapc.org/). (MAPC, 2021).

6. MA82A-09 Concord River

6.1. Waterbody Overview

The Concord River segment MA82A-09 is 0.9 miles long, located entirely within the City of Lowell. It begins at the Rogers Street Bridge and ends at its confluence with the Merrimack River. The segment is bound at the upstream end by the Concord River MA82A-08, and at the downstream end by the Merrimack River MA84A-02, neither of which are pathogen-impaired.

Tributaries include pathogen-impaired Meadow River Brook (MA82A-10), the entire Concord River upstream from Rogers Street, and the canals of Lowell. The segment occupies a narrow riparian zone in downtown Lowell. There is a thin strip of vegetation along the river, including Eastern Canal Park. There are three road crossings, Rogers Street, Church Street, and the Kearney Square Bridge.

The Concord River (MA82A-09) drains an area of 400 square miles, of which 54 mi^2 (14%) is impervious and 30 mi^2 (8%) is directly connected impervious area (DCIA). The watershed is partially[10] served by public sewer, and 70% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There is one NPDES wastewater treatment facility permit on file governing point source discharges of pollutants to surface waters in the immediate drainage area to the impaired segment (Table 6-1). There are also 54 MassDEP discharge to groundwater permits for on-site wastewater discharge within this watershed (none in the immediate drainage area). There is one combined sewer overflow (CSO) (Table 6-2). See Figure 6-1.

Reduction from Highest Calculated Geomean: 87%

Watershed Area (Acres): 256,077

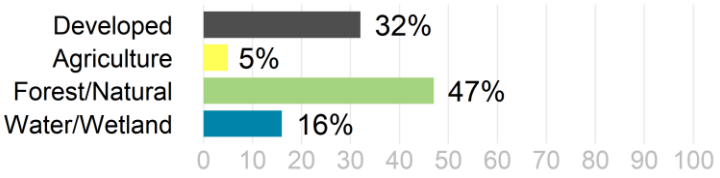
Segment Length (Miles): 0.9

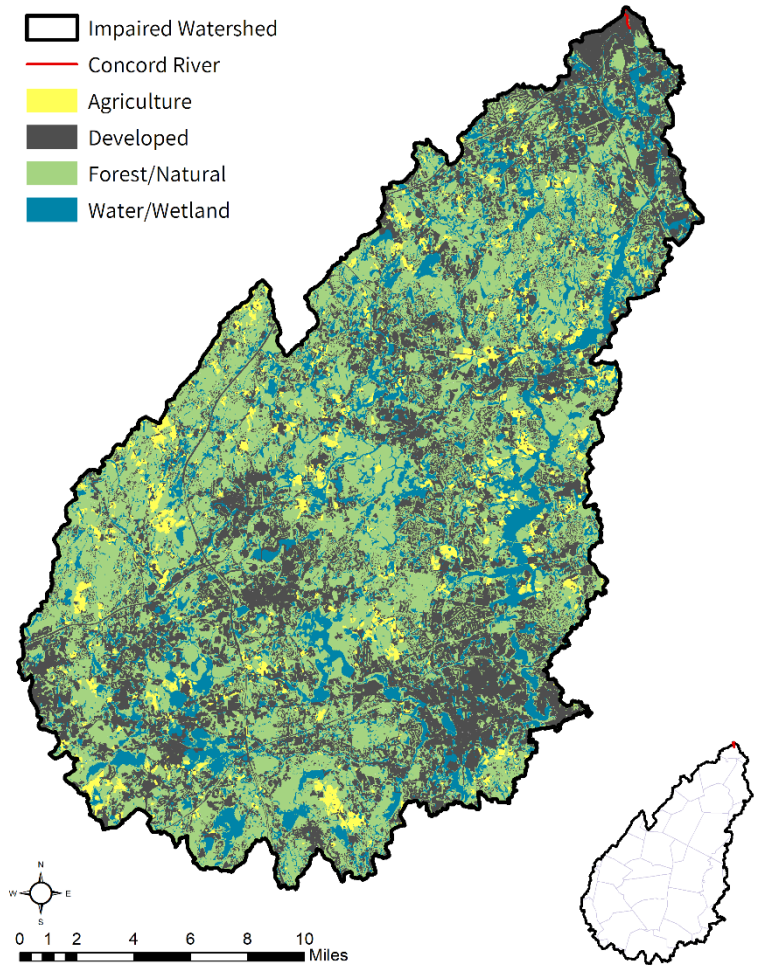
Impairment(s): *E. coli*, fecal coliform (Primary Contact Recreation)

Class (Qualifier): B (Warm Water, CSO Receiving Water)

Impervious Area (Acres, %): 34,588 (14%)

DCIA Area (Acres, %): 19,356 (8%)





[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 https://www.mass.gov/guides/water-utility-resilience-program(MassDEP, 2020), MS4 reports, and local knowledge.

Table 6-1. National Pollutant Discharge Elimination System (NPDES) permits for Wastewater Treatment Facilities (WWTF) in the segment watershed. Only permits unique to this segment watershed are shown. WWTF are identified as either municipal (MUN) or other (OTH), if applicable.

NPDES ID	NAME	TOWN	WWTF
MA0101711	BILLERICA WWTP	BILLERICA	MUN

Table 6-2. Combined Sewer Overflows (CSOs) discharging to the segment.

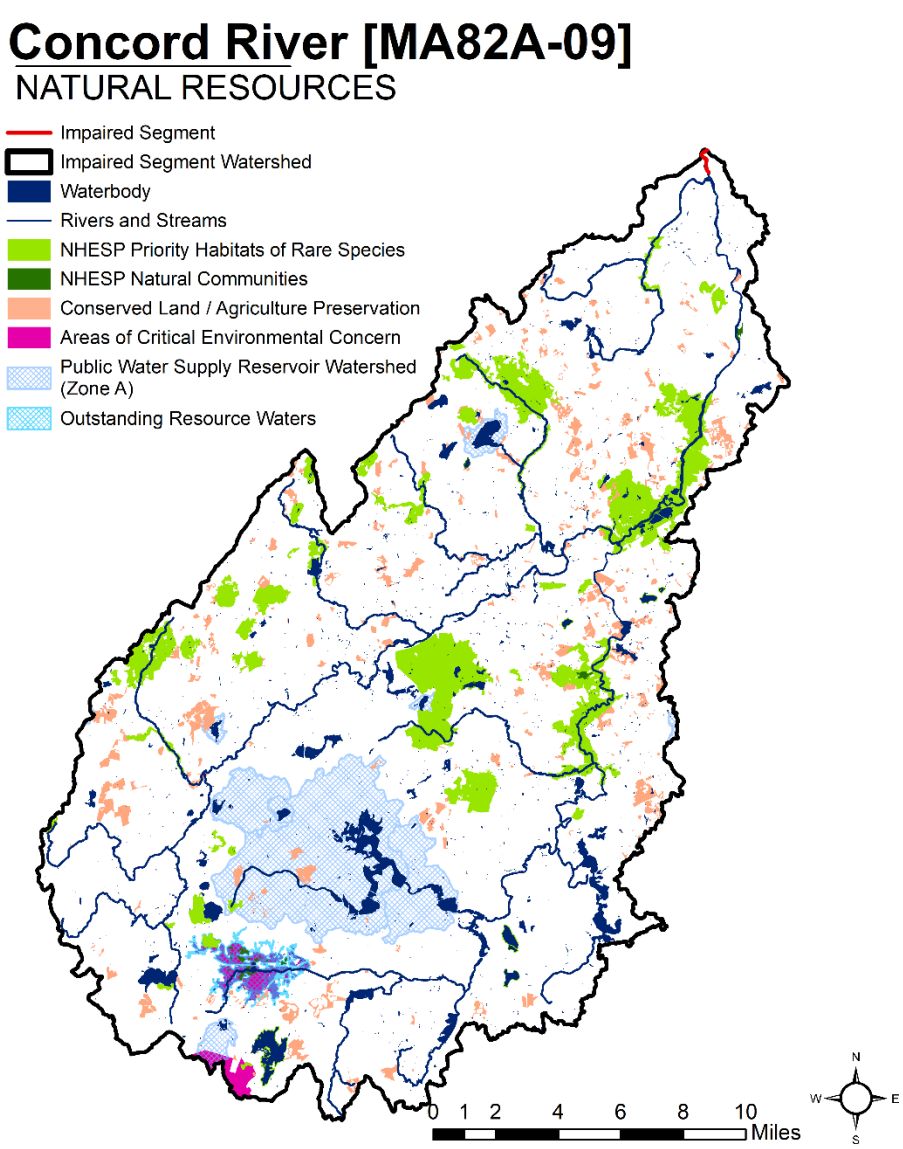
NPDES ID	NAME	TOWN	DEP OUTFALL ID
MA0100633	LOWELL REGIONAL WASTEWATER UTILITIES	LOWELL	LOW020

The upper portion of the segment is flanked by high density residential development, while the lower portion is high density commercial, ex-industrial (mill buildings converted to residences), and institutional.

The watershed of the Concord River (MA82A-09) contains two Areas of Critical Environmental Concern, "Cedar Swamp" (1,650 acres) and "Miscoe, Warren and Whitehall Watersheds" (773 acres), which combined cover 2,423 acres (1%) of the land area. Under the Natural Heritage and Endangered Species Program, there are 308 acres (0.1%) of Priority Natural Vegetation Communities and 20,853 acres (8%) of Priority Habitats of Rare Species. Over 11,626 acres (5%) of land protected in perpetuity[11] exist within the segment watershed, which is part of a total of 68,038 acres (27%) of Protected and Recreational Open Space[12]. There are 22,560 acres (9%) under Public Water Supply protection and 1,520 acres (1%) identified as Outstanding Resource Waters. See Figure 6-1.

[11] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetlands restrictions, aquifer protection, historic preservation, etc. Refer to MassGIS metadata for the Protected and Recreational Open Space data layer. Land protected in perpetuity reflect watershed-wide estimates (including for watersheds that extend outside of the State of Massachusetts).

[12] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside of the State of Massachusetts).



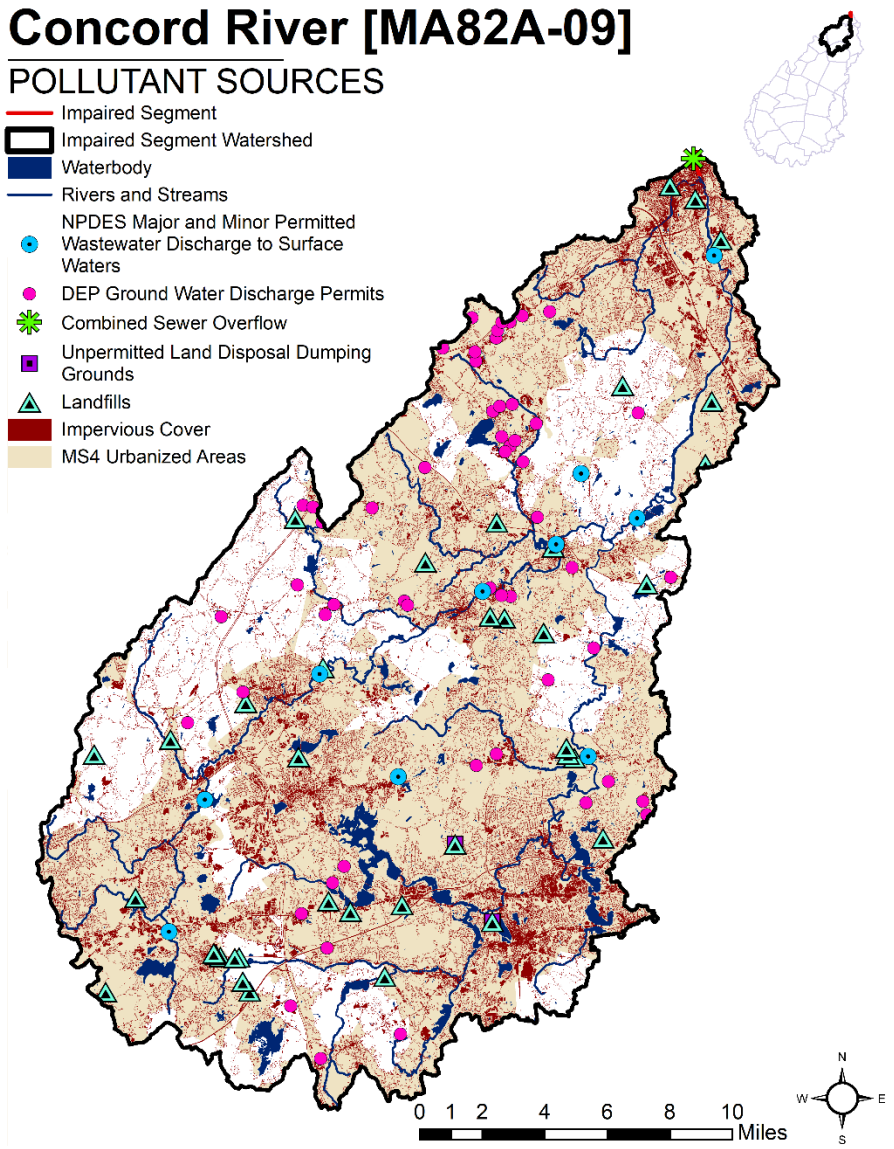


Figure 6-1. Natural resources and potential pollution sources draining to the Concord River segment MA82A-09. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, permitted facilities.

6.2. Waterbody Impairment Characterization

The Concord River (MA82A-09) is a Class B, Warm Water and CSO Receiving Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* and fecal coliform at the stations listed below (refer to Tables 6-3, 6-4; Figure 6-2). 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, 30-day rolling basis

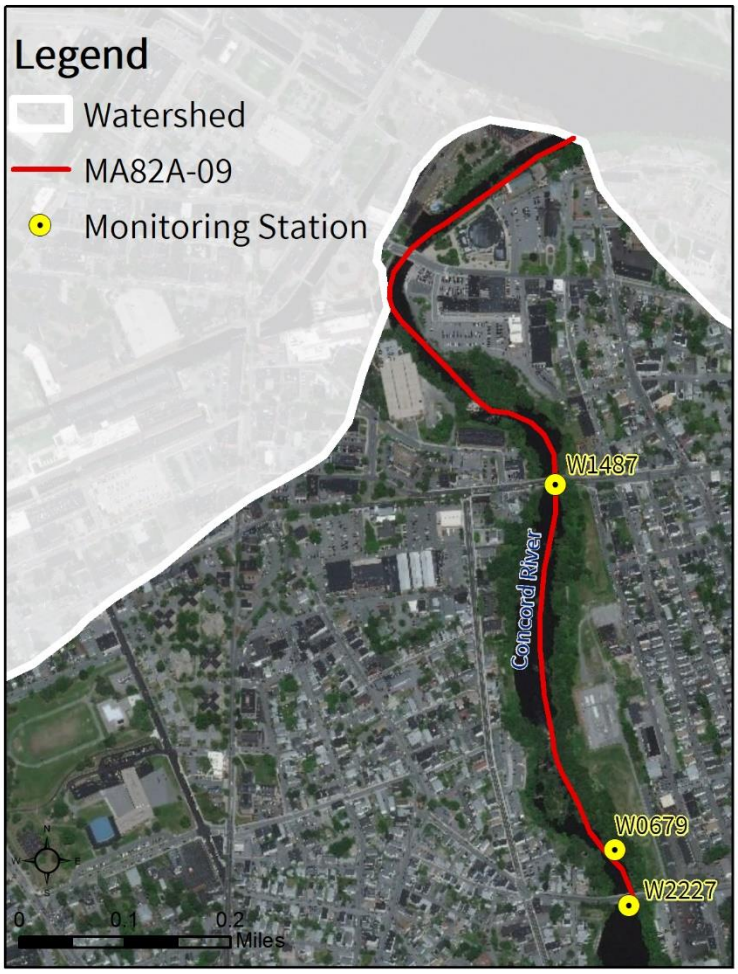


Figure 6-2. Location of monitoring station(s) along the impaired river segment.

- In 2007, three samples were collected at W0679, resulting in two days when the 30-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 three samples, one exceeded the STV criterion during wet weather.
- From 2006-2010, 16 samples were collected at W1487, resulting in seven days when the 30-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 16 samples, three exceeded the STV criterion during wet weather.
- From 2011-2013, 15 samples were collected at W2227, resulting in seven days when the 30-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 15 samples, two exceeded the STV criterion during dry weather.

Table 6-3. Summary of indicator bacteria sampling results by station for the Concord River (MA82A-09). The maximum 30-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 Statistical Threshold Value (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 30-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 30-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
W0679	7/18/07	11/7/07	3	727	2	1
W1487	5/4/06	10/20/10	16	727	7	3
W2227	3/15/11	9/25/13	15	980	7	2

Table 6-4. Indicator bacteria data by station, indicator, and date for the Concord River (MA82A-09). Each sample date was designated wet or dry weather with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text 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 Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 30-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
W0679	*E. coli*	7/18/07	WET	152	152	
W0679	*E. coli*	9/12/07	WET	727	727	
W0679	*E. coli*	11/7/07	WET	125	125	
W1487	*E. coli*	5/4/06	WET	110	110	
W1487	*E. coli*	6/8/06	WET	510	510	
W1487	*E. coli*	7/20/06	DRY	290	290	
W1487	*E. coli*	8/24/06	DRY	320	320	
W1487	*E. coli*	9/26/06	DRY	230	230	
W1487	*E. coli*	2/27/08	WET	44	44	
W1487	*E. coli*	4/23/08	DRY	11	11	
W1487	*E. coli*	6/18/08	WET	579	579	
W1487	*E. coli*	8/20/08	DRY	98	98	
W1487	*E. coli*	10/22/08	DRY	73	73	
W1487	*E. coli*	3/18/09	DRY	6	6	
W1487	*E. coli*	5/20/09	WET	99	99	
W1487	*E. coli*	7/22/09	WET	93	93	
W1487	*E. coli*	9/29/09	WET	291	291	
W1487	*E. coli*	11/17/09	WET	727	727	
W1487	*E. coli*	10/20/10	DRY	84	84	
W1487	Fecal Coliform	5/4/06	WET	110		
W1487	Fecal Coliform	6/8/06	WET	440		
W1487	Fecal Coliform	7/20/06	DRY	290		
W1487	Fecal Coliform	8/24/06	DRY	240		
W1487	Fecal Coliform	9/26/06	DRY	150		
W2227	*E. coli*	3/15/11	DRY	45	45	
W2227	*E. coli*	5/17/11	WET	308	308	
W2227	*E. coli*	7/20/11	DRY	980	980	
W2227	*E. coli*	9/21/11	DRY	308	308	
W2227	*E. coli*	11/16/11	DRY	86	86	
W2227	*E. coli*	2/22/12	DRY	38	38	
W2227	*E. coli*	4/11/12	DRY	25	25	
W2227	*E. coli*	6/20/12	DRY	105	105	
W2227	*E. coli*	8/22/12	DRY	148	148	
W2227	*E. coli*	10/24/12	DRY	142	142	
W2227	*E. coli*	1/28/13	DRY	57	57	
W2227	*E. coli*	3/20/13	WET	20	20	
W2227	*E. coli*	5/20/13	DRY	99	99	
W2227	*E. coli*	8/28/13	DRY	613	613	
W2227	*E. coli*	9/25/13	DRY	115	266	

6.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present and 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 SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants, which then becomes diluted during periods of 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).

For the Concord River (MA82A-09), elevated indicator bacteria levels during wet weather suggest 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 wet weather indicator bacteria levels.

Each potential pathogen source is described in further detail below.

Combined Sewer Overflow (CSO): There is one CSO in the segment's sub-basin, which by design releases untreated wastewater to surface waters when flows exceed system capacity, and therefore must be eliminated. For this reason, it is set as the highest priority pathogen source.

Urban Stormwater: The areas around the Concord River segment MA82A-09 are fully developed, consisting almost entirely of urban area and impervious surfaces in downtown Lowell. This segment constitutes the downstream-most end of the entire Concord River watershed, and there is a large watershed area upstream of the segment. In terms of the entire watershed, 70% of the land area is in MS4, 8% is DCIA, and there are areas of dense urban development just upstream of the segment in the South Lowell neighborhood. These factors indicate that stormwater runoff is likely a significant source of pathogens.

Illicit Sewage Discharges: A portion of the watershed is served by public sewer (nearly the entire area immediately surrounding the segment is served by sewer), and most of the watershed (70%) is designated as MS4 area. Sewer related risks include leaking infrastructure (pipes, pump stations, etc.), and sanitary sewer overflows 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 drains are also a risk.

On-Site Wastewater Disposal Systems: There are 54 (none in the immediate drainage area) groundwater discharge permits for on-site wastewater discharge, which are large-capacity septic systems (non-residential). Much of the upstream watershed is served by septic system, so malfunctioning septic systems are also a possible source. It is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: There appears to be no agricultural land along the segment, although there is agriculture throughout the watershed. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: There are small parks along the segment, and many large conservation lands further upstream in the watershed. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: Conservation and recreational lands with large open mowed areas with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water.

6.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

City of Lowell

All Lowell is US Census defined Urban Area and has been subject to the NPDES General Permits for Stormwater Discharge from MS4s (Permit ID#MAR041205). However, at time of writing, no NOI application, approval, recent MS4 report, or SWMP was found.

Lowell has the following ordinances and bylaws:

- Stormwater Ordinance or Bylaws: https://ecode360.com/34304419 (City of Lowell, 2018)
- Stormwater Utility (or similar): None found.
- Title 5 Supplemental Regulations or Bylaws: None found.
- Wetlands: https://ecode360.com/12360663 (City of Lowell, 2003)
- Pet Waste: https://ecode360.com/27625195 (City of Lowell, 2013)

Lowell's 2013 *Sustainable Lowell 2025* Master Plan covers water resources, frequently encourages effective stormwater management, proposes that a regional stormwater utility be considered, and recommends installing backflow prevention valves on CSOs and other suitable infrastructure to reduce backup flooding.

https://www.lowellma.gov/DocumentCenter/View/1517/Sustainable-Lowell-2025-PDF?bidId= (City of Lowell, 2012)

Lowell's draft 2019 Open Space and Recreation Plan: https://www.lowellma.gov/765/Open-Space-Plan (City of Lowell, 2019)

Lowell is within the service area of Northern Middlesex Council Of Governments (NMCOG, http://www.nmcog.org/). (NMCOG, 2021).

7. MA82A-10 River Meadow Brook

7.1. Waterbody Overview

The River Meadow Brook segment MA82A-10 is 6.4 miles long, located near Exit 35 of I-495, which begins at the outlet of Russell Mill Pond (MA82096), Chelmsford, flows north to northeast, and ends at the confluence with the Concord River (MA82A-08) in Lowell, approximately one mile above the latter's confluence with the Merrimack River.

Tributaries include Russell Mill Pond (an upstream impoundment of River Meadow Brook), Farley Brook, Putnam Brook, Beaver Brook (MA82A-34, pathogen-impaired), Golden Cove Brook on the north side of I-495, and an unnamed tributary draining the eastern side of the Lowell Connector.

Landmarks include South Row School and the Chelmsford Water District near the upstream end of the segment, and the highways of I-495, US Route 3, and the urban fabric of Lowell in the downstream portions, as described below. Road crossings in Chelmsford include Mill Road at the upper end, Turnpike Road and Billerica Road, then I-495 and US Route 3. In Lowell, the segment flows under Industrial Avenue, the Lowell Connector, numerous commercial area roads, and the railroad near the Lowell Train Station.

The River Meadow Brook (MA82A-10) drains an area of 27 square miles, of which 5 mi^2 (19%) is impervious and 3 mi^2 (12%) is directly connected impervious area (DCIA). The City of Chelmsford planning documents indicate over 90% of downtown areas are served by public sewer, though sewer coverage area for the entire watershed was not found. Around 81% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are two MassDEP discharge to groundwater permits for on-site wastewater discharge within the immediate drainage area to the impaired segment (Table 7-1). See Figure 7-1.

Reduction from Highest Calculated Geomean: 95%

Watershed Area (Acres): 17,195

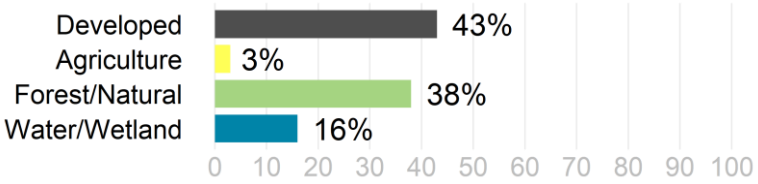
Segment Length (Miles): 6.4

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

Class: B

Impervious Area (Acres, %): 3,290 (19%)

DCIA Area (Acres, %): 2,113 (12%)



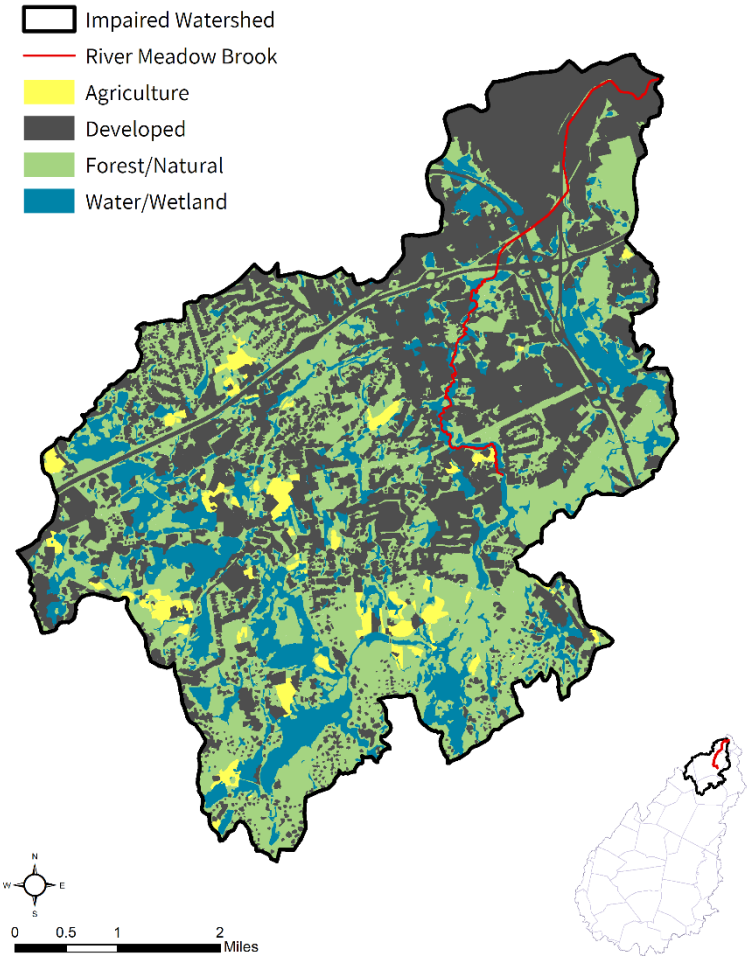


Table 7-1. Groundwater discharge permits in the segment watershed. Only permits unique to this segment watershed are shown. PERR = permit number plus renewal number. TYPE = type of groundwater discharge. Flow = permitted effluent in gallons per day (gpd).

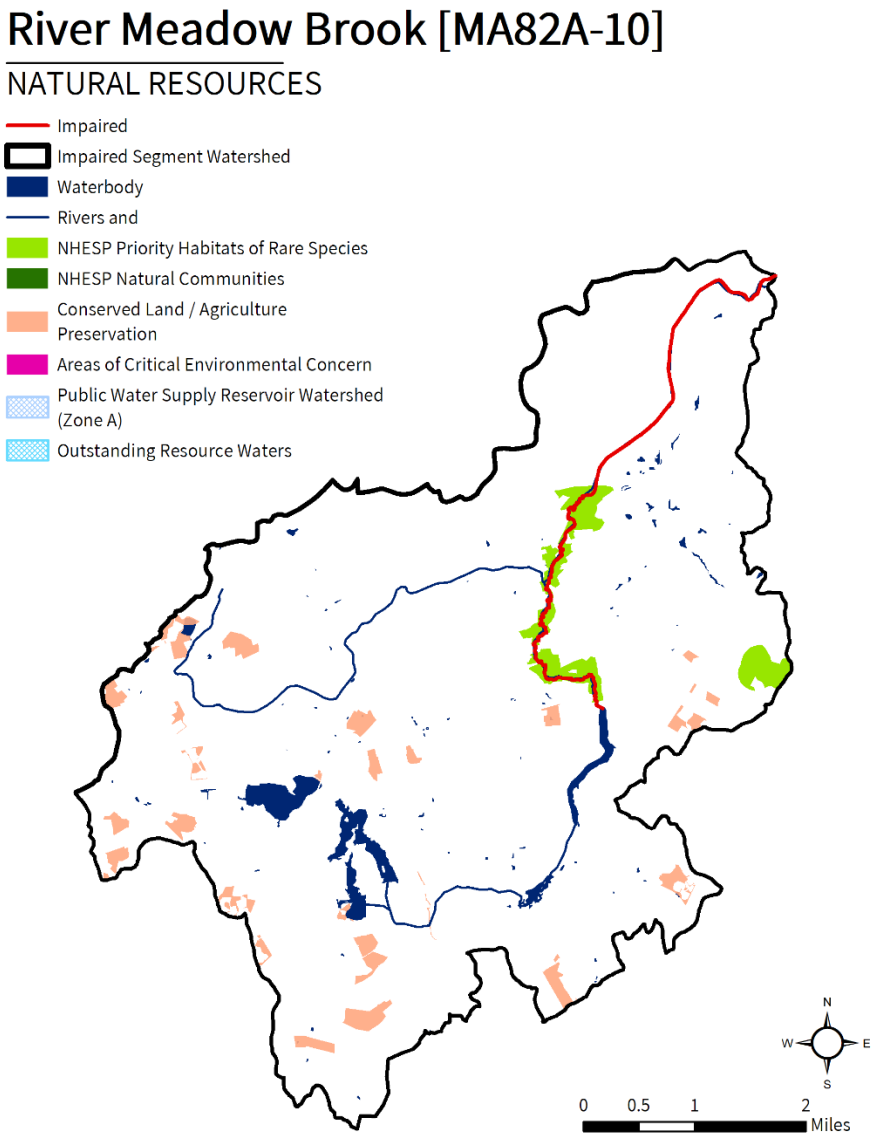
PERR	NAME	TOWN	TYPE	FLOW (GPD)
366-5	WESTFORD TECH PARK	WESTFORD	Sanitary Discharge	90,000
751-1M1	WESTFORD VALLEY MARKETPLACE	WESTFORD	Sanitary Discharge	37,000

The upstream half of the segment has a riparian area composed of open and forested wetlands surrounded by medium density residential development, then the segment flows underneath I-495, US Route 3, then the Lowell Connector, an elevated divided highway. Just to the southeast of these road crossings are the expansive highway interchanges of Exits 35A-35B-35C from I-495. The remainder of River Meadow Brook is constrained between the Lowell Connector, high density commercial and automotive-focused development, and the Silresim Superfund site and groundwater treatment plant. The final downstream portion of the segment flows through high density residential, commercial, and light industrial development near downtown Lowell.

In the watershed of River Meadow Brook (MA82A-10), under the Natural Heritage and Endangered Species Program, there are 341 acres (2%) of Priority Habitats of Rare Species. Over 444 acres (3%) of land protected in perpetuity[13] exist within the segment watershed, which is part of a total of 3,257 acres (19%) of Protected and Recreational Open Space[14]. There are no Areas of Critical Environmental Concern, areas under Public Water Supply protection, or areas identified as Outstanding Resource Waters. See Figure 7-1.

[13] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetlands restrictions, aquifer protection, historic preservation, etc. Refer to MassGIS metadata for the Protected and Recreational Open Space data layer. Land protected in perpetuity reflect watershed-wide estimates (including for watersheds that extend outside of the State of Massachusetts).

[14] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside of the State of Massachusetts).



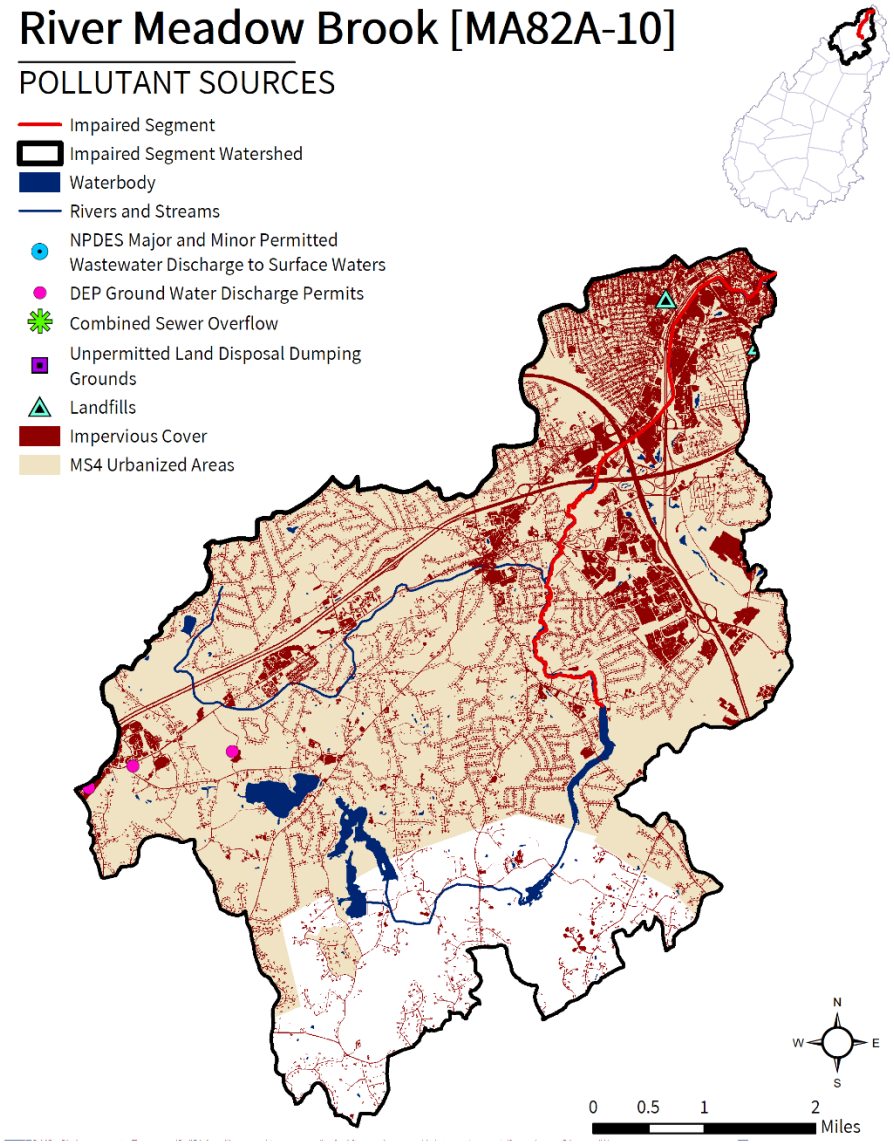


Figure 7-1. Natural resources and potential pollution sources draining to the River Meadow Brook segment MA82A-10. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, permitted facilities.

7.2. Waterbody Impairment Characterization

River Meadow Brook (MA82A-10) is a Class B Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* and fecal coliform at stations listed below (refer to Tables 7-2, 7-3; Figure 7-2). 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 2006, five samples were collected at W1488, 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. Out of five samples, one exceeded the STV criterion in wet weather.
- In 2006, five samples were collected at W1489, resulting in 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, four exceeded the STV criterion in both wet and dry weather.

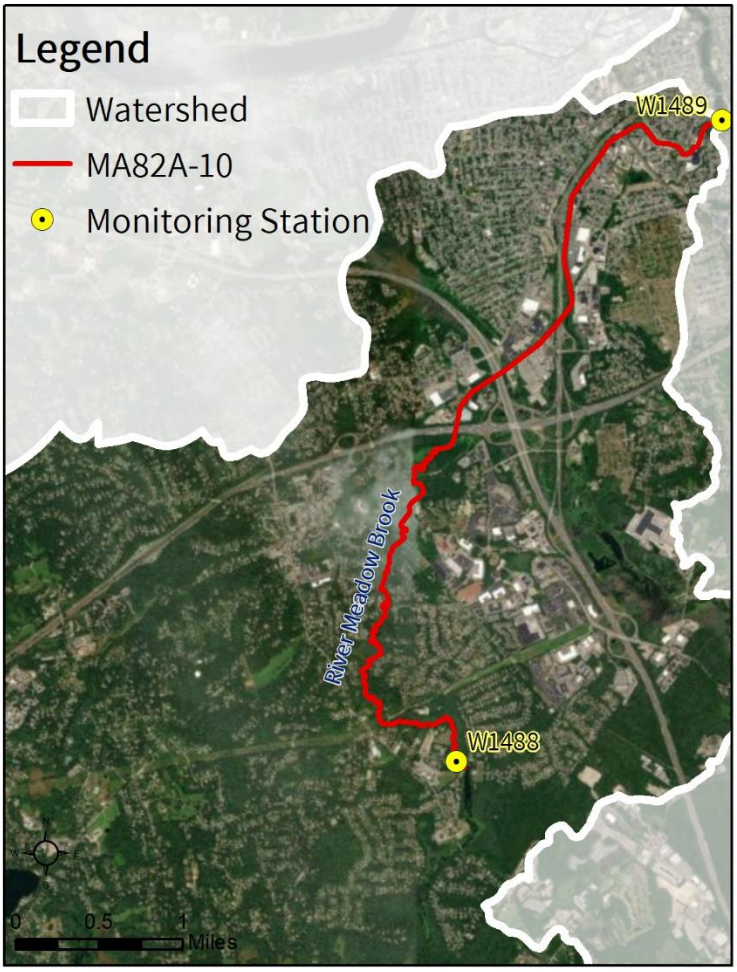


Figure 7-2. Location of monitoring station(s) along the impaired river segment.

Table 7-2. Summary of indicator bacteria sampling results by station for River Meadow Brook (MA82A-10). 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 Statistical Threshold Value (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
W1488	5/4/06	9/26/06	5	265	3	1
W1489	5/4/06	9/26/06	5	2336	5	4

Table 7-3. Indicator bacteria data by station, indicator, and date for River Meadow Brook (MA82A-10). Each sample date was designated wet or dry weather with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text 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 Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 90-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W1488	*E. coli*	5/4/06	WET	26	26	
W1488	*E. coli*	6/8/06	WET	740	139	
W1488	*E. coli*	7/20/06	DRY	260	171	
W1488	*E. coli*	8/24/06	DRY	97	265	
W1488	*E. coli*	9/26/06	DRY	71	121	
W1488	Fecal Coliform	5/4/06	WET	39		
W1488	Fecal Coliform	6/8/06	WET	520		
W1488	Fecal Coliform	7/20/06	DRY	340		
W1488	Fecal Coliform	8/24/06	DRY	190		
W1488	Fecal Coliform	9/26/06	DRY	45		
W1489	*E. coli*	5/4/06	WET	290	290	
W1489	*E. coli*	6/8/06	WET	1100	565	
W1489	*E. coli*	7/20/06	DRY	690	604	
W1489	*E. coli*	8/24/06	DRY	8400	1854	
W1489	*E. coli*	9/26/06	DRY	2200	2336	
W1489	Fecal Coliform	5/4/06	WET	270		
W1489	Fecal Coliform	6/8/06	WET	830		
W1489	Fecal Coliform	7/20/06	DRY	1000		
W1489	Fecal Coliform	8/24/06	DRY	12000		
W1489	Fecal Coliform	9/26/06	DRY	3000		

7.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present and 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 SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants, which then becomes diluted during periods of 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 River Meadow Brook (MA82A-10) at the upstream sample station (W1488) were elevated during wet weather, a result which is consistent with urban stormwater, pet waste, wildlife pathogen sources, and baseflow sources. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated wet weather indicator bacteria levels. These sources are likely in the medium density residential neighborhoods in eastern Chelmsford where the sample station is located.

The downstream sample station (W1489) showed significantly higher indicator bacteria levels during dry weather than wet weather. These facts, combined with the location of the downstream station in the densely developed areas of Chelmsford and Lowell, strongly suggest the presence of one or more baseflow pollutant sources, such as illicit sewage discharges, leaking pipes, or illegal cross-connections. Some types of septic system malfunctions, such as surface breakouts or broken pipes, may also result in these conditions, although the area

surrounding the stream is served almost entirely by public sewer and are thus less likely. Given the limited indicator bacteria data, additional sampling is warranted to determine the current status and patterns of pathogen sources in this segment.

Each potential pathogen source is described in further detail below.

Urban Stormwater: The River Meadow Brook (MA82A-10) watershed is developed, with 81% of the land area in MS4 and 12% as DCIA. The area of Chelmsford and Lowell through which the segment flows are heavily developed and characterized by dense city street networks, large commercial parking lots, and multiple divided highway interchanges. There are 62 stormwater outfalls in Chelmsford alone discharging to the segment (Lowell reports were not found). Stormwater runoff from urban areas is likely the most significant source of pathogens.

Illicit Sewage Discharges: The sub-basin immediately surrounding the segment contains areas served by public sewer, and most of the watershed (81%) is designated as MS4 area. Sewer related risks include leaking infrastructure (pipes, pump stations, etc.), and sanitary sewer overflows which may be caused by undersized infrastructure, blockages, or excessive infiltration of groundwater or rainwater into pipes, exceeding system capacity. There is recent documentation of sewage grinder pumps in Chelmsford failing and leaking. See https://www.townofchelmsford.us/535/Grinder-Pumps. (Town of Chelmsford, 2014) Illicit connections of wastewater to stormwater drains are also a risk.

On-Site Wastewater Disposal Systems: There arethree(2 in the immediate drainage area) groundwater discharge permits for on-site wastewater discharge, which are large-capacity septic systems (non-residential). Given the large portion of the upper watershed not covered by sewer service, malfunctioning septic systems further upstream are also a possible source. It is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: There are three Protected and Recreational Open Spaces categorized as agricultural, although no active agricultural activities were visible on recent aerial photos. Although there might be little or no active agriculture along the segment, there are some in the upstream portions of the watershed. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: There are a few parks, ballfields, nature preserves, and hiking trails along the segment and in the surrounding neighborhoods, and many large conservation lands further upstream in the watershed. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: Conservation and recreational lands with large open mowed areas with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water.

7.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Chelmsford

All of Chelmsford is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Chelmsford (Permit ID#MAR041185) has an EPA approved Notice of Intent (NOI). Chelmsford has mapped all of its MS4 stormwater system, with a map at https://Chelmsfordma.mapgeo.io. (Town of Chelmsford, n.d., a) It adopted IDDE, ESC, and post-construction stormwater regulations in 2008-2012. A Stormwater Utility (Enterprise Fund) was initially approved but was later tabled when the 2016 MS4 General Permit was temporarily stayed. In 2017, the Town inspected many outfalls with the help of interns, similar to a formal IDDE program (that was not yet approved) and did not find any illicit connections. The Town reports that participation in Northern Middlesex Stormwater Collaborative (NMSC) has been especially helpful in reducing costs and extending accomplishments.

Chelmsford reports 62 outfalls to River Meadow Brook MA82A-10.

Stormwater page: https://www.townofchelmsford.us/375/Stormwater (Town of Chelmsford, 2020)

SWMP: on file with Department of Public Works

Chelmsford has the following ordinances and bylaws:

- Stormwater By-law, Town Bylaw Chapter 142-6: https://www.ecode360.com/8274116 (Town of Chelmsford, 2010a)
- Stormwater Utility: http://www.townofchelmsford.us/DocumentCenter/View/9473/What-Is-a-Stormwater-Utility-FAQ-2019 (Town of Chelmsford, 2019)
- Title 5 Supplemental Regulations or Bylaws: Subsurface Sewage and Wastewater Disposal; Groundwater Protection > Regulations in addition to state code, chapter 201-24: https://ecode360.com/8275342 (Town of Chelmsford, 1995)
- Wetland Bylaws: https://www.townofchelmsford.us/DocumentCenter/View/69/ChelmsfordWetlandsBylaw?bidId= (Town of Chelmsford, 2009)
- Pet Waste: Town of Chelmsford MA codes > 11-7 Nuisances, https://www.ecode360.com/8273592?highlight=&searchId=89913796297612#8273592 (Town of Chelmsford, 2006)

Chelmsford has several planning documents, including a 2010 Master Plan, and 2013 Center Village Master Plan, draft Vinal Square Master Plan, and an ongoing Zoning Bylaw Review which seeks to implement the 2010 Master Plan recommendations. The Master Plan and Vinal Square Master Plan describes the sewer infrastructure and service, at the time of the plan covering about 93% of the town and with plans to cover all areas. Despite expansion goals, the plan also mentions the need for water conservation efforts because wastewater capacity was near its limits. It also makes brief mention of stormwater. A Water Resources section is on page 259, which cites pathogen impairments, describes in detail the rivers and streams in the area, and calls for greater riparian buffers.

Chelmsford also has an Open Space and Recreation Plan, updated in 2017. It provides a brief updated natural resource inventory, related maps, and notes that the sewer coverage was completed in 2011, and that stormwater and sewer lines are separate. It also sets goals for public education on stormwater and incentivizes low impact development to protect water quality.

Planning: https://www.townofchelmsford.us/146/Current-Planning (Town of Chelmsford, 2010b)

Chelmsford's 2017 Open Space and Recreation Plan: https://www.townofchelmsford.us/AgendaCenter/ViewFile/Item/1791?fileID=2878 (Town of Chelmsford, 2017)

In Chelmsford, there have been recent cases of sewage grinder pumps malfunctioning. These pumps are used to pre-grind domestic wastewater prior to discharging into the public sewer, and pump failure represents a risk of pathogens to the environment. The responsibility for maintenance of these privately-owned pumps has been the subject of litigation. The City of Chelmsford has developed outreach materials and an emergency maintenance policy which applies during power outages.

Grinder Pump Operation and Maintenance Manual: http://www.townofchelmsford.us/DocumentCenter/View/4830 (Town of Chelmsford, n.d., b)

Grinder Pump Emergency Pump Down Policy: https://www.townofchelmsford.us/DocumentCenter/View/8637 (Town of Chelmsford, n.d., b)

Chelmsford is within the service area of Northern Middlesex Council Of Governments (NMCOG, http://www.nmcog.org/). (NMCOG, 2021).

City of Lowell, see Section 6.4.

8. MA82A-19 Pantry Brook

8.1. Waterbody Overview

Pantry Brook segment MA82A-19 is 3.1 miles long, located entirely within the Town of Sudbury. The segment begins at its headwaters just south of Julians Way, then flows southeast, then east, until its confluence with the Sudbury River (MA82A-04). The only named tributary is Cold Brook entering from the north in the lower reaches of the segment. There are several small unnamed tributaries draining wetlands or small ponds.

Major landmarks include Josiah Haynes Elementary School near the headwaters, the Morse Road Parcel conservation land, and Pantry Brook Wildlife Management Area and Great Meadows NWR at the lower end of the segment. To the south within the watershed but about 0.5 miles from the stream are a large greenhouse business and Lincoln-Sudbury Regional High School. There are only two road crossings, Marlborough Road and Pantry Road.

Pantry Brook (MA82A-19) drains an area of six square miles, of which 0.5 mi^2 (9%) is impervious and 0.2 mi^2 (3%) is directly connected impervious area (DCIA). In terms of land area, no record of sewer service in the watershed was found, and 57% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are no additional NPDES permits on file. There is one MassDEP discharge to groundwater permit for on-site wastewater discharge within this watershed (Table 8-1). See Figure 8-1.

Reduction from Highest Calculated Geomean: *NA*

Watershed Area (Acres): 3,853

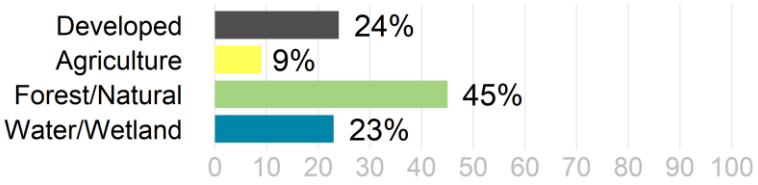
Segment Length (Miles): 3.1

Impairment(s): Fecal Coliform (Primary Contact Recreation)

Class: B

Impervious Area (Acres, %): 339 (9%)

DCIA Area (Acres, %): 124 (3%)



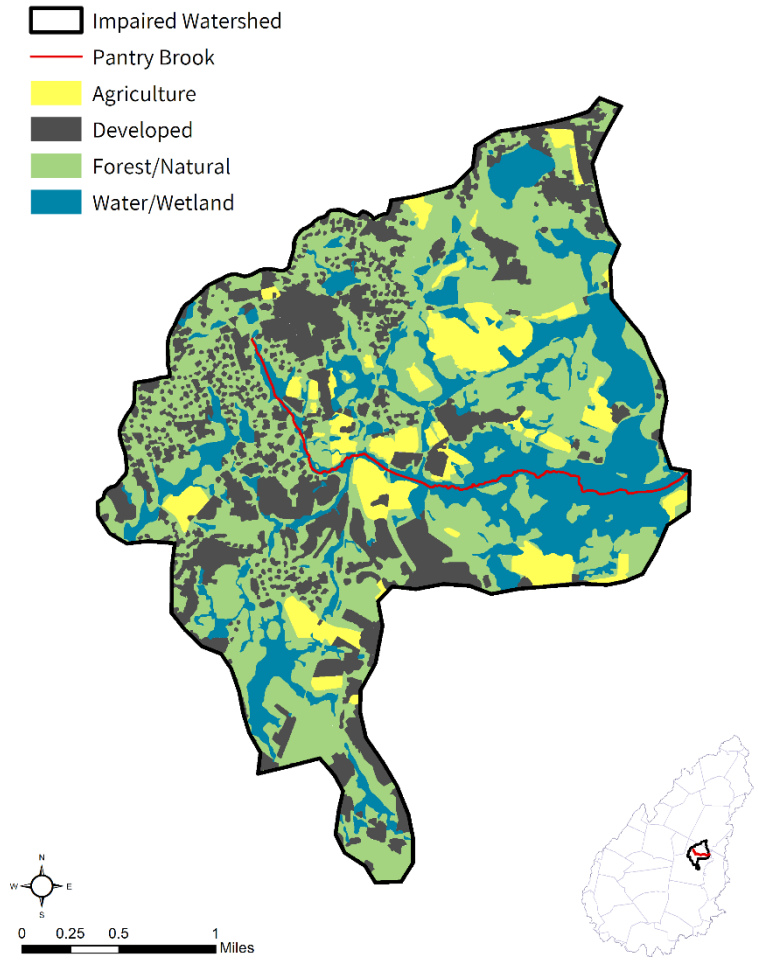


Table 8-1. Groundwater discharge permits in the segment watershed. Only permits unique to this segment watershed are shown. PERR = permit number plus renewal number. TYPE = type of groundwater discharge. Flow = permitted effluent in gallons per day (gpd).

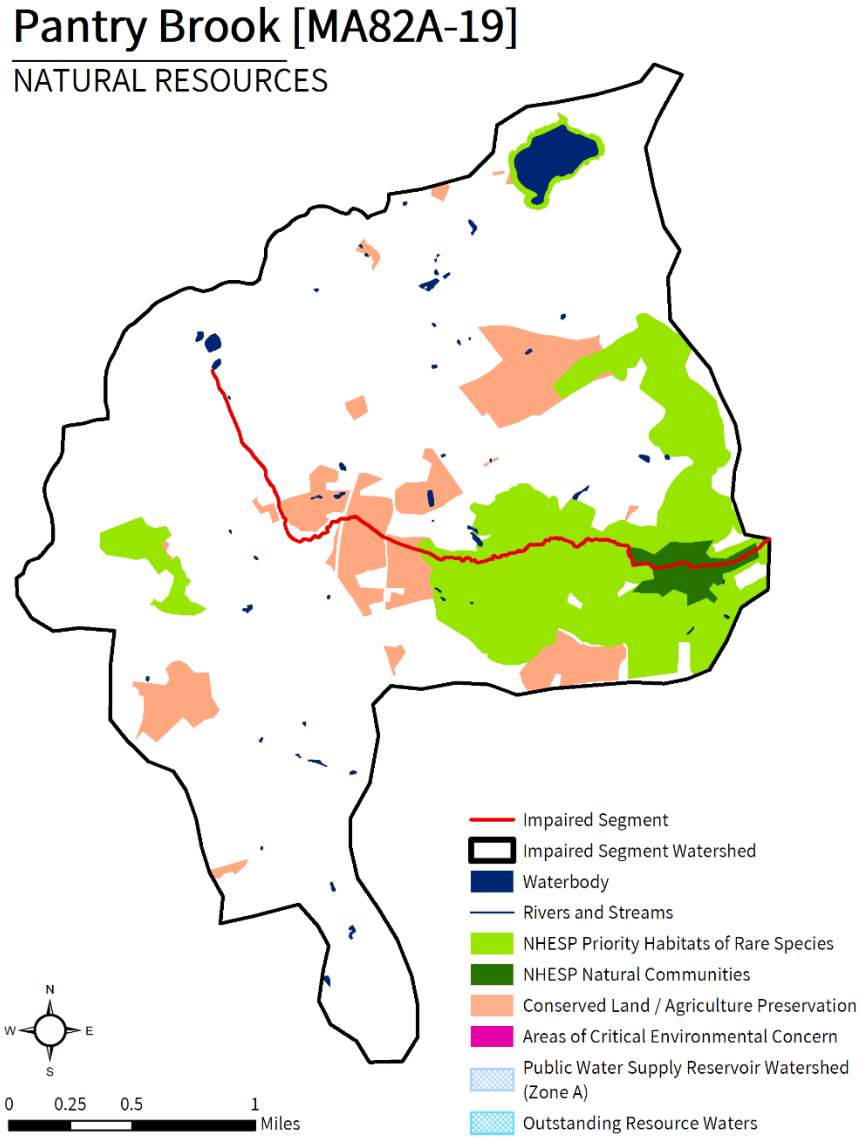
PERR	NAME	TOWN	TYPE	FLOW (GPD)
378-2	LINCOLN-SUDBURY HIGH	SUDBURY	Sanitary Discharge	20,000

The upper half of the watershed contains low to medium density residential development, a few large farm fields including some in row crops. The lower portion of the segment is dominated by large emergent and forested wetlands.

In the watershed of Pantry Brook (MA82A-19), under the Natural Heritage and Endangered Species Program, there are 47 acres (1%) of Priority Natural Vegetation Communities and 682 acres (18%) of Priority Habitats of Rare Species. Over 363 acres (9%) of land protected in perpetuity[15] exist within the segment watershed, which is part of a total of 1,286 acres (33%) of Protected and Recreational Open Space[16]. Caruso MFCLT and Barton MFCLT2 agricultural areas and the Pantry Brook Farm conservation area are close to or on the impaired segment banks. There are no Areas of Critical Environmental Concern, no areas under Public Water Supply protection, or areas identified as Outstanding Resource Waters. See Figure 8-1.

[15] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetlands restrictions, aquifer protection, historic preservation, etc. Refer to MassGIS metadata for the Protected and Recreational Open Space data layer. Land protected in perpetuity reflect watershed-wide estimates (including for watersheds that extend outside of the State of Massachusetts).

[16] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside of the State of Massachusetts).



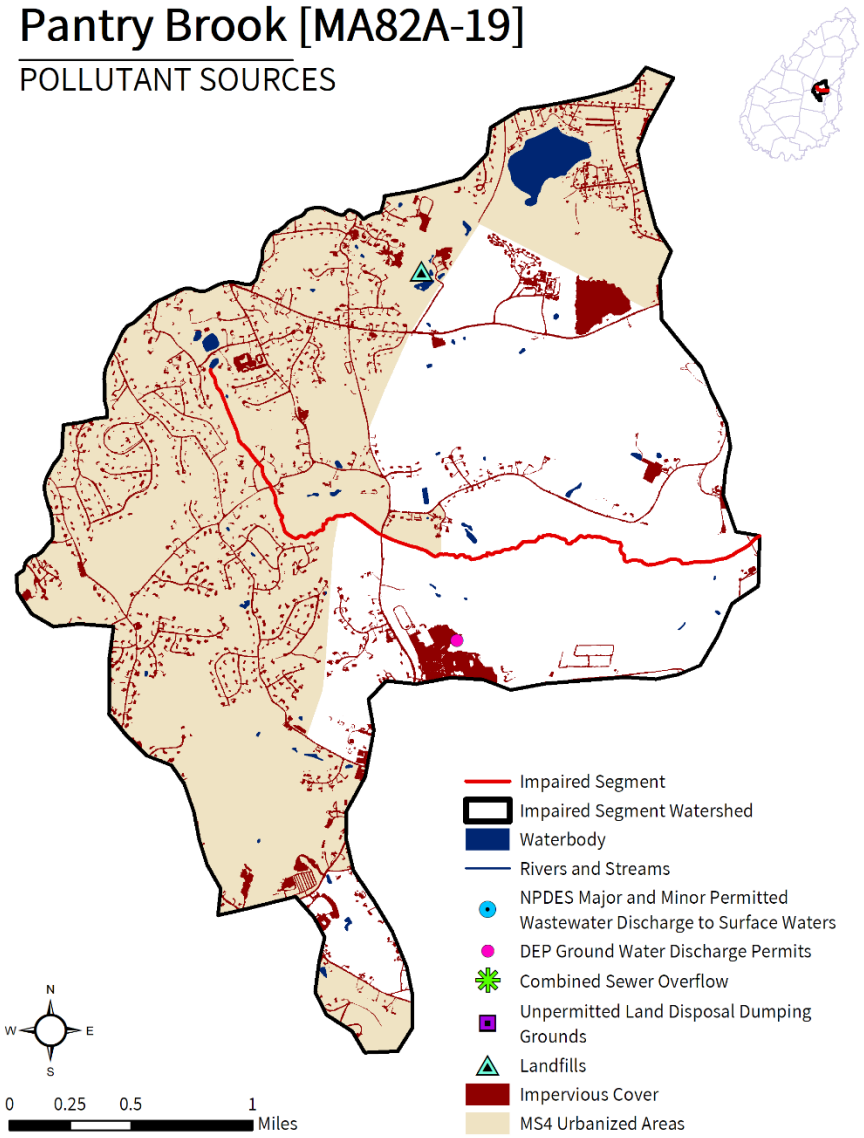


Figure 8-1. Natural resources and potential pollution sources draining to the Pantry Brook segment MA82A-19. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, permitted facilities. Note: the large block of impervious cover shown in the northern section of the watershed is a gravel pit (not impervious cover).

8.2. Waterbody Impairment Characterization

Pantry Brook (MA82A-19) is a Class B Water (MassDEP, 2021). The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria fecal coliform. No recent data are available to present here but a historic WPP monitoring station is presented (Figure 8-2). The pathogen impairment for Primary Contact Recreation for Pantry Brook (MA82A-19) was carried forward from the SuAsCo Watershed 2001 Water Quality Assessment Report (MassDEP, 2005), a report where the assessment rationale and water quality data which informed the assessment are presented.

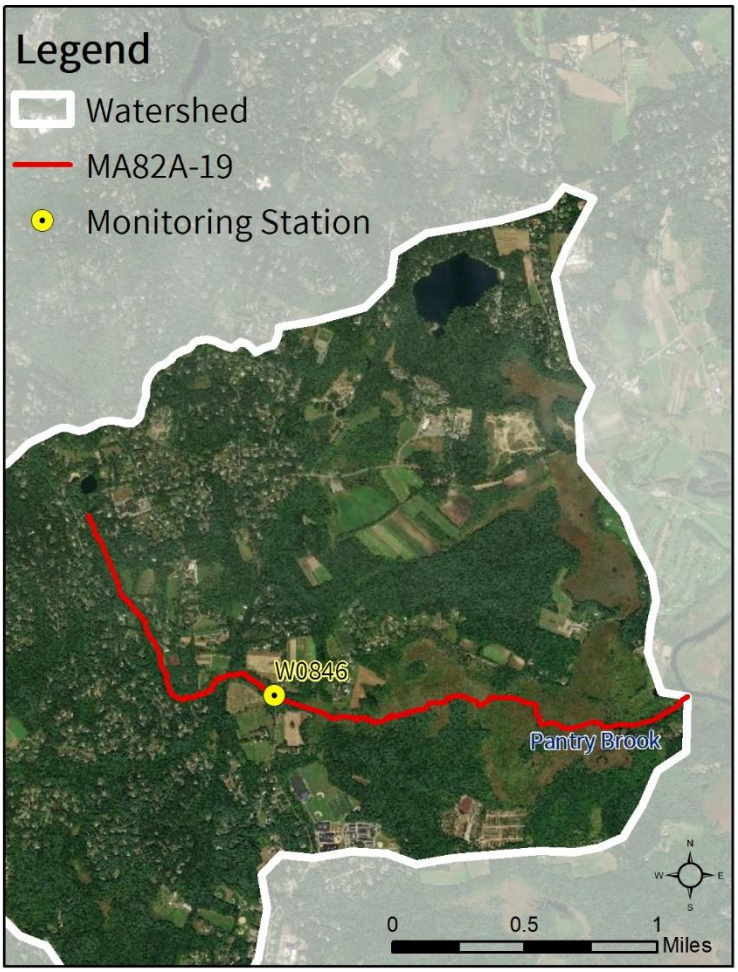


Figure 8-2. Location of monitoring station(s) along the impaired river segment.

8.3. Potential Pathogen Sources

Urban Stormwater: Most of the Pantry Brook (MA82A-19) watershed consists of low-to-medium density residential areas, with 57% of the land area in MS4 and 3% as DCIA. Over half of the land is regulated for stormwater and developed area runoff is likely the most significant source of pathogens.

Illicit Sewage Discharges: With 57% of the watershed designated as MS4 area and given the significant residential development, the most likely type of Illicit connections is from septic systems to stormwater drains.

On-Site Wastewater Disposal Systems: There is one groundwater discharge permit for on-site wastewater discharge, which is a large-capacity septic system (non-residential). With none of the land area likely in sewer service, malfunctioning septic systems are a possible source of pathogen pollutants. It is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: There are large agricultural fields including row crops near the brook. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: About 33% of the watershed is Protected and Recreational Open Space, including large wetlands in the lower portion of the river. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens. The expanse of residential neighborhoods likely includes a large dog population that defecate on lawns and/or along the streets.

Wildlife Waste: Conservation and recreational lands with large open mowed areas with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water.

8.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Sudbury. see Section 3.4.

9. MA82A-22 Unnamed Tributary

9.1. Waterbody Overview

Unnamed Tributary segment MA82A-22, locally known as Cochituate Brook, is 1.4 miles long, located just north of Exit 13 of the Massachusetts Turnpike (I-90), entirely within the Town of Framingham. It begins at the outlet of the north basin of Lake Cochituate (MA82020), flows generally northwest to its end at the confluence with the pathogen-impaired Sudbury River (MA82A-03).

Segment MA82A-22, or Cochituate Brook, in addition to Lake Cochituate, has one unnamed tributary (labeled Bannister Brook on Google Maps) draining the area just west of Exit 13 of I-90.

Major landmarks, besides I-90, include Reardon Park with ballfields abutting the stream, the Cochituate Rail Trail which runs alongside the left bank of the stream, and the commercial area just south of the Saxonville neighborhood within Framingham. The brook has two road crossings, Old Connecticut Path and School Street.

The Unnamed Tributary (MA82A-22) drains an area of 20 square miles, of which 5 mi^2 (25%) is impervious and 4 mi^2 (19%) is directly connected impervious area (DCIA). The watershed is mostly[17] served by public sewer, and 84% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are no additional NPDES permits on file. There are two MassDEP discharge to groundwater permits for on-site wastewater discharge within this watershed (Table 9-1). See Figure 9-1.

Reduction from Highest Calculated Geomean: 59%

Watershed Area (Acres): 13,036

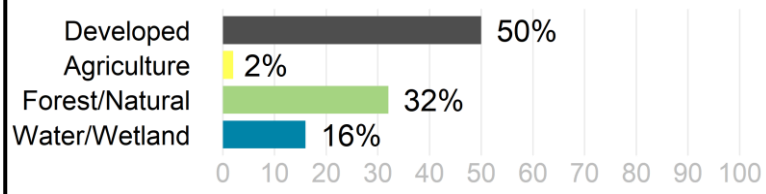
Segment Length (Miles): 1.4

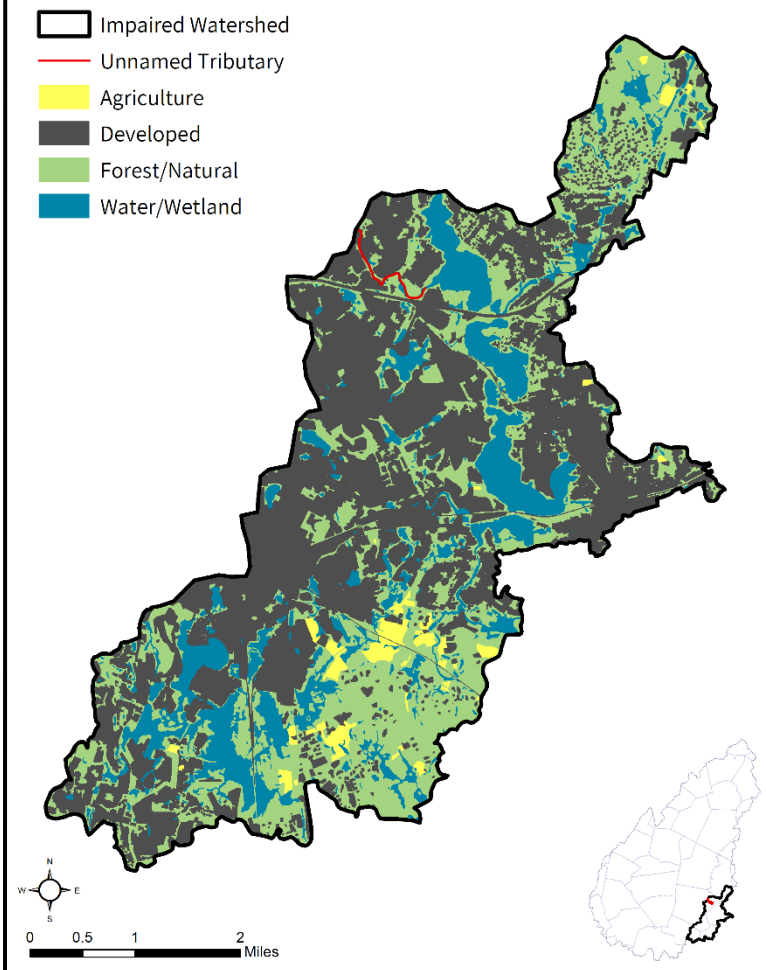
Impairment(s): *E. coli* (Primary Contact Recreation)

Class: B

Impervious Area (Acres, %): 3,267 (25%)

DCIA Area (Acres, %): 2,421 (19%)





[17] 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 https://www.mass.gov/guides/water-utility-resilience-program(MassDEP, 2020), MS4 reports, and local knowledge.

Table 9-1. 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)
604-3	HILLS @ MAINSTONE CONDO.	WAYLAND	Sanitary Discharge	36,000
650-2	MEADOWS @ MAINSTONE FARM	WAYLAND	Sanitary Discharge	24,640

The riparian corridor is dominated by high density commercial and transportation infrastructure, including an interstate interchange, a large trucking facility, other commercial buildings with expansive parking lots, and high-density residential development.

In the watershed of Unnamed Tributary (MA82A-22), under the Natural Heritage and Endangered Species Program, there are 107 acres (1%) of Priority Habitats of Rare Species. Over 354 acres (3%) of land protected in perpetuity[18] exist within the segment watershed, which is part of a total of 2,208 acres (17%) of Protected and Recreational Open Space[19]. There are no Areas of Critical Environmental Concern, no areas under Public Water Supply protection, and no areas identified as Outstanding Resource Waters. See Figure 9-1.

[18] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetlands restrictions, aquifer protection, historic preservation, etc. Refer to MassGIS metadata for the Protected and Recreational Open Space data layer. Land protected in perpetuity reflect watershed-wide estimates (including for watersheds that extend outside of the State of Massachusetts).

[19] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside of the State of Massachusetts).

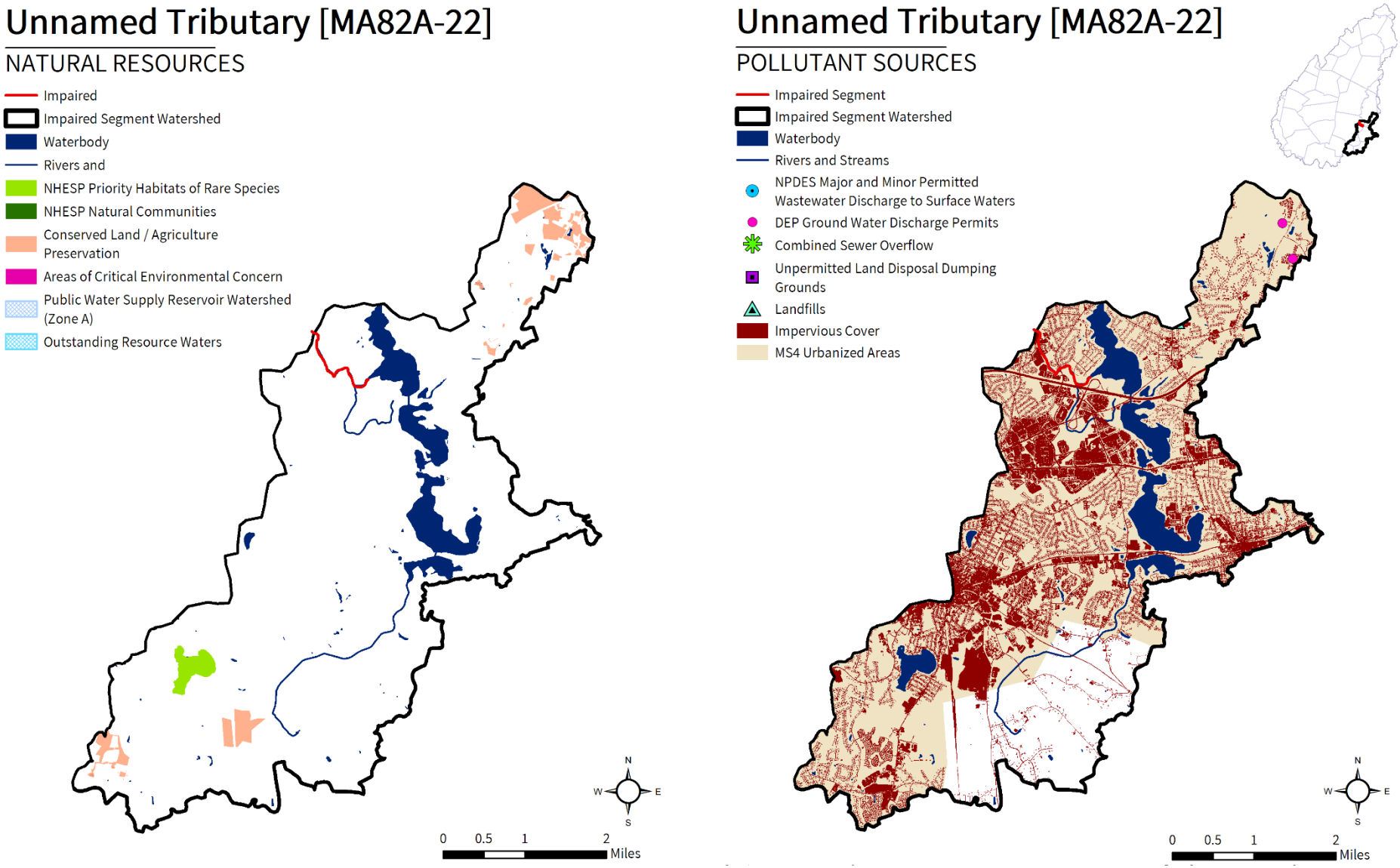


Figure 9-1. Natural resources and potential pollution sources draining to the Unnamed Tributary segment MA82A-22. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, permitted facilities.

9.2. Waterbody Impairment Characterization

The Unnamed Tributary (MA82A-22) is a Class B Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* at the station listed below (refer to Tables 9-2, 9-3; Figure 9-2). 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 2010, six samples were collected at W2135, resulting in 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 six samples, one exceeded the STV criterion during wet weather.

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

Table 9-2. Summary of indicator bacteria sampling results by station for the Unnamed Tributary (MA82A-22). 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 Statistical Threshold Value (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
W2135	5/4/10	9/13/10	6	307	5	1

Table 9-3. Indicator bacteria data by station, indicator, and date for the Unnamed Tributary (MA82A-22). Each sample date was designated wet or dry weather with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text 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 Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 90-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W2135	*E. coli*	5/4/10	DRY	70	70	
W2135	*E. coli*	6/8/10	DRY	290	142	
W2135	*E. coli*	6/24/10	WET	410	203	
W2135	*E. coli*	7/13/10	DRY	300	224	
W2135	*E. coli*	8/9/10	DRY	250	307	
W2135	*E. coli*	9/13/10	WET	190	276	

9.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present and 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 SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants, which then becomes diluted during periods of 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).

The indicator bacteria data for the Unnamed Tributary (MA82A-22) were elevated during both wet and dry weather. Elevated counts during wet weather suggest 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 wet weather indicator bacteria levels. Indicator bacteria levels were also elevated during dry weather, suggesting that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, may also be a factor.

Given the relatively small sample set, additional sampling under both wet and dry conditions, ideally at more than one location, would likely help in identifying pollutant sources.

Each potential pathogen source is described in further detail below.

Urban Stormwater: Portions of Unnamed Tributary (MA82A-22) watershed are highly developed, with 84% of the land area in MS4, 19% as DCIA, including large parking lots and transportation infrastructure and high-density residential development. Stormwater runoff from urban areas is likely the most significant source of pathogens.

Illicit Sewage Discharges: Most of the watershed is serviced by sewer and designated as MS4 area. Sewer related risks include leaking infrastructure (pipes, pump stations, etc.), and sanitary sewer overflows which may be caused by undersized infrastructure, blockages, or excessive infiltration of groundwater or rainwater into pipes, exceeding system capacity. The Town of Framingham carried out a $120M plan over the past ten years to repair and rebuild sewer infrastructure and eliminate CSO discharges, so sources should be reduced compared to the past. Illicit connections of wastewater to stormwater drains are also a risk.

On-Site Wastewater Disposal Systems: There are two groundwater discharge permits for on-site wastewater discharge, which are large-capacity septic systems (non-residential). Given the portion of the watershed not

covered by sewer service, malfunctioning septic systems are also a possible source. It is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: There are some agricultural fields, including row crops and hayfields, in the upper watershed. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: There are a few parks and ballfields adjacent to the river, plus hundreds of acres of conservation lands. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: Conservation and recreational lands with large open mowed areas with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water.

9.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Framingham

All of Framingham is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Framingham (Permit ID#MAR041116) has an EPA approved Notice of Intent (NOI) and has mapped all of its MS4 stormwater system, with an electronic map submitted with its NOI. It adopted IDDE, ESC, and post-construction stormwater regulations in 2008. Among the many activities cited in its 2018 MS4 report were a stream cleanup with OARS, expanded stormwater mapping, addressing two illicit discharges, and updating the IDDE plan in preparation for the new MS4 General Permit.

Framingham reports 20 outfalls to Unnamed Tributary (Cochituate Brook) MA82A-22.

Stormwater page: https://www.framinghamma.gov/1133/Stormwater-Management (City of Framingham, 2020)

SWMP: on file with DPW.

Framingham has the following ordinances and bylaws:

- Stormwater management in Zoning By-law, page 135: https://webapps.framinghamma.gov/WebLink/ElectronicFile.aspx?docid=1247234&dbid=0&repo=Framingham (City of Framingham, 2019)
- Wetland Bylaws: https://www.framinghamma.gov/DocumentCenter/View/421/Wetlands-Protection-Bylaw?bidId= (City of Framingham, 2005)

Framingham's two-part Master Plan (2008, 2012) has a Natural Resources and Environmental Protection section (p. 165, Part 1), a NPDES Phase II Program section (p. 161, Part 1), a Wastewater section (p. 154, Part 1), and one page dedicated to Stormwater Management, as Appendix B to Part 2. In 2008, the plan stated that the Town was engaged in a $120M effort to design and reconstruct significant parts of the sewer collection system, including eliminating CSO events, and faced a compliance deadline of 2013 regarding SSO events. Work included developing a Comprehensive Wastewater Management Plan (CWMP). https://www.framinghamma.gov/294/Framingham-Master-Plan (City of Framingham, 2014)

Framingham's Open Space and Recreation Plan is being updated in 2020: https://www.framinghamma.gov/DocumentCenter/View/12753/Final-OSRP-2013-Complete?bidId= (City of Framingham, 2013)

10. MA82A-25 Sudbury River

10.1. Waterbody Overview

The Sudbury River segment MA82A-25 is 6.3 miles long, located near Exit 22 of I-495 (intersection with the Massachusetts Turnpike, I-90). It begins at Fruit Street bridge at the border of Hopkinton and Westborough, being bound on the upstream end by a segment of the Sudbury River (MA82A-01) which is not pathogen-impaired. It then flows east to form the Hopkinton-Southborough border, then the Ashland-Southborough border, before flowing east through Ashland to end at the inlet of Framingham Reservoir #2 (MA82045, formerly part of segment MA82A-02) in Ashland.

Segment MA82A-25 contains the Whitehall Reservoir, the Westboro Reservoir, and the Ashland Reservoir. Tributaries are Whitehall Brook, Rutters Brook, and Jackstraw Brook, plus several unnamed streams draining wetlands and small ponds. Upstream of the segment is another reach of the Sudbury River (unimpaired) and Cedar Swamp Pond.

Major landmarks in the watershed, from upstream to downstream, include the Hopkinton Country Club, Southborough Rod & Gun Club recreational lands, Highland Park which abuts the river, the Cordaville neighborhood and the Southborough train station, Hopkinton State Park, Sudbury River Park and Gryncel Park which both abut the river, Ashland Fish and Game lands, downtown Ashland and train station, and the David Mindess School, and Wildwood Cemetery that abuts the lowermost portion of the segment. The road crossings, from upstream to downstream, are Fay Court, Cedar Street, Howe Street, Cordaville Road, Myrtle Street, Concord Street, Front Street, and Union Street (twice). In addition, the Boston Subdivision double track railroad runs along the river corridor and crosses the segment twice.

The Sudbury River (MA82A-25) drains an area of 43 square miles, of which 5 mi^2 (12%) is impervious and 3 mi^2 (7%) is directly connected impervious area (DCIA). The watershed is

Reduction from Highest Calculated Geomean: 53%

Watershed Area (Acres): 27,748

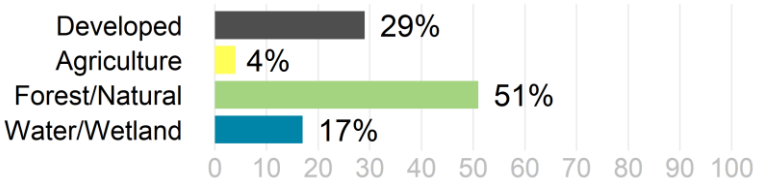
Segment Length (Miles): 6.3

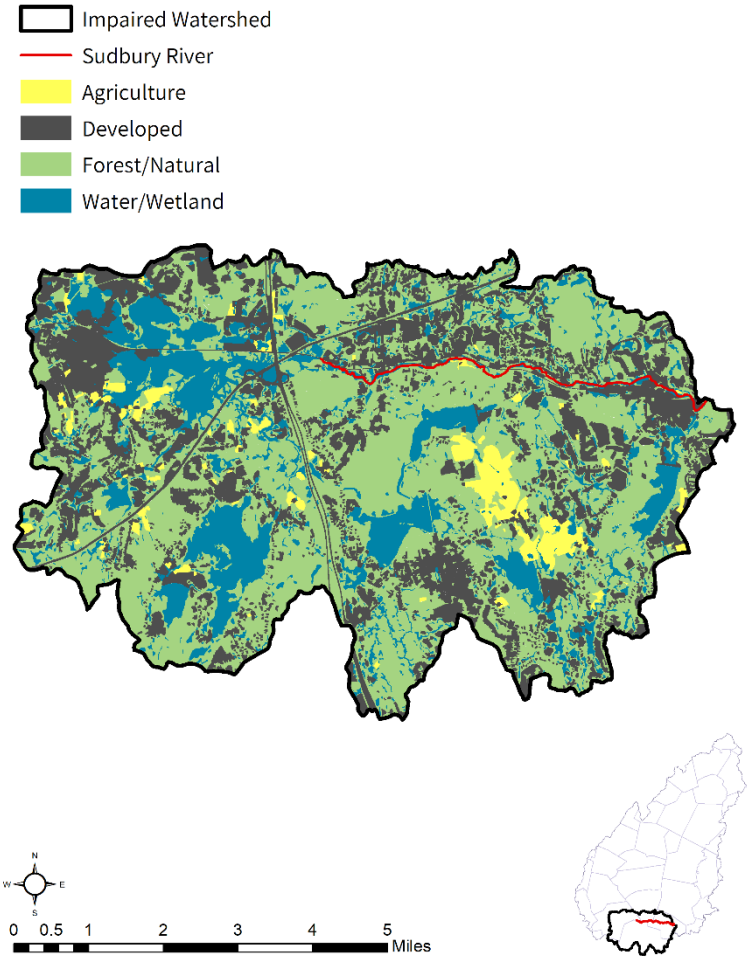
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifier): B (Warm Water , High Quality Water)

Impervious Area (Acres, %): 3,455 (12%)

DCIA Area (Acres, %): 1,877 (7%)





partially[20] served by public sewer, and 62% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are four MassDEP discharge to groundwater permits for on-site wastewater discharge within this watershed (Table 10-1). See Figure 10-1.

Table 10-1. 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)
290-4	INDIAN BROOK CONDO	HOPKINTON	Sanitary Discharge	32,400
841-1	FRUIT STREET WWTF	HOPKINTON	Sanitary Discharge	100,000
874-0M2	LEGACY FARMS	HOPKINTON	Sanitary Discharge	290,000
432-3	WEDGEWOOD CONDOMINIUMS	SOUTHBOROUGH	Sanitary Discharge	31,680

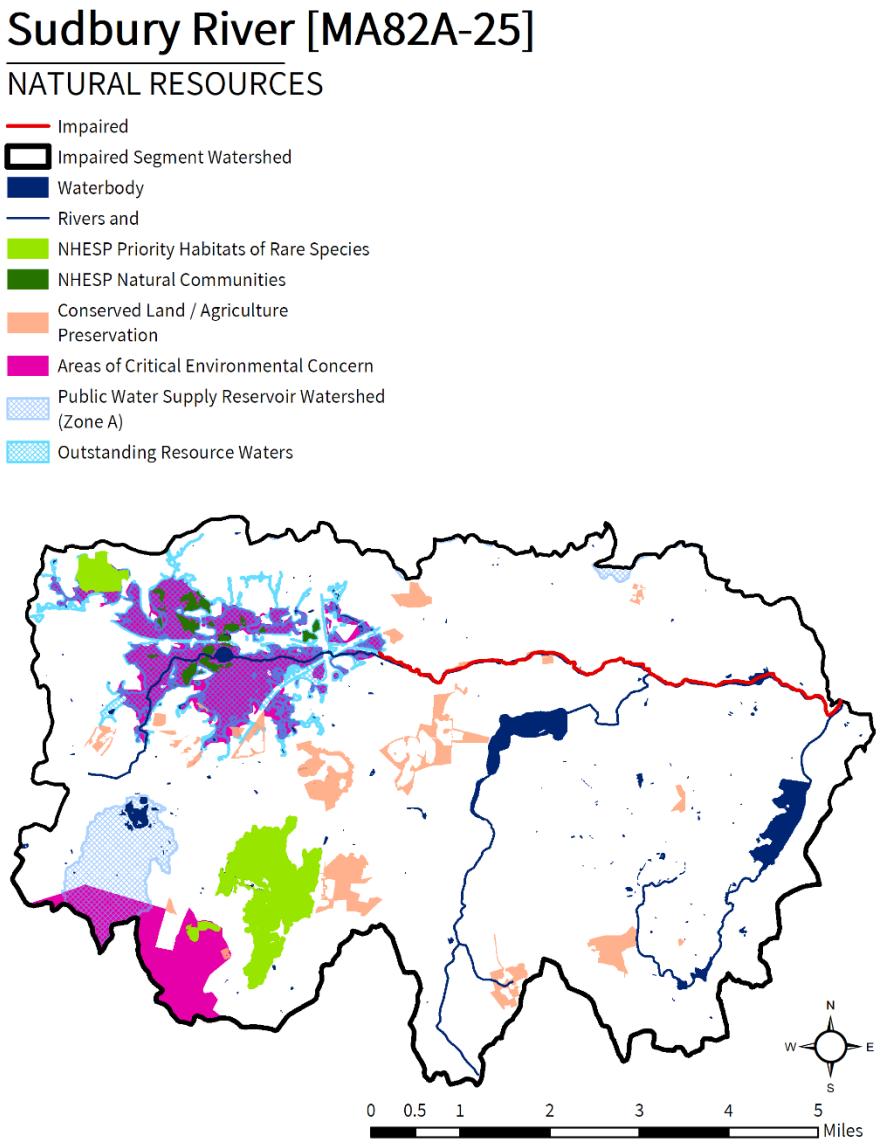
The upper area of the watershed contains large open space and recreational lands, much of which are wooded, followed by low density residential and commercial development, including areas concentrated along the riverbanks. The most downstream portion of the segment in downtown Ashland is medium to high density residential and commercial development, interspersed with large, wooded areas.

The watershed of the Sudbury River (MA82A-25) contains two Areas of Critical Environmental Concern, "Cedar Swamp" (1,650 acres) and "Miscoe, Warren and Whitehall Watersheds" (771 acres), which combined cover 2,421 acres (9%) of the land area. Under the Natural Heritage and Endangered Species Program, there are 132 acres (0.5%) of Priority Natural Vegetation Communities and 832 acres (3%) of Priority Habitats of Rare Species. Over 859 acres (3%) of land protected in perpetuity[21] exist within the segment watershed, which is part of a total of 7,527 acres (27%) of Protected and Recreational Open Space[22]. There are 843 acres under Public Water Supply protection and 1,520 acres identified as Outstanding Resource Waters. See Figure 10-1.

[20] 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 https://www.mass.gov/guides/water-utility-resilience-program(MassDEP, 2020), MS4 reports, and local knowledge.

[21] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetlands restrictions, aquifer protection, historic preservation, etc. Refer to MassGIS metadata for the Protected and Recreational Open Space data layer. Land protected in perpetuity reflect watershed-wide estimates (including for watersheds that extend outside of the State of Massachusetts).

[22] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside of the State of Massachusetts).



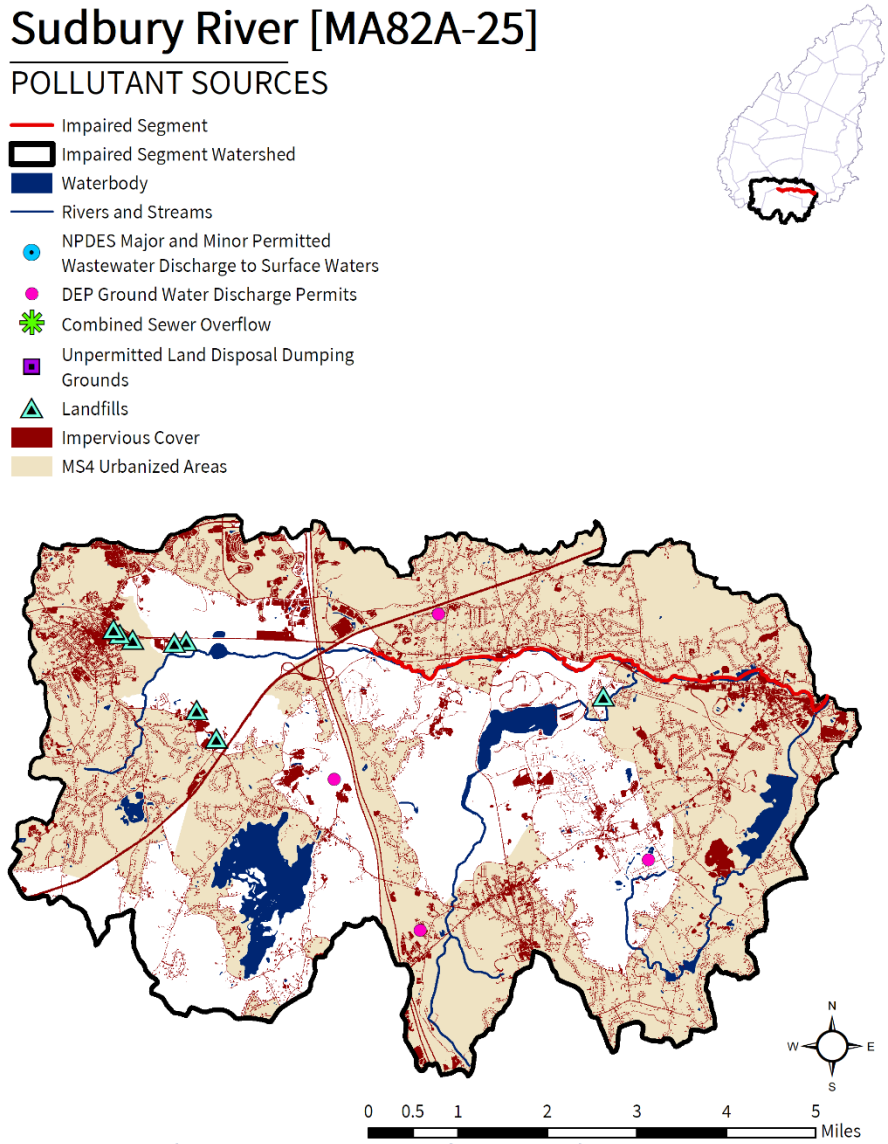


Figure 10-1. Natural resources and potential pollution sources draining to the Sudbury River segment MA82A-25. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, permitted facilities.

10.2. Waterbody Impairment Characterization

The Sudbury River (MA82A-25) is a Class B, Warm Water and High Quality Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* at the stations listed below (refer to Tables 10-2, 10-3; Figure 10-2). 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 2006, five samples were collected at W0832, resulting in one day 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, none exceeded the STV criterion.
- In 2006, five samples were collected at W0838, resulting in four 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.

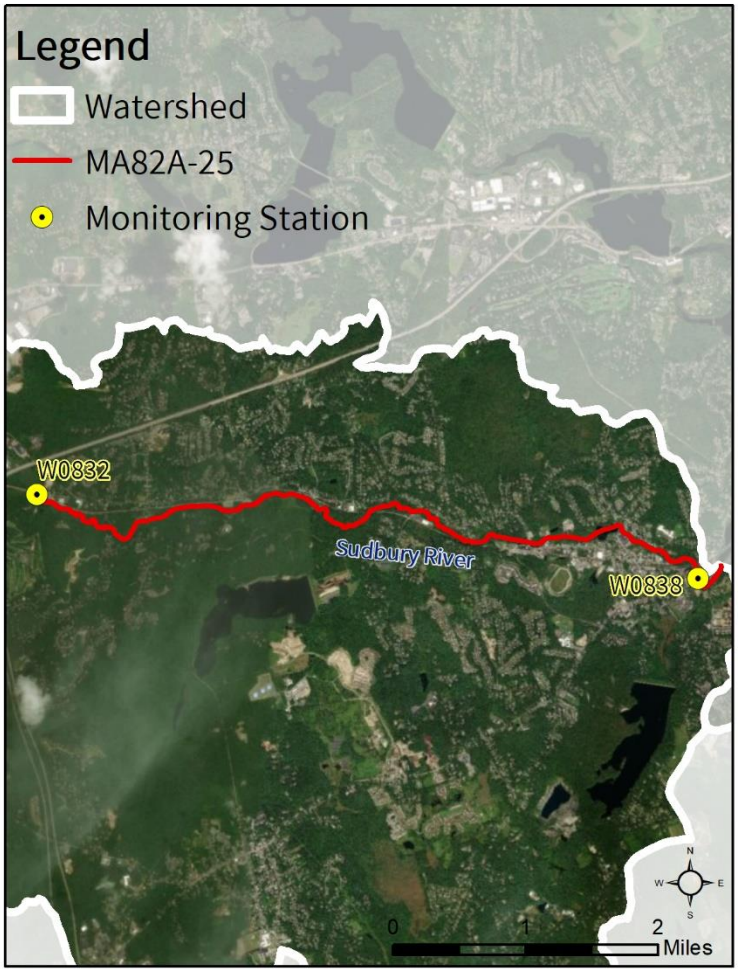


Figure 10-2. Location of monitoring station(s) along the impaired river segment.

Table 10-2. Summary of indicator bacteria sampling results by station for the Sudbury River (MA82A-25). 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 Statistical Threshold Value (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
W0832	5/4/06	9/26/06	5	127	1	0
W0838	5/4/06	9/26/06	5	270	4	1

Table 10-3. Indicator bacteria data by station, indicator, and date for the Sudbury River (MA82A-25). Each sample date was designated wet or dry weather with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text 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 Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 90-day geomean) for *E. coli* indicator bacteria

Unique Station ID	Indicator	Date	Wet/Dry	Result	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W0832	*E. coli*	5/4/06	WET	39	39	
W0832	*E. coli*	6/8/06	WET	290	106	
W0832	*E. coli*	7/20/06	DRY	71	93	
W0832	*E. coli*	8/24/06	DRY	100	127	
W0832	*E. coli*	9/26/06	DRY	45	68	
W0832	Fecal Coliform	5/4/06	WET	39		
W0832	Fecal Coliform	6/8/06	WET	250		
W0832	Fecal Coliform	7/20/06	DRY	6		
W0832	Fecal Coliform	8/24/06	DRY	32		
W0832	Fecal Coliform	9/26/06	DRY	52		
W0838	*E. coli*	5/4/06	WET	90	90	
W0838	*E. coli*	6/8/06	WET	540	220	
W0838	*E. coli*	7/20/06	DRY	130	185	
W0838	*E. coli*	8/24/06	DRY	280	270	
W0838	*E. coli*	9/26/06	DRY	190	191	
W0838	Fecal Coliform	5/4/06	WET	58		
W0838	Fecal Coliform	6/8/06	WET	610		
W0838	Fecal Coliform	7/20/06	DRY	180		
W0838	Fecal Coliform	8/24/06	DRY	250		
W0838	Fecal Coliform	9/26/06	DRY	400		

10.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present and 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 SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants, which then becomes diluted during periods of 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).

The downstream sample station (W0838) showed indicator bacteria elevated during wet weather, suggesting possible sources from 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 wet weather indicator bacteria levels.

Given the relatively small sample set, additional sampling under both wet and dry conditions would likely help in identifying pollutants sources.

Each potential pathogen source is described in further detail below.

Urban Stormwater: The Sudbury River (MA82A-25) watershed has 62% of the land area in MS4 and 7% as DCIA. The watershed overall is moderately developed, and the pattern of development concentrates along the

river corridor, especially in the lower segment. Stormwater runoff from urban areas is likely the most significant source of pathogens.

Illicit Sewage Discharges: With a portion of the watershed in sewer service and most of the watershed (62%) designated as MS4, both sanitary sewers and septic systems are possible source categories. Sewer related risks include leaking infrastructure (pipes, pump stations, etc.), and sanitary sewer overflows 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 drains are also a risk.

On-Site Wastewater Disposal Systems: There are four groundwater discharge permits for on-site wastewater discharge, which are large-capacity septic systems (non-residential). Given the large portion of the watershed not covered by sewer service, malfunctioning septic systems are also a possible source. It is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: While there is only a small amount of agriculture in the watershed, activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: There are large conservation and recreation lands in the watershed, especially around the upper portions of the river segment. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: Conservation and recreational lands with large open mowed areas with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water.

10.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Ashland

The entire area of Ashland is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. MAR041086, has an EPA approved Notice of Intent (NOI) and has mapped all of its MS4 stormwater system, with a map at https://www.ashlandmass.com/306/Stormwater-Advlsory-Commlttee. (Town of Ashland, 2020) It adopted IDDE, ESC, and post-construction stormwater regulations in 2007-08. There are 15 reported outfalls to Sudbury River MA82A-25. A Stormwater Utility (Enterprise Fund) is planned. Town does not currently have stable funding for MS4. Supplemental connection to MWRA (Massachusetts Water Resources Authority).

Stormwater page: https://www.ashlandmass.com/524/Stormwater---NPDES (Town of Ashland, n.d., a)

SWMP: components at stormwater page above, completion was anticipated in fall of 2018, according to 2018 MS4 report.

Ashland has the following ordinances and bylaws:

- Stormwater Management Bylaw: https://www.ashlandmass.com/DocumentCenter/View/501/Stormwater-Management-Bylaw-PDF?bidId= (Town of Ashland, 2007)
- Proposed Stormwater Utility (Enterprise Fund), presented in November 2018: https://www.ashlandmass.com/DocumentCenter/View/4206/11-28-2018-Stormwater-Utility-Presentation?bidId= (Town of Ashland, 2018)
- Sewer Betterment Assessment Chapter 235 of Town of Ashland Code: https://ecode360.com/13018238. (Town of Ashland, 2000). Chapter 303 is in adherence to Title V: https://ecode360.com/13018257 (Town of Ashland, 2010a)
- Open Space, limited section on Design Standards > Section 344-16: https://ecode360.com/12612537 (Town of Ashland, n.d., b)
- Wetlands Protection: Ashland Town Codes > Chapter 280: https://ecode360.com/13018248 (Town of Ashland, 2009)

- Pet Waste: Town of Ashland codes > Dog Waste Disposal: https://ecode360.com/12609861 (Town of Ashland, 2013)

Ashland has a 2003 Comprehensive Plan, and a *draft Plan Ashland, Comprehensive Plan Community Vision, Goals and Land Use Element*. See https://www.ashlandmass.com/513/Resources. (Town of Ashland, 2016). The plan mentions the Stormwater bylaw but does not go into detail regarding pathogen-impaired waters or the impaired segment specifically.

Ashland's 2010 Open Space and Recreation Plan: http://www.ashlandopenspace.org/ (Town of Ashland, 2010b)

Ashland is part of the MetroWest Regional Collaborative (MWRC) within the Metropolitan Area Planning Council (MAPC, http://www.mapc.org/). (MAPC, 2021).

Town of Hopkinton

Most of Hopkinton is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Hopkinton (Permit ID#MAR041124) has an EPA approved Notice of Intent (NOI) and has mapped all of its MS4 stormwater system, with an electronic map as part of its NOI. It adopted IDDE regulations in 2017, and ESC and post-construction stormwater regulations in 2008. Among the actions taken during the 2017-18 reporting period was redeveloping the DPW facility with many stormwater structural improvements. Hopkinton reports no stormwater outfalls directly to a pathogen-impaired river.

Stormwater page: http://www.hopkintonma.gov/departments/department_of_public_works/Stormwater.php (Town of Hopkinton, 2016)

SWMP: NOI states it will be completed in 2018-19 permit year.

Hopkinton has the following ordinances and bylaws:

- Stormwater Management and Erosion Control Bylaw (Chapter 172 of General Bylaws): https://www.hopkintonma.gov/General%20Bylaw%20Book%202018%20[Final].pdf (Town of Hopkinton, 2018)
- Stormwater Regulations: http://www.mapc.org/wp-content/uploads/2017/11/Hopkinton-Stormwater-Regulations-2008-Final-Adopted.pdf (Town of Hopkinton, 2008)
- Wetland Protection Regulations: https://www.hopkintonma.gov/Departments/Land%20Use%20Planning%20&%20Permitting/Conservation%20Commission/Town%20of%20Hopkinton%20Wetlands%20Protection%20Regulations%20February%2011,%202013.pdf (Town of Hopkinton, 2013b)

Hopkinton's 2007 Master Plan's Natural Resources and Open Space Resources, Water Resources section is on page 21, including a list of 303(d) Category 5 waters, and mentions the need to protect all waters from polluted stormwater. In the section on sewer service (p. 53-54), the plan states that sewer service has generally only been extended into areas that were densely developed and experiencing severe wastewater related problems. Future extensions of sewer service are discouraged, since they would increase development density. http://www.hopkintonma.gov/Businesses/eGovernment/Minutes%20&%20Documents/Hopkinton%20Master%20Plan%202007.pdf (Town of Hopkinton, 2007)

Hopkinton's 2013 Open Space and Recreation Plan https://drive.google.com/file/d/12lF7pM8pFm4-grJK6sQSL8NxbYeaWqYk/view (Town of Hopkinton, 2013a)
Hopkinton is part of the South West Advisory Planning Committee (SWAP) within the Metropolitan Area Planning Council (MAPC, http://www.mapc.org/). (MAPC, 2021).

Town of Southborough

The entire area of Southborough is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Southborough (Permit ID#MAR041160) has an EPA approved Notice of Intent (NOI) and has mapped all of its MS4 stormwater system, with a map submitted with its NOI. It adopted IDDE, ESC, and post-construction stormwater regulations in 2006. Its most recent MS4 report indicates that four illicit discharges

were found during the reporting period which require further investigation. Southborough reports 28 outfalls to the Sudbury River MA82A-25.

Stormwater page: https://www.southboroughtown.com/highway/pages/stormwater-management-information (Town of Southborough, n.d., c)

SWMP: https://www.southboroughtown.com/public-works-dpw/files/southborough-stormwater-management-plan (Town of Southborough, 2003)

Southborough has the following ordinances and bylaws:

- Stormwater Ordinance or Bylaws: https://ecode360.com/9540541 (Town of Southborough, n.d., b)
- Stormwater Utility (or similar): None found.
- Title 5 Supplemental Regulations or Bylaws: Yes, Town of Southborough Codes, chapter 223-7: https://ecode360.com/9540880 (Town of Southborough, n.d., a)
- Wetlands: Town of Southborough Codes, Chapter 170 Wetlands Protection: https://ecode360.com/9539470 (Town of Southborough, 1995)
- Pet Waste: Town of Southborough Codes, chapter 81-11 > Removal of dog litter: https://ecode360.com/31593892 (Town of Southborough, 2016)
- Contact Recreation Regulations or Bylaws: None found.
- Lower Impact Development Bylaws: https://www.southboroughtown.com/planning/files/special-permit-lower-impact-development-lid-bylaws (Town of Southborough, 2015a) and Regulations: https://www.southboroughtown.com/planning/files/special-permit-lower-impact-development-lid-regulations (Town of Southborough, 2015b)

Southborough's 2008 Master Plan states the town has no sewer system at all, though 85% of the town is on public water. The plan cites the work of residents in forming the group Sudbury Watershed Monitoring and Protection (SWAMP). It also mentions the Lower Impact Development bylaws and regulations, approved in 2006, which require developers to consider stormwater and impervious surfaces. https://www.southboroughtown.com/planning/pages/master-plandocuments (Town of Southborough, 2008)

An Open Space and Recreation Plan is in progress.

Southborough is part of the MetroWest Regional Collaborative (MWRC) within the Metropolitan Area Planning Council (MAPC, http://www.mapc.org/). (MAPC, 2021).

Town of Westborough

The entire town of Westborough is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Westborough (Permit ID#MAR041173) has an EPA approved Notice of Intent (NOI) and has mapped all of its MS4 stormwater system, with a paper map filed with its NOI, and GIS map on file with the Town. It adopted IDDE, ESC, and post-construction stormwater regulations in 2008. The MS4 report for the 2017-18 year outlined many successful stormwater-related activities, but also cites the need for dedicated funding and that a stormwater utility may be required.

Stormwater page: https://www.town.westborough.ma.us/town-engineer/pages/stormwater-information (Town of Westborough, 2019b)

SWMP: on file with DPW.

Westborough has the following ordinances and bylaws:

- Stormwater Ordinance or Bylawshttps://www.town.westborough.ma.us/sites/g/files/vyhlif5176/f/uploads/general_bylaws_through_atm_2019_final.pdf (Town of Westborough, 2019a)
- Stormwater Utility (or similar): Recommended in 2018 Open Space and Recreation Plan: https://www.town.westborough.ma.us/conservation-commission/news/approved-open-space-and-recreation-plan (Town of Westborough, 2018)
- Title 5 Supplemental Regulations or Bylaws: Not found.

- Wetlands: https://www.town.westborough.ma.us/sites/g/files/vyhlif5176/f/uploads/westboroughwetlandsregulations_amended_05082012.pdf (Town of Westborough, 2012)
- Pet Waste: General Bylaws – Article 38 – Animal Control. Section 4 – Restraint, Page 53: https://www.town.westborough.ma.us/sites/g/files/vyhlif5176/f/uploads/general_bylaws_through_atm_2019_final.pdf (Town of Westborough, 2019a)
- Illicit discharges covered in General Bylaws. Article 55 - Discharges to Municipal Storm Drain Systems. General Bylaws, Page 83: https://www.town.westborough.ma.us/sites/g/files/vyhlif5176/f/uploads/general_bylaws_through_atm_2019_final.pdf (Town of Westborough, 2019a)

Westborough's 2003 Master Plan discusses water resources in Section 5.1, pathogen impairments in Section 5.2, wastewater in Section 7.6.2, and stormwater in Section 13.1. It states 80-85% of the town is on sewer, with Public Works Department pursuing a *Sewer Facilities Master Plan* that would eventually extend sewer service throughout town. The plan also includes a buildout analysis of future wastewater needs. https://www.town.westborough.ma.us/planning/pages/2003-master-plan (Town of Westborough, 2003)

Westborough's 2018 Open Space and Recreation Plan contains an updated natural resource inventory and documents many recent stormwater management installations and practices. It also cites strong public support for increased stormwater management, including the creation of a stormwater enterprise fund (stormwater utility). https://www.town.westborough.ma.us/conservation-commission/news/approved-open-space-and-recreation-plan (Town of Westborough, 2018)

Westborough is within the service area of Central Massachusetts Regional Planning Commission (CMRPC, http://www.cmrpc.org/). (CMRPC, 2021).

11. MA82A-34 Beaver Brook

11.1. Waterbody Overview

Beaver Brook segment MA82A-34 is 6.3 miles long, located just southwest of the junction of I-495 and US Route 3. The segment begins at the brook's headwaters, south of Rack Road, Chelmsford, then flows southwest into Westford before turning east then northeast back into Chelmsford. The segment ends at its confluence with pathogen-impaired River Meadow Brook (MA82A-10) in Chelmsford. Beaver Brook has several unnamed tributaries draining small ponds and wetlands and flows through Tadmuck Swamp near its crossing with I-495.

Major landmarks in the watershed include I-495 at and around the Massachusetts Visitors Center, Cider Mill Pond Conservation Area, Mystery Spring conservation area, the mostly forested wetland Tadmuck Swamp, the Bruce Freeman Rail Trail which runs adjacent to portions of the brook, and downtown Chelmsford at Central Square. There are seven road crossings upstream of I-495, including Pine Hill Road in Westford. Downstream of I-495, the major crossings are Littleton Road in Westford, and Garrison Road, Hunt Road, MA-110/Littleton Road (twice), MA-4/Central Square/Boston Road under which the river is culverted for 78 meters, and Summer Street in Chelmsford.

Beaver Brook (MA82A-34) drains an area of 5.6 square miles, of which 0.9 mi^2 (16%) is impervious and 0.5 mi^2 (9%) is directly connected impervious area (DCIA). City of Chelmsford planning documents indicate over 90% of downtown areas are served by public sewer, and online infrastructure maps[23] indicate sewer service throughout the city. The entire watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are no additional NPDES permits on file. There is one MassDEP discharge to groundwater permit for on-site wastewater discharge within this watershed (Table 11-1). See Figure 11-1.

Reduction from Highest Calculated Geomean: 38%

Watershed Area (Acres): 3,575

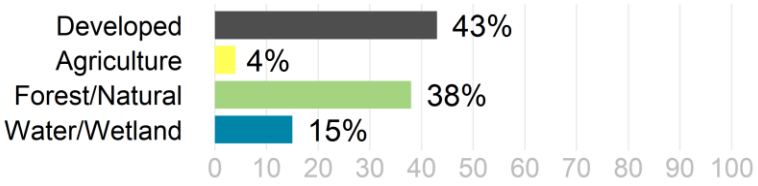
Segment Length (Miles): 6.3

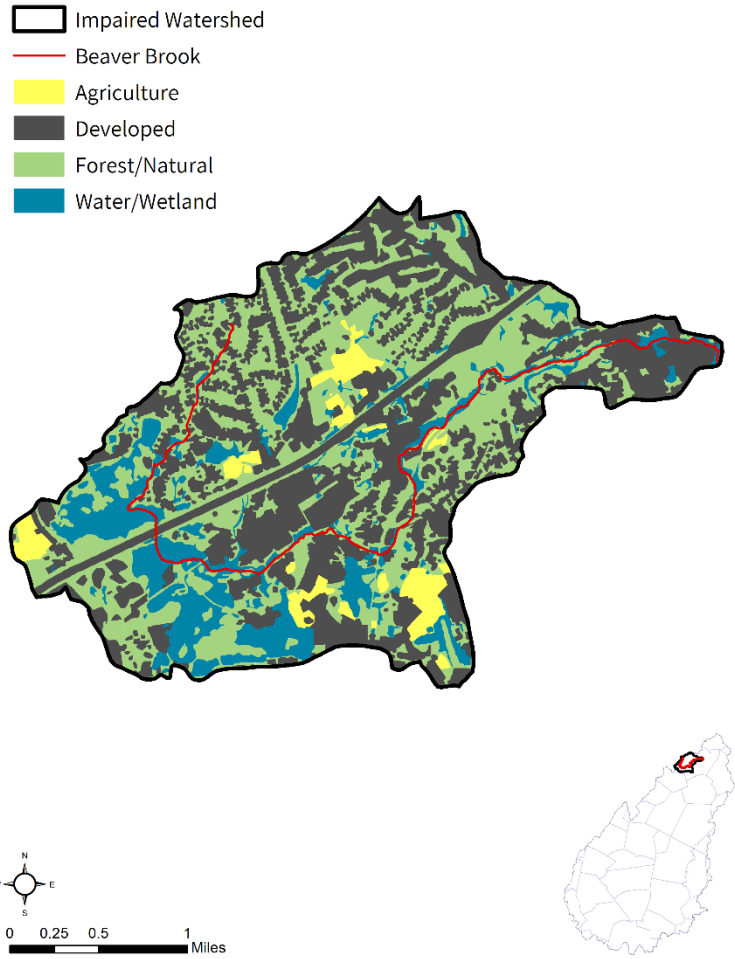
Impairment(s): *E. coli* (Primary Contact Recreation)

Class: B

Impervious Area (Acres, %): 567 (16%)

DCIA Area (Acres, %): 304 (9%)





[23] https://www.townofchelmsford.us/504/GIS-Mapping

Table 11-1. 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).

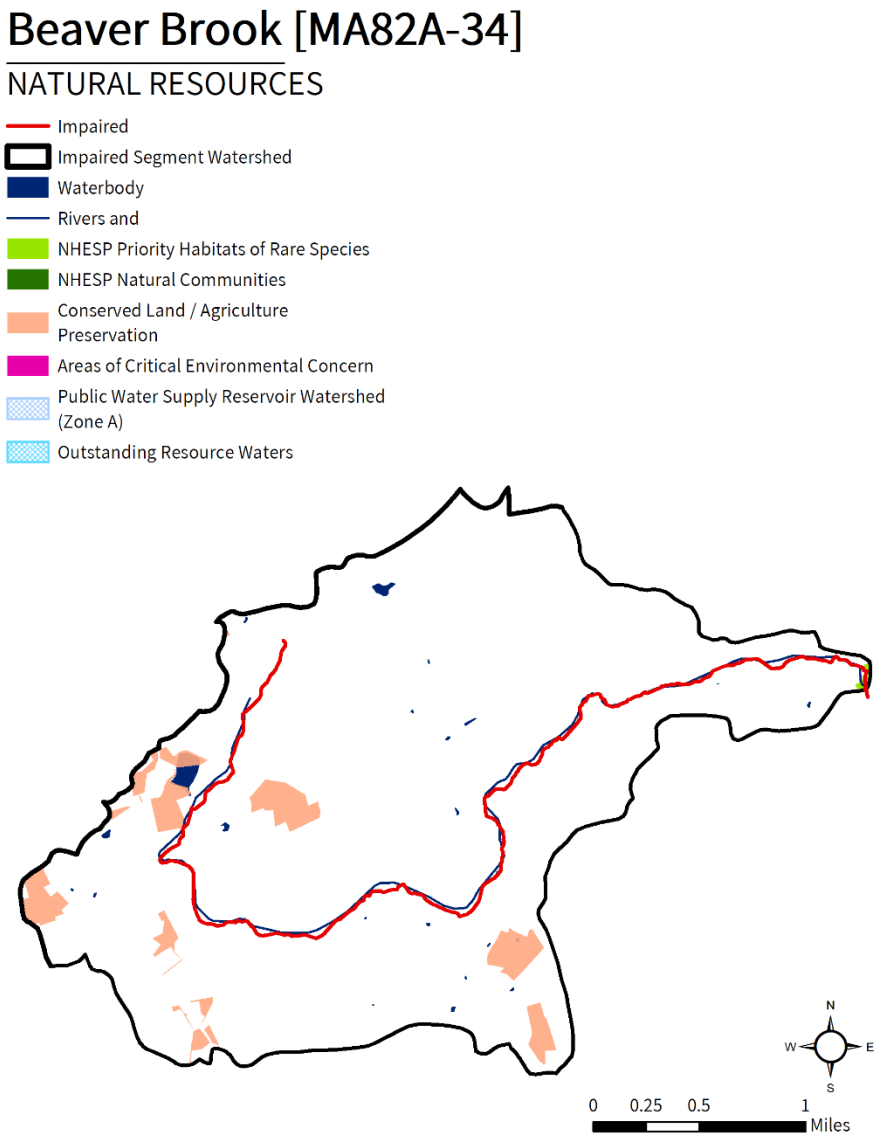
PERR	NAME	TOWN	TYPE	FLOW (GPD)
927-0	PRINCETON WESTFORD APARTMENT HOMES	WESTFORD	Sanitary Discharge	39,220

The upper watershed consists of low-density residential development interspersed with conservation lands, farms, and wetlands. Downstream of the I-495 crossing, the watershed and river corridor show increasingly dense commercial and residential development in the area around Chelmsford Commons, including a high-density mobile home park abutting the river, and medium-density commercial and residential development. Further downstream, the riparian corridor contains open meadow wetlands about 50 m wide and tracts of woods. The lowest reaches of the segment at downtown Chelmsford are dominated by medium-density residential and high-density commercial development (Central Square) within which the stream is channelized between parking lots and buildings or culverted, followed by medium-density residential development and some open wetland at the segment end.

In the watershed of Beaver Brook (MA82A-34), under the Natural Heritage and Endangered Species Program, there are three acres (0.1%) of Priority Habitats of Rare Species. Over 144 acres (4%) of land protected in perpetuity[24] exist within the segment watershed, which is part of a total of 323 acres (4%) of Protected and Recreational Open Space[25]. There are no Areas of Critical Environmental Concern, no areas under Public Water Supply protection, and no areas identified as Outstanding Resource Waters. See Figure 11-1.

[24] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetlands restrictions, aquifer protection, historic preservation, etc. Refer to MassGIS metadata for the Protected and Recreational Open Space data layer. Land protected in perpetuity reflect watershed-wide estimates (including for watersheds that extend outside of the State of Massachusetts).

[25] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside of the State of Massachusetts).



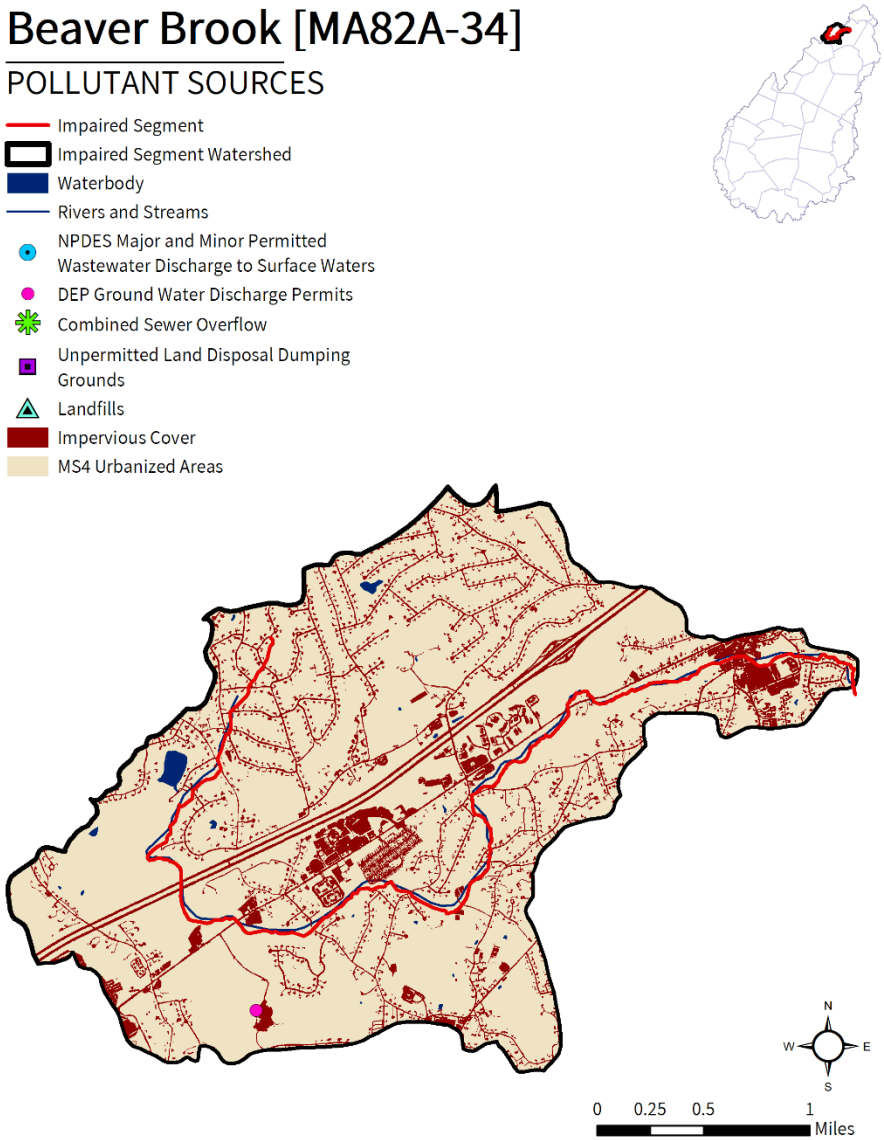


Figure 11-1. Natural resources and potential pollution sources draining to the Beaver Brook segment MA82A-34. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, permitted facilities.

11.2. Waterbody Impairment Characterization

Beaver Brook (MA82A-34) is a Class B Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* at the station listed below (refer to Tables 11-2, 11-3; Figure 11-2). 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 2010, six samples were collected at W2130, resulting in six 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 six samples, one exceeded the STV criterion during dry weather.

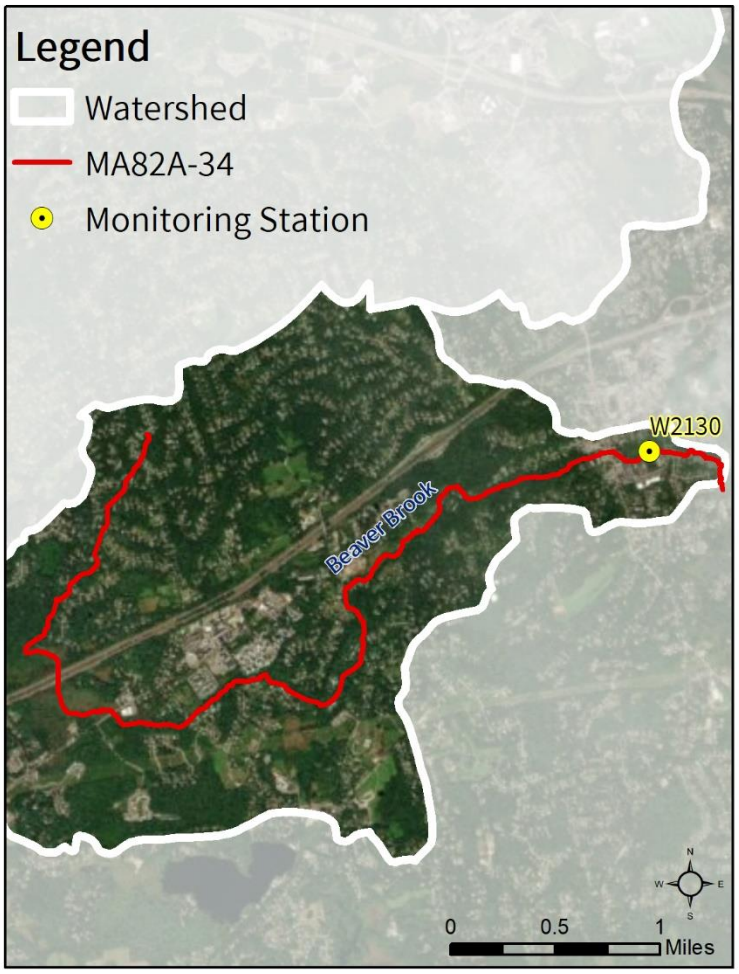


Figure 11-2. Location of monitoring station(s) along the impaired river segment.

Table 11-2. Summary of indicator bacteria sampling results by station for Beaver Brook (MA82A-34). 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 Statistical Threshold Value (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
W2130	5/11/10	9/21/10	6	204	6	1

Table 11-3. Indicator bacteria data by station, indicator, and date for the Beaver Brook (MA82A-34). Each sample date was designated wet or dry weather with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text 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 Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 90-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W2130	*E. coli*	5/11/10	WET	180	180	
W2130	*E. coli*	6/15/10	DRY	220	199	
W2130	*E. coli*	7/1/10	DRY	110	163	
W2130	*E. coli*	7/20/10	DRY	140	157	
W2130	*E. coli*	8/16/10	DRY	510	204	
W2130	*E. coli*	9/21/10	DRY	110	171	

11.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present and 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 SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants, which then becomes diluted during periods of 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).

The indicator bacteria data for Beaver Brook (MA82A-34) were elevated during wet weather, suggesting that urban stormwater, pet waste, and wildlife are potential 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 wet weather indicator bacteria levels. Given the relatively small sample set, additional sampling under both wet and dry conditions, ideally at more than one location, would help in identifying pathogen sources.

Each potential pathogen source is described in further detail below.

Urban Stormwater: Portions of Beaver Brook (MA82A-34) watershed are highly developed, with the entire land area in MS4 and 9% as DCIA, as well as areas of dense commercial and residential neighborhoods. Stormwater runoff from urban areas is likely the most significant source of pathogens.

Illicit Sewage Discharges: Nearly the entire watershed is serviced by sewer and designated as MS4 area. Sewer related risks include leaking infrastructure (pipes, pump stations, etc.), and sanitary sewer overflows 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 drains are also a risk.

On-Site Wastewater Disposal Systems: There is one groundwater discharge permit for on-site wastewater discharge, which is a large-capacity septic system (non-residential). It is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Agricultural activities visible on recent aerial photos include open fields and row crops and nearby pasture through which a tributary to Beaver Brook flows. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: The upper watershed contains conservation lands and wetlands. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: Conservation and recreational lands with large open mowed areas with a clear sightline to a waterbody may attract excessive waterfowl and elevate pathogen counts in the water.

11.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Chelmsford. see Section 7.4.

Town of Westford

Almost all of Westford is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Westford (Permit ID#MAR041232) has an EPA approved Notice of Intent (NOI). However, only about half of the length of Nashoba Brook MA82B-14 is within the MS4 area. It has mapped all of its MS4 stormwater system, with a map submitted with its NOI. It adopted IDDE, ESC, and post-construction stormwater regulations in 2008. In 2017, the Town received a Section 319 grant to develop a Stormwater Utility to ensure stable funding to implement the SWMP. The most recent MS4 report lists two outfalls to Nashoba Brook MA82B-14 and its tributaries/wetlands.

Stormwater page: https://westfordma.gov/183/Stormwater (Town of Westford, 2018b)

SWMP: https://www.westfordma.gov/339/Managing-Our-Stormwater (Town of Westford, 2017) and https://westfordma.gov/DocumentCenter/View/4236/c-Summer2015FactSheet?bidId= (Town of Westford, 2015)

Westford has the following ordinances and bylaws:

- Stormwater Ordinance or Bylaws: https://westfordma.gov/DocumentCenter/View/830/Bylaws-Chapter-147---Stormwater-Management-PDF (Town of Westford, 2008)
- Stormwater Utility (or similar): No but grant funding for this purpose received in 2017.
- Title 5 Supplemental Regulations or Bylaws: https://westfordma.gov/281/Septic-Systems-Title-5 (Town of Westford, 2019)
- Wetlands: https://www.westfordma.gov/DocumentCenter/View/2577/Wetlands-Bylaw-PDF?bidId= (Town of Westford, 2012)
- Pet Waste: https://www.westfordma.gov/CivicAlerts.aspx?AID=861 (Town of Westford, 2020)

Westford's 2009 Comprehensive Plan has a water resources section, including an impervious surface analysis for each subwatershed in town. The plan states that development on remaining "Approval Not Required" lots may occur in conflict with stormwater needs. It also recommends that the town monitor the effectiveness of LID and stormwater activities. https://westfordma.gov/DocumentCenter/View/728/2009-Comprehensive-Master-Plan-PDF?bidId= (Town of Westford, 2009)

Westford's 2018 draft Open Space and Recreation Plan contains recommendations relevant to water quality, including more complete vegetative zones around waterbodies, continued monitoring, and continued enforcement and enhancement of water protection bylaws and regulations. https://westfordma.gov/DocumentCenter/View/6721/2018-Open-Space-and-Recreation-Plan---DRAFT (Town of Westford, 2018a)

Westford is within the service area of Northern Middlesex Council Of Governments (NMCOG, http://www.nmcog.org/). (NMCOG, 2021)

12. MA82B-02 Assabet River

12.1. Waterbody Overview

The Assabet River segment MA82B-02 is 3.8 miles long, located about four miles west of the I-495 corridor. It begins at the Westborough WWTP discharge (NPDES: MA0100412) near Meadow Road in Westborough, then flows north, forming a portion of the Westborough-Northborough municipal border, then continues north to end at US Route 20/Main Street in Northborough. The segment is bound at the upstream end by another Assabet River segment and the stream draining Hocomonco Pond (MA82060), and at the downstream end by pathogen-impaired segment MA82B-03 of the Assabet River. Its tributaries include Hop Brook and several unnamed tributaries.

Major landmarks in the watershed, proceeding downstream, are Indian Meadows Golf Course which abuts the river, Wayne F. McCallum Wildlife Management Area, the South Street Park/Ellsworth McAfee Park with ballfields within about 50 meters of the river, and Juniper Hill Golf Course where the river flows through several greens without any naturalized vegetative buffer. Road crossings include Turnpike Road/MA-9 in Westborough, a divided highway; Davis Street and South Street along the Westborough-Northborough border; and School Street and Brigham Street in Northborough. The Fitchburg Subdivision railroad also crosses the segment near the downstream end.

The Assabet River segment MA82B-02 drains an area of 20 square miles, of which 3 mi^2 (14%) is impervious and 2 mi^2 (8%) is directly connected impervious area (DCIA). The watershed is partially[26] served by public sewer, and 97% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There is one NPDES wastewater treatment facility permit on file governing point source discharges of pollutants to surface waters (Table 12-1). See Figure 12-1.

Reduction from Highest Calculated Geomean: 96%

Watershed Area (Acres): 12,771

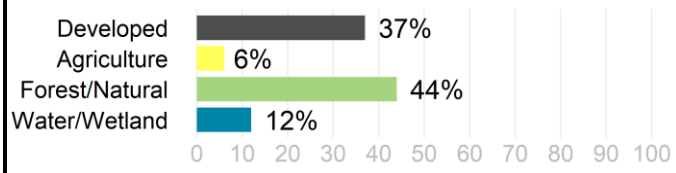
Segment Length (Miles): 3.8

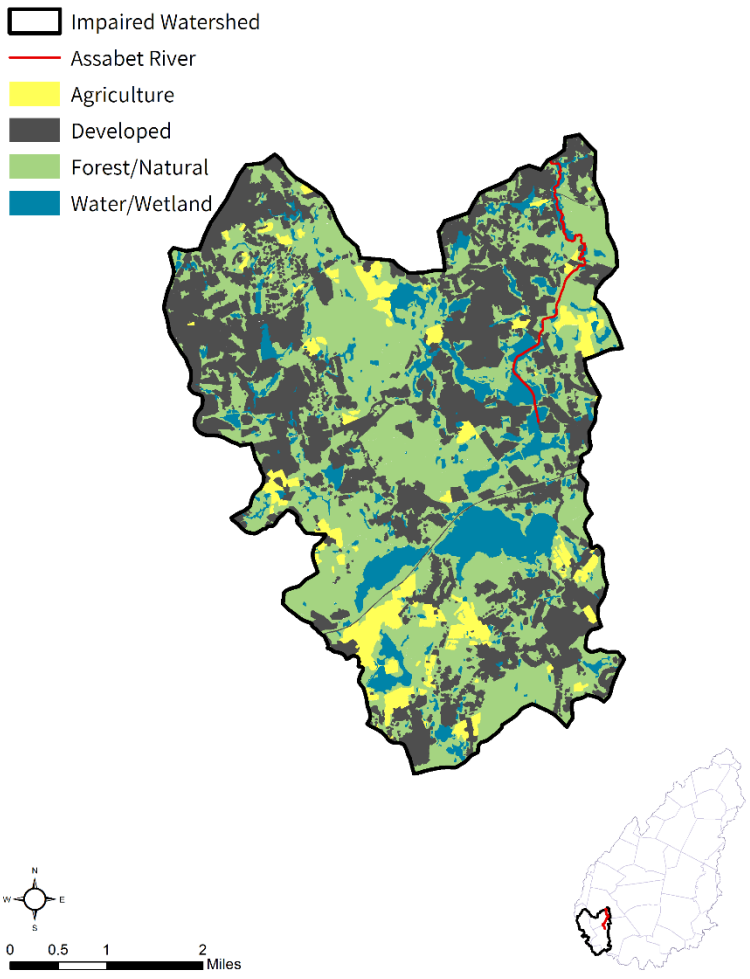
Impairment(s): *E. coli*, fecal coliform (Primary Contact Recreation)

Class (Qualifier): B (Warm Water)

Impervious Area (Acres, %): 1,846 (14%)

DCIA Area (Acres, %): 1,014 (8%)





[26] 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 https://www.mass.gov/guides/water-utility-resilience-program(MassDEP, 2020), MS4 reports, and local knowledge.

Table 12-1. National Pollutant Discharge Elimination System (NPDES) permits for Wastewater Treatment Facilities (WWTF) in the segment watershed. Only permits unique to this segment watershed are shown. WWTF are identified as either municipal (MUN) or other (OTH), if applicable.

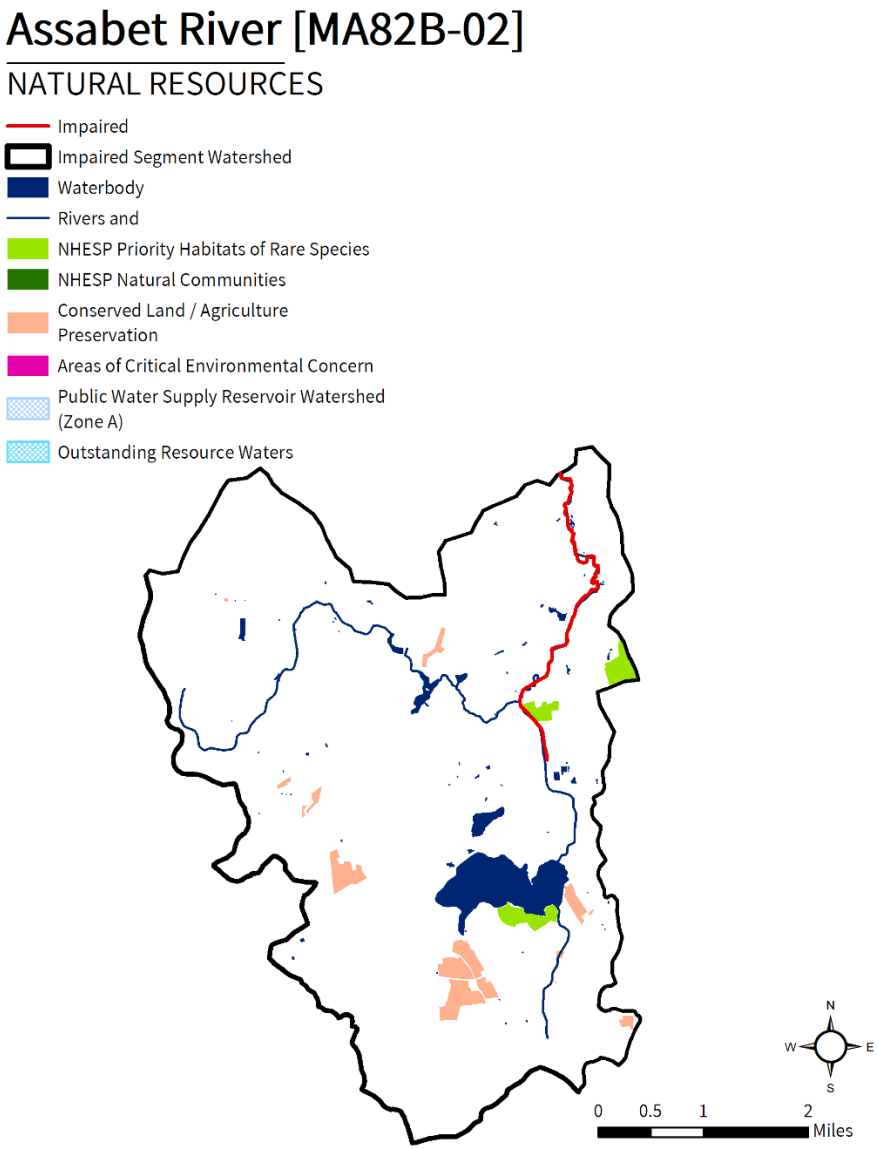
NPDES ID	NAME	TOWN	WWTF
MA0100412	WESTBOROUGH WWTP	WESTBOROUGH	MUN

Except for the commercial development along MA-9 at the upper end of the segment, as well as the golf courses and park cited above, most of the riparian corridor is wooded, with sparse areas of low-density residential development. Only the lower portion of the segment, approximately for one mile, is bordered by medium-density residential development beyond a wooded buffer.

The watershed of the Assabet River (MA82B-02) contains an Area of Critical Environmental Concern, "Miscoe, Warren and Whitehall Watersheds," 2.8 acres (0.02%). Under the Natural Heritage and Endangered Species Program, there are 130 acres (1%) of Priority Habitats of Rare Species. Over 248 acres (2%) of land protected in perpetuity[27] exist within the segment watershed, which is part of a total of 2,330 acres (18%) of Protected and Recreational Open Space[28]. There are no areas under Public Water Supply protection and no areas identified as Outstanding Resource Waters. See Figure 12-1.

[27] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetlands restrictions, aquifer protection, historic preservation, etc. Refer to MassGIS metadata for the Protected and Recreational Open Space data layer. Land protected in perpetuity reflect watershed-wide estimates (including for watersheds that extend outside of the State of Massachusetts).

[28] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside of the State of Massachusetts).



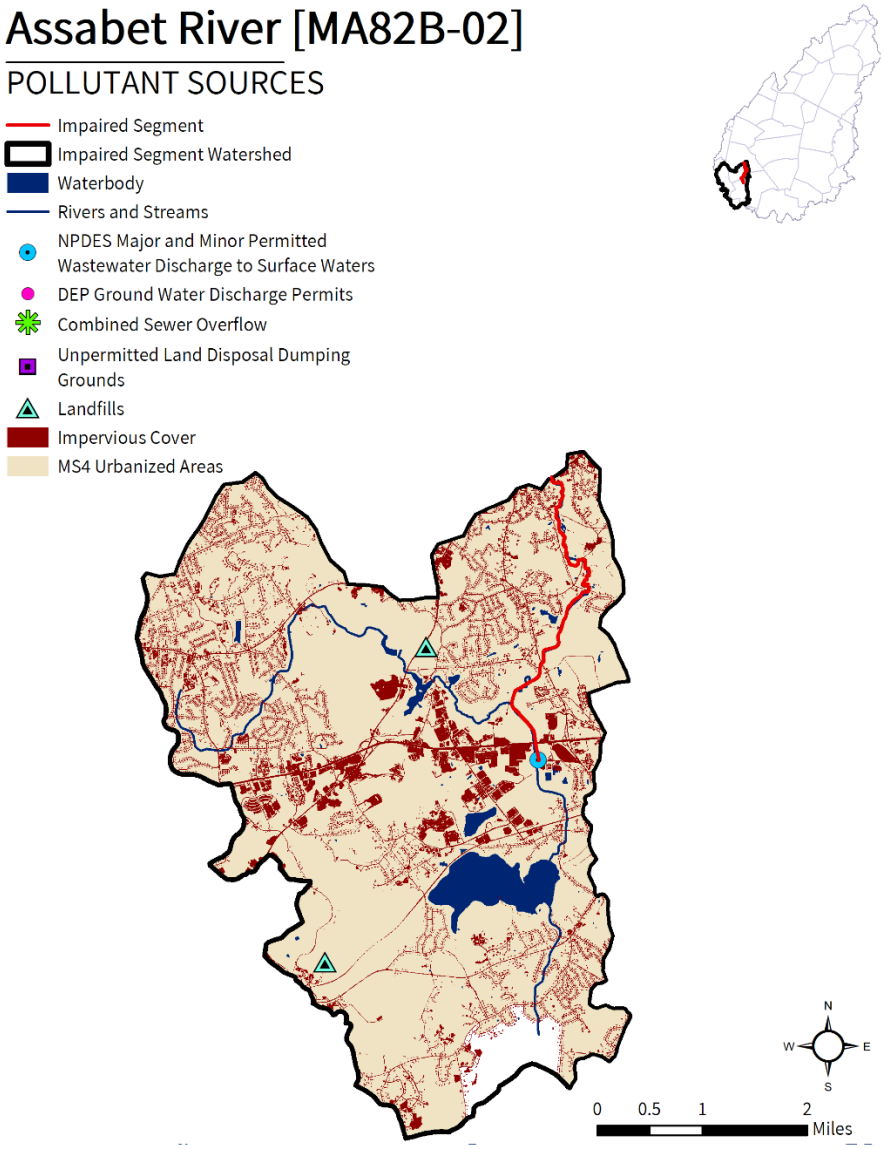


Figure 12-1. Natural resources and potential pollution sources draining to the Assabet River segment MA82B-02. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, permitted facilities.

12.2. Waterbody Impairment Characterization

The Assabet River (MA82B-02) is a Class B, Warm Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* and fecal coliform at the stations listed below (refer to Tables 12-2, 12-3; Figure 12-2). 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, 30-day rolling basis.

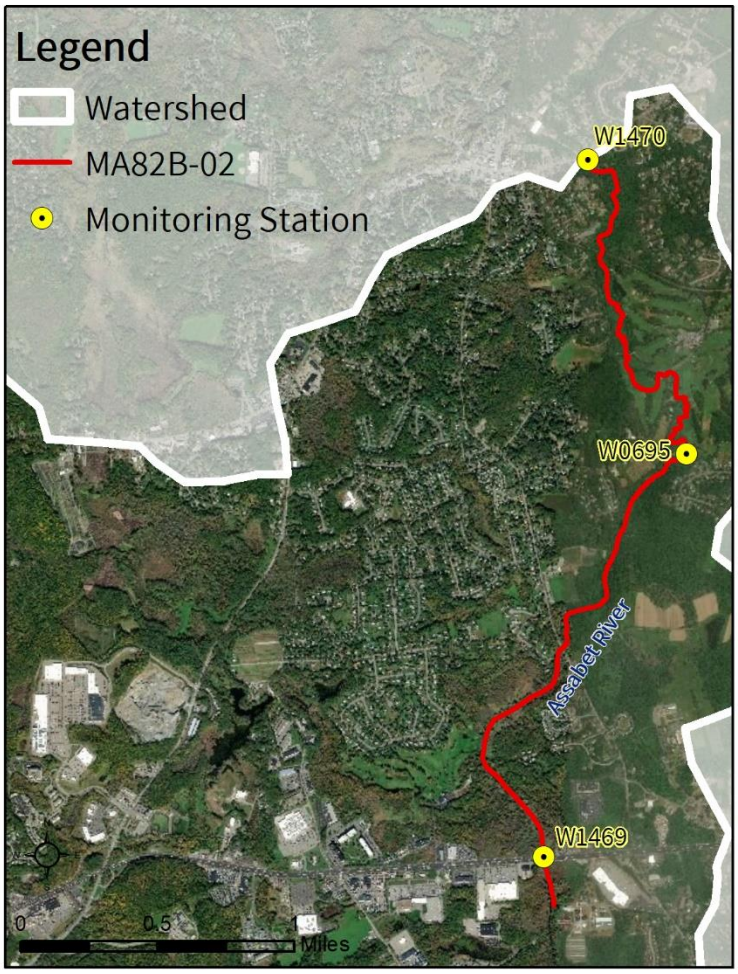


Figure 12-2. Location of monitoring station(s) along the impaired river segment.

- From 2006-2013, 38 samples were collected at W0695, resulting in 19 days when the 30-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 38 samples, eight exceeded the STV criterion from 2006-2011 during both wet and dry weather.
- In 2006, five samples were collected at W1469, resulting in four days when the 30-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 during both wet and dry weather.
- In 2006, five samples were collected at W1470, resulting in five days when the 30-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 during both wet and dry weather.

Table 12-2. Summary of indicator bacteria sampling results by station for the Assabet River (MA82B-02). The maximum 30-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 Statistical Threshold Value (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 30-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 30-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
W0695	5/3/06	9/25/13	38	2420	19	8
W1469	5/3/06	9/25/06	5	2800	4	2
W1470	5/3/06	9/25/06	5	1000	5	3

Table 12-3. Indicator bacteria data by station, indicator, and date for the Assabet River (MA82B-02). Each sample date was designated wet or dry weather with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text 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 Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 30-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
W0695	*E. coli*	5/3/06	WET	300	300	
W0695	*E. coli*	6/7/06	WET	960	960	
W0695	*E. coli*	7/19/06	DRY	2000	2000	
W0695	*E. coli*	8/23/06	DRY	190	190	
W0695	*E. coli*	9/25/06	DRY	180	180	
W0695	*E. coli*	7/18/07	DRY	345	345	
W0695	*E. coli*	9/12/07	WET	2420	2420	
W0695	*E. coli*	11/7/07	WET	249	249	
W0695	*E. coli*	2/27/08	WET	32	32	
W0695	*E. coli*	4/23/08	DRY	57	57	
W0695	*E. coli*	6/18/08	WET	488	488	
W0695	*E. coli*	8/20/08	DRY	91	91	
W0695	*E. coli*	10/22/08	DRY	44	44	
W0695	*E. coli*	1/21/09	DRY	9	9	
W0695	*E. coli*	3/18/09	DRY	1	1	
W0695	*E. coli*	5/20/09	DRY	152	152	
W0695	*E. coli*	7/22/09	WET	345	345	
W0695	*E. coli*	9/29/09	WET	1550	1550	
W0695	*E. coli*	11/17/09	DRY	24	24	
W0695	*E. coli*	2/18/10	DRY	41	41	
W0695	*E. coli*	8/25/10	WET	687	687	
W0695	*E. coli*	10/20/10	DRY	124	124	
W0695	*E. coli*	1/19/11	WET	2420	2420	
W0695	*E. coli*	3/15/11	DRY	21	21	
W0695	*E. coli*	5/17/11	WET	435	435	
W0695	*E. coli*	7/20/11	DRY	276	276	
W0695	*E. coli*	9/21/11	DRY	65	65	
W0695	*E. coli*	11/16/11	DRY	13	13	
W0695	*E. coli*	2/22/12	DRY	2	2	
W0695	*E. coli*	4/11/12	DRY	19	19	
W0695	*E. coli*	6/20/12	DRY	121	121	
W0695	*E. coli*	8/22/12	DRY	121	121	
W0695	*E. coli*	10/24/12	DRY	75	75	
W0695	*E. coli*	1/28/13	DRY	54	54	
W0695	*E. coli*	3/20/13	WET	18	18	
W0695	*E. coli*	5/20/13	DRY	130	130	
W0695	*E. coli*	8/28/13	DRY	345	345	
W0695	*E. coli*	9/25/13	DRY	185	253	
W0695	Fecal Coliform	5/3/06	WET	340		
W0695	Fecal Coliform	6/7/06	WET	900		
W0695	Fecal Coliform	7/19/06	DRY	1600		
W0695	Fecal Coliform	8/23/06	DRY	200		
W0695	Fecal Coliform	9/25/06	DRY	140		
W1469	*E. coli*	5/3/06	WET	370	370	
W1469	*E. coli*	6/7/06	WET	2800	2800	
W1469	*E. coli*	7/19/06	DRY	800	800	
W1469	*E. coli*	8/23/06	DRY	190	190	
W1469	*E. coli*	9/25/06	DRY	26	26	
W1469	Fecal Coliform	5/3/06	WET	460		

Unique Station ID	Indicator	Date	Wet/Dry	Result	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
W1469	Fecal Coliform	6/7/06	WET	2800		
W1469	Fecal Coliform	7/19/06	DRY	1200		
W1469	Fecal Coliform	8/23/06	DRY	130		
W1469	Fecal Coliform	9/25/06	DRY	65		
W1470	*E. coli*	5/3/06	WET	460	460	
W1470	*E. coli*	6/7/06	WET	900	900	
W1470	*E. coli*	7/19/06	DRY	1000	1000	
W1470	*E. coli*	8/23/06	DRY	150	150	
W1470	*E. coli*	9/25/06	DRY	170	170	
W1470	Fecal Coliform	5/3/06	WET	520		
W1470	Fecal Coliform	6/7/06	WET	760		
W1470	Fecal Coliform	7/19/06	DRY	17000		
W1470	Fecal Coliform	8/23/06	DRY	160		
W1470	Fecal Coliform	9/25/06	DRY	140		

12.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present and 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 SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants, which then becomes diluted during periods of 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).

The indicator bacteria data for the Assabet River (MA82B-02) were elevated during both wet and dry weather at all three sample stations, indicating urban stormwater, pet waste, and wildlife pathogen sources, as well as baseflow sources. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated wet weather indicator bacteria levels. Elevated indicator bacteria during dry weather suggest possible baseflow pollutants sources from illicit sewage discharges, such as a leaking pipe or illegal cross-connection, or septic system malfunctions, such as surface breakouts or broken pipes.

Each potential pathogen source is described in further detail below.

Urban Stormwater: Portions of the Assabet River (MA82B-02) watershed are highly developed, with 97% of the land area in MS4, 8% as DCIA, and a few areas of dense commercial and residential development at the upstream and downstream ends of the segment. Stormwater runoff from urban areas is likely the most significant source of pathogens.

Illicit Sewage Discharges: With some of the watershed serviced by sewer and most (97%) of the watershed designated as MS4 area, illicit storm drain connections and/or illicit discharges from failing infrastructure such as leaky sewer lines or SSOs are likely a significant source of pathogens.

On-Site Wastewater Disposal Systems: With only a portion of the land area served by sewers, malfunctioning septic systems are possible sources. It is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Areas of row crops and plant nurseries are visible on recent aerial photos. 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 middle part of the segment is flanked by woods. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: Conservation and recreational lands with large open mowed areas with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water.

12.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Northborough

Most of Northborough is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Northborough (Permit ID#MAR041143) has an EPA approved Notice of Intent (NOI) and has mapped all of its MS4 stormwater system, with a map attached to its NOI. It adopted IDDE, ESC, and post-construction stormwater regulations in 2008-09.

Stormwater page: https://www.town.northborough.ma.us/engineering-department/pages/stormwater-drainage (Town of Northborough, 2016)

SWMP: at above stormwater link.

Northborough has the following ordinances and bylaws:

- Stormwater Ordinance or Bylaws: Not found.
- Stormwater Utility (or similar): None found.
- Title 5 Supplemental Regulations or Bylaws: https://www.town.northborough.ma.us/health-department/pages/septic-systems-title-v (Town of Northborough, n.d., b)
- Wetlands: https://www.town.northborough.ma.us/sites/g/files/vyhlif3571/f/uploads/wetlands_bylaw_and_regs_voted2019.06.10.pdf (Town of Northborough, 2000)
- Pet Waste: https://www.town.northborough.ma.us/sites/g/files/vyhlif3571/f/uploads/pooperscooperexcerpt.pdf (Town of Northborough, n.d., a)

Northborough's previous Master Plan was written in 1988 and updated in 1997, approved by the Planning Board but never taken to Town Meeting, according to Planning Board minutes from September 4, 2007. Northborough is in the process of updating its Master Plan. See: http://northboromp.com/default.asp (Town of Northborough, 2020a).

Open Space and Recreation Plan: https://www.town.northborough.ma.us/open-space-committee/pages/northborough-open-space-recreation-plan-2020-update (Town of Northborough, 2020b)

Northborough is within the service area of Central Massachusetts Regional Planning Commission (CMRPC, http://www.cmrpc.org/). (CMRPC, 2021).

Town of Westborough. see Section 10.4. Westborough reports six outfalls to the Assabet River MA82B-02.

13. MA82B-03 Assabet River

13.1. Waterbody Overview

The Assabet River segment MA82B-03 is 2.4 miles long, located just south of the I-290 and I-495 junction. The segment starts at the dam (NATID: MA02843) at US Route 20 in Northborough and flows northeast almost entirely within the Town of Northborough to end at the Marlborough West Wastewater Treatment Plant discharge (NPDES: MA0100480), about 0.1 miles from the municipal border. The segment is bound upstream by the Assabet River segment MA82A-02, and downstream by the Assabet River segment MA82A-04, both pathogen-impaired. Tributaries to the segment include Cold Brook Meadow, Howard Brook, Stirrup Brook, and a few unnamed tributaries draining small wetlands and ponds.

Major landmarks include the stone Wachusett Aqueduct Bridge, passing over the Assabet River Reservoir and Hudson Street; Casey Field/Memorial Field ballparks; the MWRA Wachusett Aqueduct Trail along portions of the abandoned railroad; the Edmund Hill Woods conservation area; Michael P. Yellick Conservation Area with hiking trails following the river; and the Tyler Site F.C., a wooded and open wetland conservation and recreation land of Massachusetts DCR Division of State Parks and Recreation, through the lower half of the segment. Road crossings are River Street and Allen Street in Northborough and Boundary Street in Marlborough.

The Assabet River segment MA82B-03 drains an area of 35 square miles, of which 4.9 mi^2 (14%) is impervious and 2.6 mi^2 (7%) is directly connected impervious area (DCIA). The watershed is partially[29] served by public sewer, and 85% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). See Figure 13-1.

The watershed and river corridor are characterized by medium density residential development, with some commercial buildings along major roads. Hudson Street follows the upstream half of the segment closely, in some places with only a few

Reduction from Highest Calculated Geomean: 94%

Watershed Area (Acres): 22,608

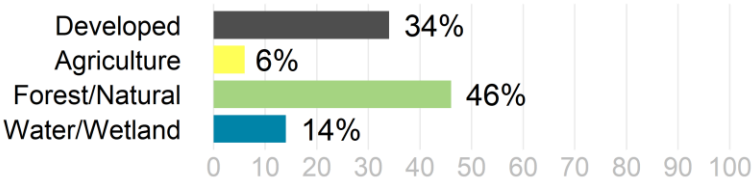
Segment Length (Miles): 2.4

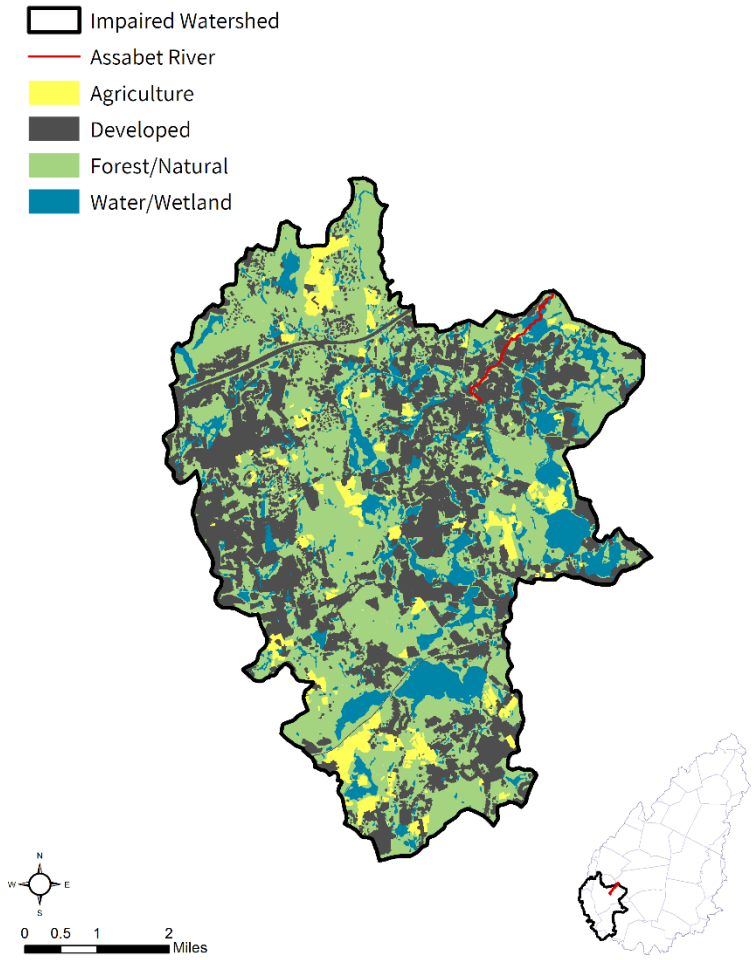
Impairment(s): *E. coli*, fecal coliform (Primary Contact Recreation)

Class (Qualifier): B (Warm Water)

Impervious Area (Acres, %): 3,134 (14%)

DCIA Area (Acres, %): 1,648 (7%)





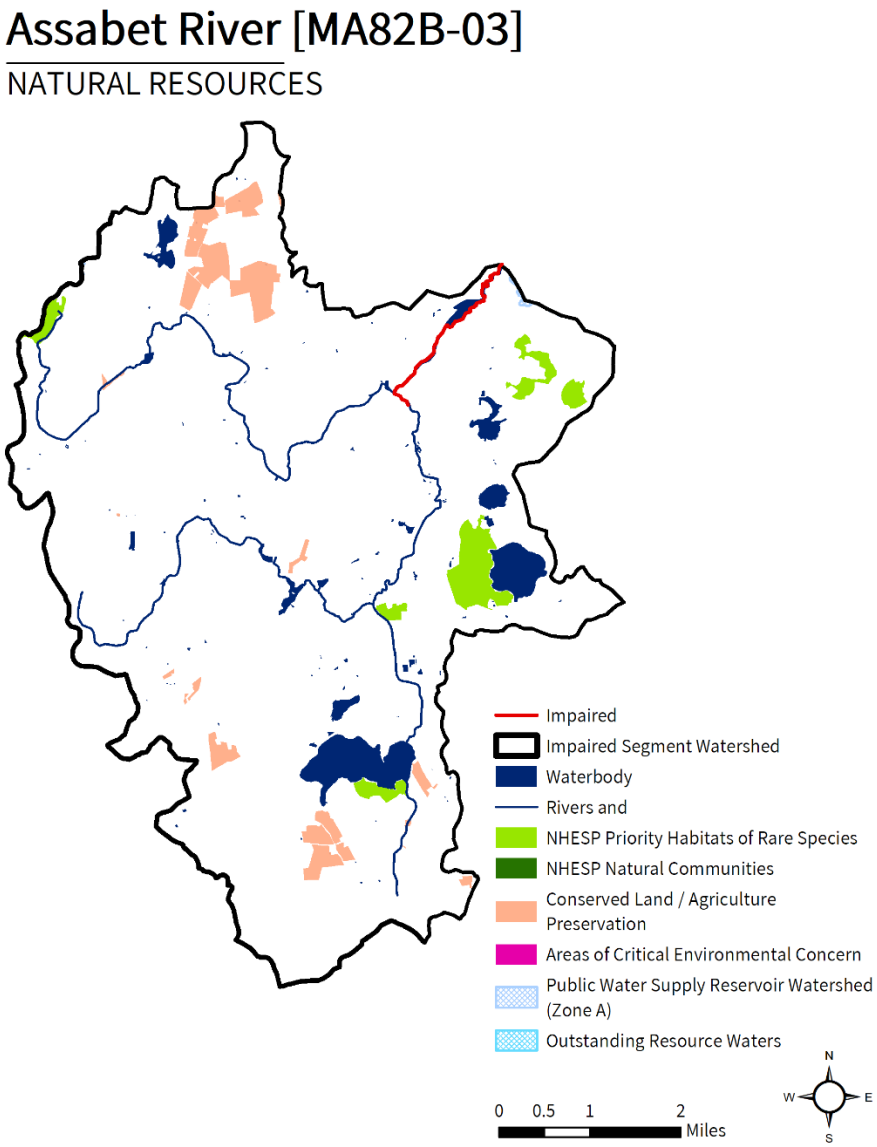
[29] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project https://www.mass.gov/guides/water-utility-resilience-program(MassDEP, 2020), MS4 reports, and local knowledge.

feet of mowed grass separating them. The lower half of the segment flows through large open wetlands, with low density residential development beyond.

The watershed of the Assabet River (MA82B-03) contains an Area of Critical Environmental Concern, "Miscoe, Warren and Whitehall Watersheds," 2.8 acres (0.01%). Under the Natural Heritage and Endangered Species Program, there are 500 acres (2%) of Priority Habitats of Rare Species. Over 662 acres (3%) of land protected in perpetuity[30] exist within the segment watershed, which is part of a total of 4,873 acres (22%) of Protected and Recreational Open Space[31]. There are no areas under Public Water Supply protection and no areas identified as Outstanding Resource Waters. See Figure 13-1.

[30] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetlands restrictions, aquifer protection, historic preservation, etc. Refer to MassGIS metadata for the Protected and Recreational Open Space data layer. Land protected in perpetuity reflect watershed-wide estimates (including for watersheds that extend outside of the State of Massachusetts).

[31] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside of the State of Massachusetts).



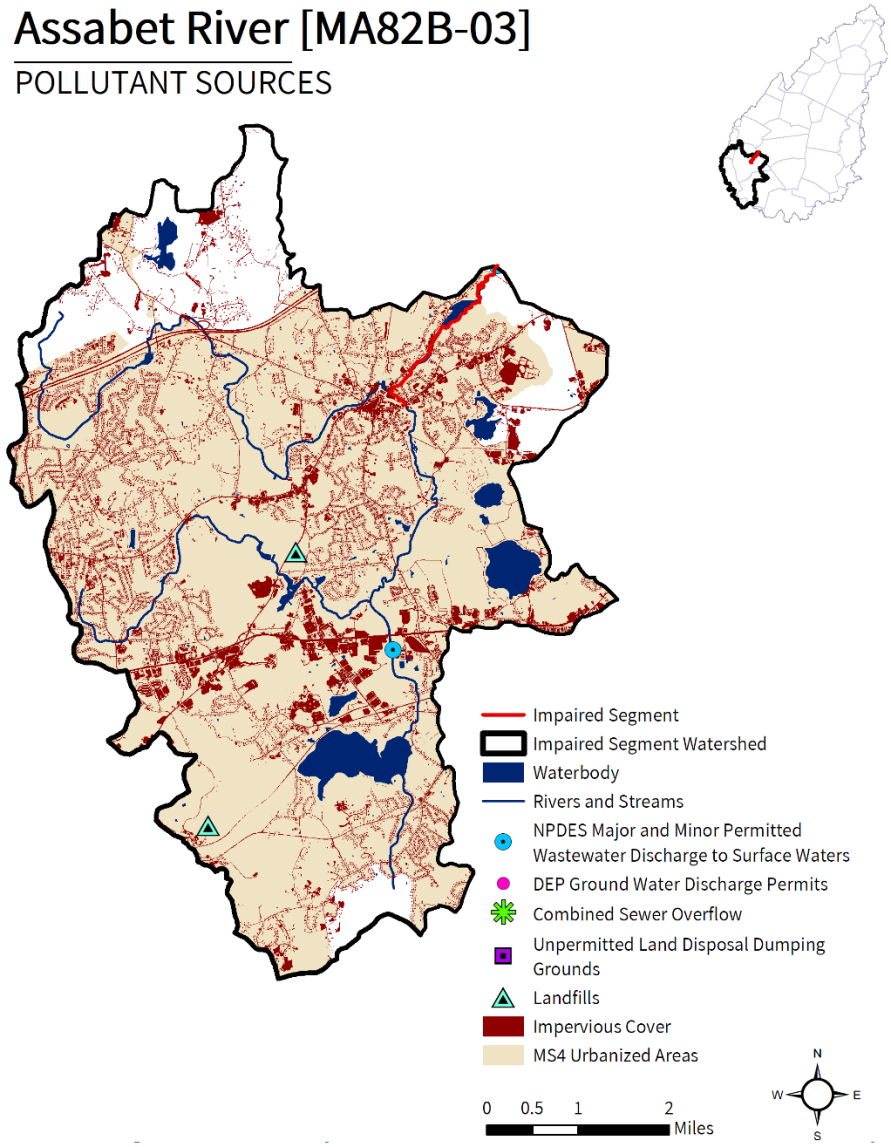


Figure 13-1. Natural resources and potential pollution sources draining to the Assabet River segment MA82B-03. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, permitted facilities.

13.2. Waterbody Impairment Characterization

The Assabet River (MA82B-03) is a Class B, Warm Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* and fecal coliform at the stations listed below (refer to Tables 13-1, 13-2; Figure 13-2). 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, 30-day rolling basis.

- In 2006, five samples were collected at W1471, resulting in five days when the 30-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 during both wet and dry weather.
- In 2006, five samples were collected at W1472, resulting in three days when the 30-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 wet weather.

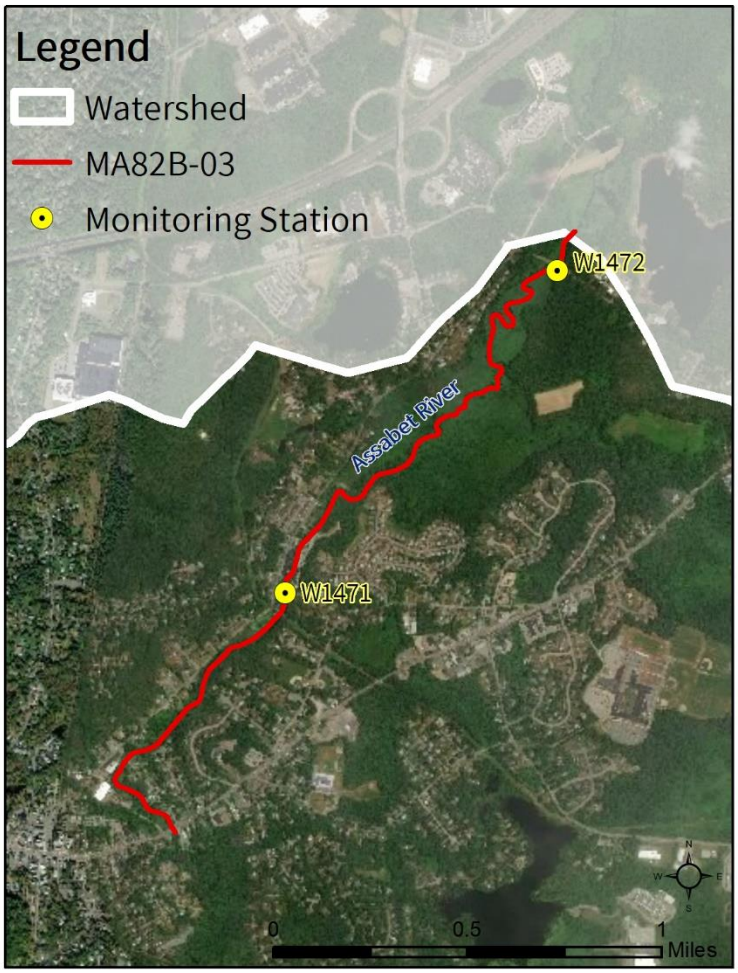


Figure 13-2. Location of monitoring station(s) along the impaired river segment.

Table 13-1. Summary of indicator bacteria sampling results by station for the Assabet River (MA82B-03). The maximum 30-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 Statistical Threshold Value (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 30-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 30-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
W1471	5/3/06	9/25/06	5	2000	5	3
W1472	5/3/06	9/25/06	5	550	3	1

Table 13-2. Indicator bacteria data by station, indicator, and date for the Assabet River (MA82B-03). Each sample date was designated wet or dry weather with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text 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 Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 30-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
W1471	*E. coli*	5/3/06	WET	520	520	
W1471	*E. coli*	6/7/06	WET	780	780	
W1471	*E. coli*	7/19/06	DRY	2000	2000	
W1471	*E. coli*	8/23/06	DRY	130	130	
W1471	*E. coli*	9/25/06	DRY	130	130	
W1471	Fecal Coliform	5/3/06	WET	240		
W1471	Fecal Coliform	6/7/06	WET	620		
W1471	Fecal Coliform	7/19/06	DRY	1600		
W1471	Fecal Coliform	8/23/06	DRY	150		
W1471	Fecal Coliform	9/25/06	DRY	170		
W1472	*E. coli*	5/3/06	WET	310	310	
W1472	*E. coli*	6/7/06	WET	550	550	
W1472	*E. coli*	7/19/06	DRY	330	330	
W1472	*E. coli*	8/23/06	DRY	65	65	
W1472	*E. coli*	9/25/06	DRY	58	58	
W1472	Fecal Coliform	5/3/06	WET	460		
W1472	Fecal Coliform	6/7/06	WET	430		
W1472	Fecal Coliform	7/19/06	DRY	420		
W1472	Fecal Coliform	8/23/06	DRY	130		
W1472	Fecal Coliform	9/25/06	DRY	84		

13.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present and 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 SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants, which then becomes diluted during periods of 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).

The indicator bacteria data for the Assabet River (MA82B-03) were elevated during wet weather at both sample stations, which suggests 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 wet weather indicator bacteria levels. Indicator bacteria were higher at the upstream sample station (W1471) compared to the downstream station (W1472), suggesting that sources in the upper half of the segment closer to the urban center of Northborough may be greater than those downstream, which are predominantly recreational lands and wetlands. This would further support urban stormwater and pet waste as major pathogen sources.

The upstream station (W1471) also showed elevated indicator bacteria during dry weather, which suggests possible baseflow pollutant sources from illicit sewage discharges, such as a leaking pipes or illegal cross-connections, or septic system malfunctions, such as surface breakouts or broken pipes.

Each potential pathogen source is described in further detail below.

Urban Stormwater: Portions of the Assabet River (MA82B-03) watershed are highly developed, with 85% of the land area in MS4, 7% as DCIA, medium and low density residential in the central part of the segment, and small areas of higher density development in the upstream segment area. Much of the development is concentrated within or close to the river corridor. Stormwater runoff from urban areas is likely the most significant source of pathogens.

Illicit Sewage Discharges: With some portion of the land area in sewer service and most of the watershed (85%) designated as MS4 area, leaky sewer lines and illicit connections of wastewater to stormwater drains are potential sources of pathogens.

On-Site Wastewater Disposal Systems: With portions of the watershed served by septic systems, it is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Based on land use data, agriculture accounts for about 6% of land area. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: There are large conservation lands and wetlands in the lower portion of the river, and smaller parks and other open spaces elsewhere. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: Conservation and recreational lands with large open mowed areas with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water.

13.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Marlborough

Almost all of Marlborough is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Marlborough (Permit ID#MAR041128) has an EPA approved Notice of Intent (NOI) and has mapped all of its MS4 stormwater system, with an online map at https://www.axisgis.com/marlboroughma/. (City of Marlborough, n.d., b). It adopted IDDE, ESC, and post-construction stormwater regulations in 2009.

Stormwater page: https://ecode360.com/15931519 (City of Marlborough, 2009)

SWMP: https://www.marlborough-ma.gov/engineering-division/pages/stormwater-management (City of Marlborough, n.d., b)

Marlborough has the following ordinances and bylaws:

- Stormwater Ordinance or Bylaws: https://www.ecode360.com/documents/MA1056/source/346020.pdf (City of Marlborough, 2009)
- Stormwater Utility (or similar): None found.
- Title 5 Supplemental Regulations or Bylaws: None found.
- Wetlands: https://ecode360.com/9216851 (City of Marlborough, 1991)
- Pet Waste: https://ecode360.com/9210023 (City of Marlborough, 2004)

Marlborough's 2013 *Marlborough Economic Development Master Plan* mentions water and wastewater, primarily in terms of facilitating connection to and increasing capacity of the City's two WWTPs.

2011-18 Open Space and Recreation Plan: https://www.marlborough-ma.gov/sites/g/files/vyhlif3411/f/uploads/osrp_2011-2018.pdf (City of Marlborough, 2011)

Marlborough is part of the MetroWest Regional Collaborative (MWRC) within the Metropolitan Area Planning Council (MAPC, http://www.mapc.org/). (MAPC, 2021).

Town of Northborough. see Section 12.4.

14. MA82B-04 Assabet River

14.1. Waterbody Overview

The Assabet River segment MA82B-04 is eight miles long and begins at the Marlborough Westerly Wastewater Treatment Plant discharge (NPDES: MA0100480), then flows north through the western tip of Marlborough, then northeast through short sections of Berlin and again Marlborough. Afterwards, it flows northeast through Hudson to end at the Hudson Wastewater Treatment Facility discharge (NPDES: MA0101788). Segment MA82B-04 is bound upstream by Assabet River segment MA82B-03 and downstream by Assabet River segment MA82B-05, both pathogen-impaired. Tributaries to the segment include the streams draining Solomon Pond and Muddy Pond, Millham Brook draining Millham Reservoir, North Brook, Barefoot Brook, Gates Pond Brook, Hog Brook, and Danforth Brook draining Bruces Pond.

Major landmarks from upstream to down, include Hillside School Farm, Solomon Pond Mall and nearby commercial development, the New England Sports Center in Marlborough, Hudson High School with ballfields and the Assabet River Nature Trail abutting the river, Fossile Conservation Land, Apsley Park, and Wood Park abutting the river in Hudson, the impoundment at Washington Street in downtown Hudson where a portion of the river is channelized and abuts buildings, the Assabet River Nature Trail which crosses the river at Main Street, and the Hudson Fire, Police, and Public Works facilities at the segment's end. Road crossings include Robin Hill Street, Donald J Lynch Boulevard, and I-290 in Marlborough; Bridge Road in Berlin; and I-495, Chaplin Road, Washington Street/MA-85, Houghton Street, Broad Street, Forest Avenue, Main Street/MA-62, and Cox Street in Hudson.

The Assabet River segment MA82B-04 drains an area of 74 square miles, of which 10 mi^2 (13%) is impervious and 5 mi^2 (7%) is directly connected impervious area (DCIA). The watershed is partially[32] served by public sewer, and 61% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are two NPDES wastewater treatment facility permits on file governing point

Reduction from Highest Calculated Geomean: 98%

Watershed Area (Acres): 47,365

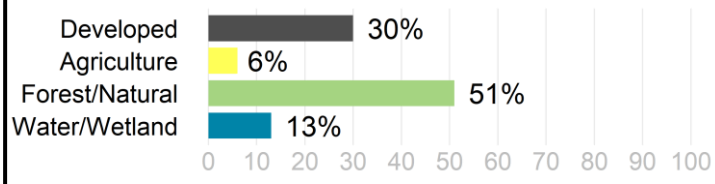
Segment Length (Miles): 8.0

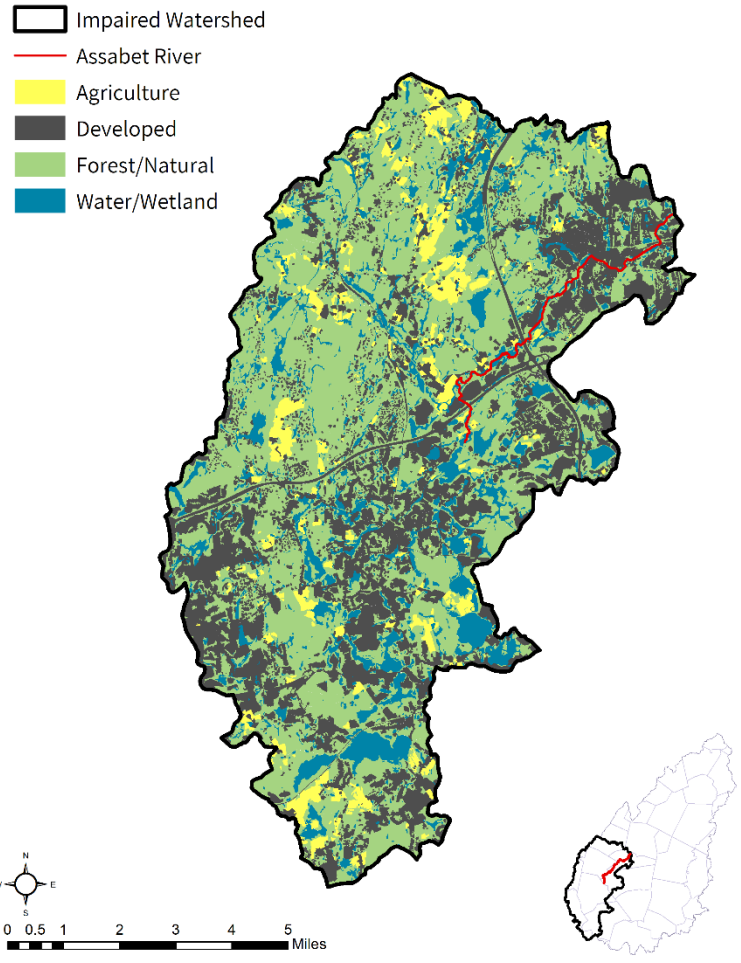
Impairment(s): *E. coli*, fecal coliform (Primary Contact Recreation)

Class (Qualifier): B (Warm Water)

Impervious Area (Acres, %): 6,294 (13%)

DCIA Area (Acres, %): 3,390 (7%)





[32] 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 https://www.mass.gov/guides/water-utility-resilience-program(MassDEP, 2020), MS4 reports, and local knowledge.

source discharges of pollutants to surface waters in the immediate drainage area to the impaired segment (Table 14-1). There are also two MassDEP discharge to groundwater permits for on-site wastewater discharge within the watershed (Table 14-2). See Figure 14-1.

Table 14-1. National Pollutant Discharge Elimination System (NPDES) permits for Wastewater Treatment Facilities (WWTF) in the segment watershed. Only permits unique to this segment watershed are shown. WWTF are identified as either municipal (MUN) or other (OTH), if applicable.

NPDES ID	NAME	TOWN	WWTF
MA0100480	MARLBOROUGH WESTERLY WWTP	MARLBOROUGH	MUN
MA0101788	HUDSON WWTF	HUDSON	MUN

Table 14-2. 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)
857-1	SAWYER HILL CO HOUSING DEVELOPMENT	BERLIN	Sanitary Discharge	21,600
834-1	HUDSON HIGHLANDS	HUDSON	Sanitary Discharge	82,000

The upper portion of the river segment in Marlborough and Berlin has wide wooded buffers in most locations, despite also crossing under two interstate highways and passing high density commercial development. In Hudson, the watershed and river flow through medium density residential development, then high density residential and commercial development in downtown Hudson near Washington Street. From there until the end of the segment, the river flows through medium density residential and commercial development, though often with a wooded buffer.

The watershed of the Assabet River (MA82B-04) contains an Area of Critical Environmental Concern, "Miscoe, Warren and Whitehall Watersheds," 2.8 acres (0.01%). Under the Natural Heritage and Endangered Species Program, there are 2,472 acres (5%) of Priority Habitats of Rare Species. There are 2,774 acres under Public Water Supply protection and no areas identified as Outstanding Resource Waters. Over 2,326 acres (5%) of land protected in perpetuity[33] exist within the segment watershed, which is part of a total of 9,980 acres (21%) of Protected and Recreational Open Space[34]. See Figure 14-1.

[33] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetlands restrictions, aquifer protection, historic preservation, etc. Refer to MassGIS metadata for the Protected and Recreational Open Space data layer. Land protected in perpetuity reflect watershed-wide estimates (including for watersheds that extend outside of the State of Massachusetts).

[34] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside of the State of Massachusetts).

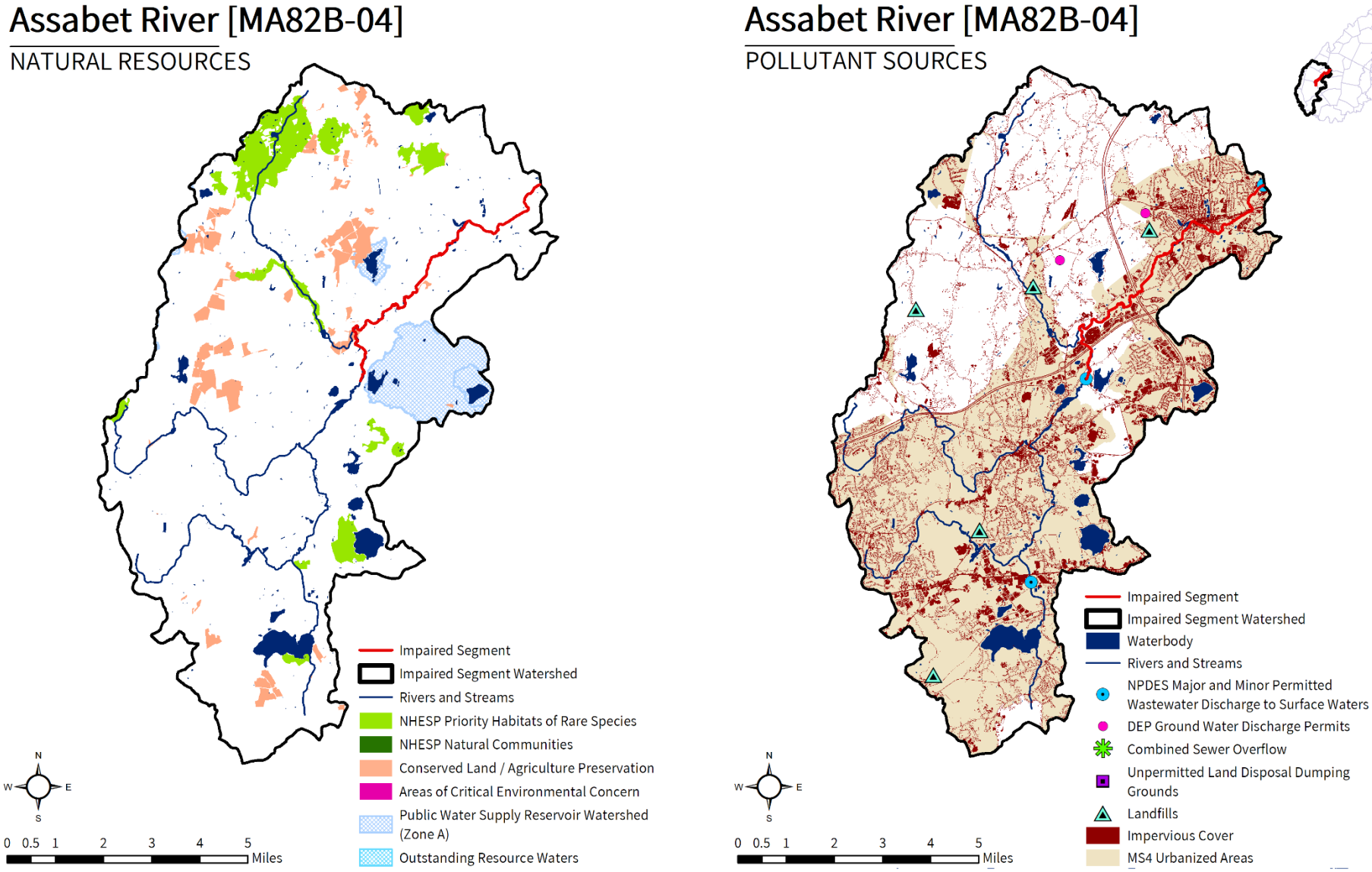


Figure 14-1. Natural resources and potential pollution sources draining to the Assabet River segment MA82B-04. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, permitted facilities.

14.2. Waterbody Impairment Characterization

The Assabet River (MA82B-04) is a Class B, Warm Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* and fecal coliform at the stations listed below (refer to Tables 14-3, 14-4; Figure 14-2). 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, 30-day rolling basis.

Figure 14-2. Location of monitoring station(s) along the impaired river segment.

- In 2006, five samples were collected at W1473, resulting in three days when the 30-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, none exceeded the STV criterion.
- In 2006, five samples were collected at W1474, resulting in four days when the 30-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 2006, five samples were collected at W1475, resulting in five days when the 30-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.

Table 14-3. Summary of indicator bacteria sampling results by station for the Assabet River (MA82B-04). The maximum 30-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 Statistical Threshold Value (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 30-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 30-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
W1473	5/3/06	9/25/06	5	370	3	0
W1474	5/3/06	9/25/06	5	1800	4	1
W1475	5/3/06	9/25/06	5	8000	5	1

Table 14-4. Indicator bacteria data by station, indicator, and date for the Assabet River (MA82B-04). Each sample date was designated wet or dry weather with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text 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 Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 30-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
W1473	*E. coli*	5/3/06	WET	220	220	
W1473	*E. coli*	6/7/06	WET	360	360	
W1473	*E. coli*	7/19/06	DRY	370	370	
W1473	*E. coli*	8/23/06	DRY	110	110	
W1473	*E. coli*	9/25/06	DRY	110	110	
W1473	Fecal Coliform	5/3/06	WET	280		
W1473	Fecal Coliform	6/7/06	WET	350		
W1473	Fecal Coliform	7/19/06	DRY	370		
W1473	Fecal Coliform	8/23/06	DRY	100		
W1473	Fecal Coliform	9/25/06	DRY	39		
W1474	*E. coli*	5/3/06	WET	220	220	
W1474	*E. coli*	6/7/06	WET	290	290	
W1474	*E. coli*	7/19/06	DRY	1800	1800	
W1474	*E. coli*	8/23/06	DRY	150	150	
W1474	*E. coli*	9/25/06	DRY	90	90	
W1474	Fecal Coliform	5/3/06	WET	180		
W1474	Fecal Coliform	6/7/06	WET	320		
W1474	Fecal Coliform	7/19/06	DRY	560		
W1474	Fecal Coliform	8/23/06	DRY	100		
W1474	Fecal Coliform	9/25/06	DRY	84		
W1475	*E. coli*	5/3/06	WET	260	260	
W1475	*E. coli*	6/7/06	WET	390	390	
W1475	*E. coli*	7/19/06	DRY	8000	8000	
W1475	*E. coli*	8/23/06	DRY	220	220	
W1475	*E. coli*	9/25/06	DRY	290	290	
W1475	Fecal Coliform	5/3/06	WET	350		
W1475	Fecal Coliform	6/7/06	WET	550		
W1475	Fecal Coliform	7/19/06	DRY	12000		
W1475	Fecal Coliform	8/23/06	DRY	240		
W1475	Fecal Coliform	9/25/06	DRY	310		

14.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present and 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 SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants, which then becomes diluted during periods of 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 Assabet River (MA82B-04) were elevated during dry weather, indicating possible baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems. Given the relatively small sample set, additional sampling under both wet and dry conditions, including upstream and downstream of downtown Hudson, would likely help in identifying pollutant sources.

Each potential pathogen source is described in further detail below.

Urban Stormwater: Portions of the Assabet River (MA82B-04) watershed are highly developed, with 61% of the land area in MS4 and 7% as DCIA. In the upstream area, there are two major interstate highways and large commercial properties with expansive parking lots close the river. In the downstream area, there is high density commercial and residential development in downtown Hudson. Stormwater runoff from urban areas is likely the most significant source of pathogens.

Illicit Sewage Discharges: With some portion of the land area in sewer service and most (61%) of the watershed designated as MS4 area, leaky sewer lines and illicit connections to storm drains are also possible sources. Sewer related risks include leaking infrastructure (pipes, pump stations, etc.), and sanitary sewer overflows, which may be caused by undersized infrastructure, blockages, or excessive infiltration of groundwater or rainwater into pipes, exceeding system capacity.

On-Site Wastewater Disposal Systems: There are two groundwater discharge permits for on-site wastewater discharge, which are large-capacity septic systems (non-residential). Much of the residential development in the watershed uses septic systems for wastewater treatment; it is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: There are nearly 3,000 acres of agricultural areas in the watershed, and large open fields with no vegetative buffer are visible along the river in recent aerial photos. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: There are several parks and ballfields in proximity to the river, and nearly 10,000 acres of open space land in the watershed. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: Conservation and recreational lands with large open mowed areas with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water.

14.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Berlin

The Town of Berlin contains relatively little "Urban Area" as defined by the US Census and is covered by an MS4 General Permit waiver from the NPDES II / MS4 program.

Berlin has no ordinances and bylaws relating to pathogen-impaired waters:

- Wetlands Protection Bylaw was repealed in 2004. The Berlin Conservation Commission administers the Massachusetts Wetlands Protection Act M. G. L. ch. 131, s.40 for activities within the town.
- Stormwater Ordinance or Bylaws: None found.
- Stormwater Utility (or similar): None found.
- Title 5 Supplemental Regulations or Bylaws: None found.
- Pet Waste: None found.

The Town of Berlin's Master Plan from 2013 includes Section 4: Natural, Cultural, and Historic Resources > Natural Resources > watersheds, page 41. It also mentions stormwater issues through the document, including in its implementation plan (starting p. 59). It also states that Berlin has been one of few surrounding towns not to create any public sewer or water system, although the plan mentions some support for allowing "package" wastewater treatment systems to overcome some of the risks associated with individual septic systems. http://www.townofberlin.com/planning-board/files/berlin-master-plan (Town of Berlin, 2013)

Berlin's 2011 Open Space and Recreation Plan, which recommends the Town consider a stormwater bylaw. http://www.townofberlin.com/conservation-commission/files/2011-2018-open-space-and-recreation-plan (Town of Berlin, 2011)

Berlin is within the service area of Central Massachusetts Regional Planning Commission (CMRPC, http://www.cmrpc.org/). (CMRPC, 2021).

Town of Hudson

Most of Hudson is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Hudson (Permit ID#MAR041198) has an EPA approved Notice of Intent (NOI) and has mapped all of its MS4 stormwater system, with a map submitted with its NOI. It adopted IDDE, ESC, and post-construction stormwater regulations in 2008.

Hudson reports 29 outfalls to the Assabet River MA84B-04.

SWMP: https://www.townofhudson.org/sites/g/files/vyhlif3281/f/uploads/2020.06.30_hudson_swmp-signed.pdf (Town of Hudson, 2020)

Hudson has the following ordinances and bylaws:

- Pet waste: None found.

Hudson's 2014 Master Plan has a brief section on natural resources and goals and mentions the Assabet River as both a recreational asset and an impaired waterbody in many sections. It has a stormwater section, page 7-9, and discusses wastewater, page 7-7. It discusses collaboration with the SuAsCo Watershed Community Council and the Organization for the Assabet River (OARS) on education and cleanup efforts. https://www.townofhudson.org/master-plan-steering-committee/pages/hudson-master-plan (Town of Hudson, 2014)

Hudson's 2016 Open Space and Recreation Plan: https://www.townofhudson.org/sites/g/files/vyhlif3281/f/uploads/open_space_recreation_plan_2016.pdf (Town of Hudson, 2016)

Hudson is part of the Minuteman Advisory Group on Interlocal Coordination within the Metropolitan Area Planning Council (MAPC, http://www.mapc.org/). (MAPC, 2021).

Town of Marlborough. see Section 13.4. Marlborough reports nine outfalls to Assabet River MA82B-04.

15. MA82B-05 Assabet River

15.1. Waterbody Overview

The Assabet River segment MA82B-05 is 8.2 miles long and begins at the Hudson Wastewater Treatment Plant discharge (NPDES: MA0101788) in Hudson, then flowing generally east through Stow, then into Maynard where the segment ends at the USGS gage (#01097000) at MA-27/MA-62 in Maynard. Assabet River segment MA82B-05 is bound upstream by pathogen-impaired Assabet River segment MA82B-04, and downstream by a portion of the Assabet River which is not pathogen-impaired. Tributaries include Fort Meadow Brook, a short stream that drains Lake Boon, Elizabeth Brook, Taylor Brook, and Millpond (Maynard).

Major landmarks include a large solar panel installation in Hudson, expansive fields mowed to near the water's edge in Stow, Stow Acres Golf Club with some greens near the water but screened by a wooded buffer, the impoundment near Gleasondale Road, large agricultural fields in Stow, the wooded Gardner Hill Conservation Area which abuts the river, a grass airstrip on Crow Island, the Stowaway Golf Course with minimal greens, the Assabet River Trail, and downtown Maynard. Road crossings include Gleasondale Road and Sudbury Road in Stow, and Riverside Park Road, Great Road, Mill Street, Florida Road, Main Street, and Walnut Street in Maynard.

The Assabet River segment MA82B-05 drains an area of 96 square miles, of which 12 mi^2 (13%) is impervious and 7 mi^2 (7%) is directly connected impervious area (DCIA). The watershed is partially[35] served by public sewer, and 61% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). See Figure 15-1.

The watershed and river corridor of the upstream portion of the segment are dominated by fields, woods, and wetlands, with very sparse medium density residential development. The middle portion of the segment to White Pond Road, is dominated by forest, while the downstream portion is medium density residential and high-density commercial development.

Reduction from Highest Calculated Geomean: 94%

Watershed Area (Acres): 61,211

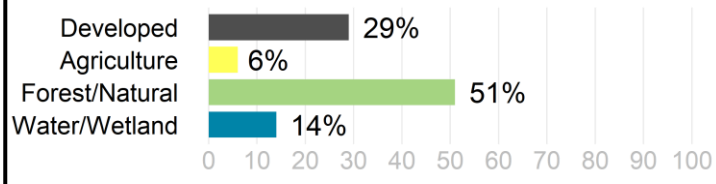
Segment Length (Miles): 8.2

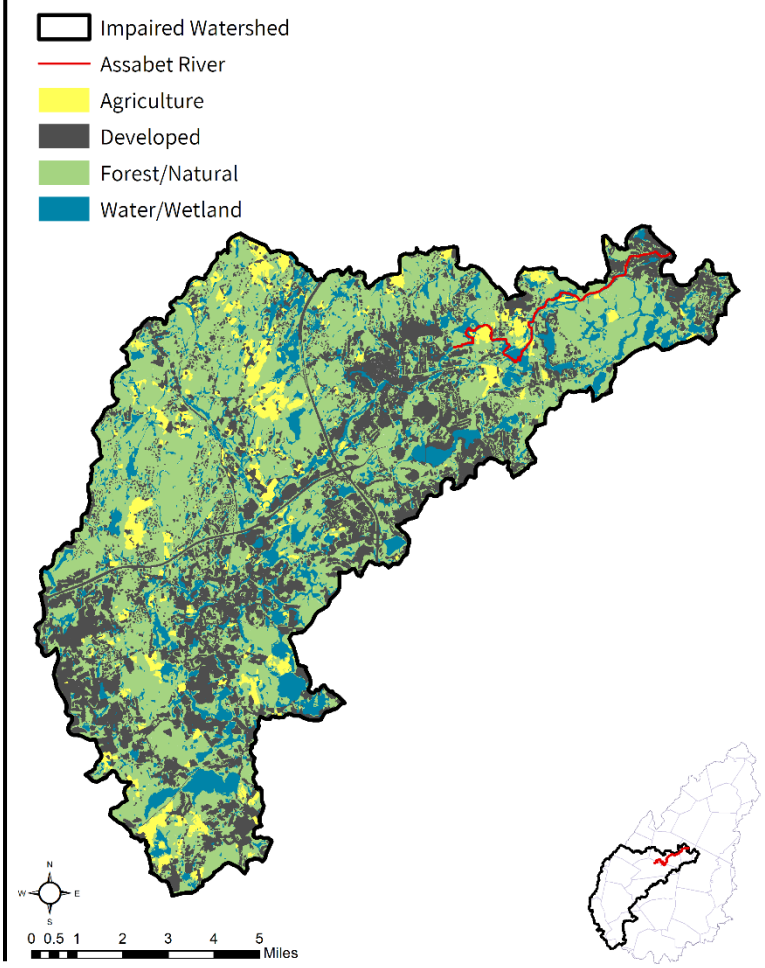
Impairment(s): *E. coli*, fecal coliform (Primary Contact Recreation)

Class (Qualifier): B (Warm Water)

Impervious Area (Acres, %): 7,906 (13%)

DCIA Area (Acres, %): 4,202 (7%)





[35] 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 https://www.mass.gov/guides/water-utility-resilience-program(MassDEP, 2020), MS4 reports, and local knowledge.

The watershed of the Assabet River (MA82B-05) contains an Area of Critical Environmental Concern, "Miscoe, Warren and Whitehall Watersheds," 2.8 acres (0.005%). Under the Natural Heritage and Endangered Species Program, there is one acre (0.002%) of Priority Natural Vegetation Communities and 4,639 acres (8%) of Priority Habitats of Rare Species. Over 2,527 acres (4%) of land protected in perpetuity[36] exist within the segment watershed, which is part of a total of 14,114 acres (23%) of Protected and Recreational Open Space[37]. There are 2,978 acres (5%) under Public Water Supply protection and no areas identified as Outstanding Resource Waters. See Figure 15-1.

[36] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetlands restrictions, aquifer protection, historic preservation, etc. Refer to MassGIS metadata for the Protected and Recreational Open Space data layer. Land protected in perpetuity reflect watershed-wide estimates (including for watersheds that extend outside of the State of Massachusetts).

[37] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside of the State of Massachusetts).

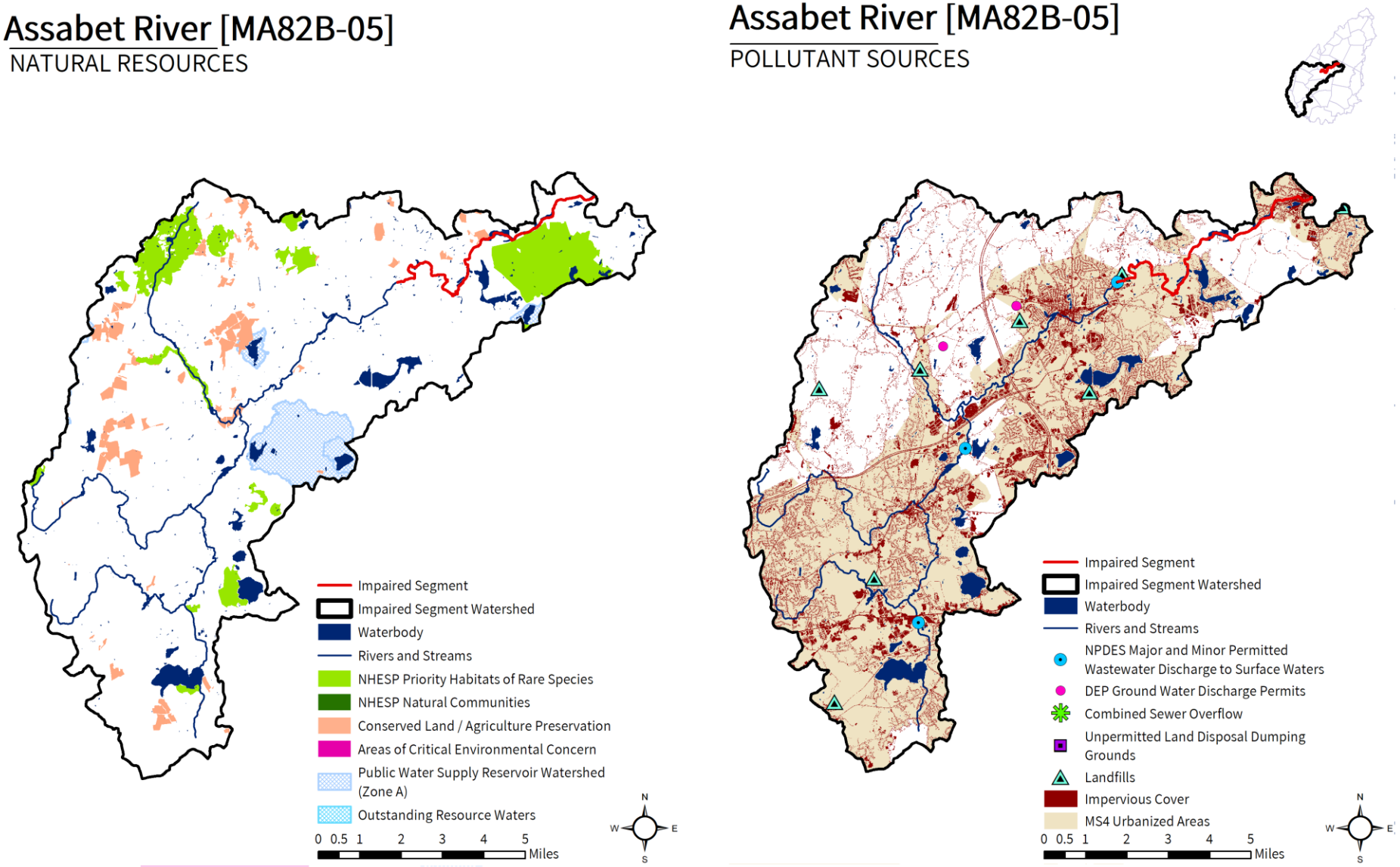


Figure 15-1. Natural resources and potential pollution sources draining to the Assabet River segment MA82B-05. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, permitted facilities.

15.2. Waterbody Impairment Characterization

The Assabet River (MA82B-05) is a Class B, Warm Water, (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* and fecal coliform at the stations listed below (refer to Tables 15-1, 15-2; Figure 15-2). 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, 30-day rolling basis.

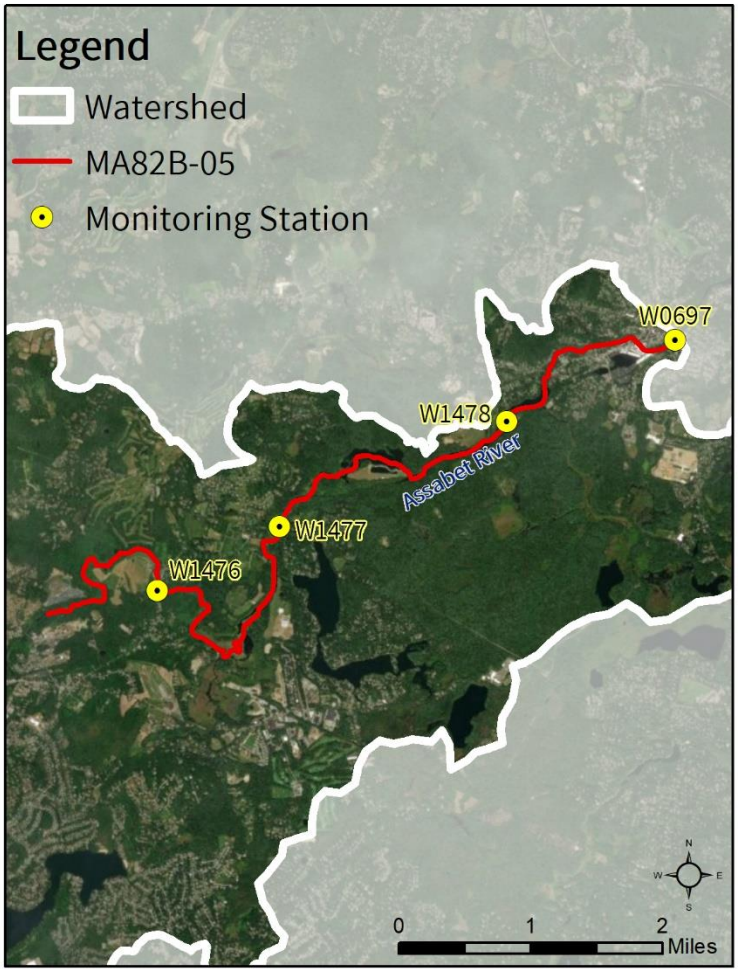


Figure 15-2. Location of monitoring station(s) along the impaired river segment.

- From 2007-2013, 32 samples were collected at W0697, resulting in 21 days when the 30-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 32 samples, 13 exceeded the STV criterion in all years during both wet and dry weather.
- In 2006, five samples were collected at W1476, resulting in four days when the 30-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, none exceeded the STV criterion.
- In 2006, five samples were collected at W1477, resulting in two days when the 30-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, none exceeded the STV criterion.
- In 2006, five samples were collected at W1478, resulting in one day when the 30-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, none exceeded the STV criterion.

Table 15-1. Summary of indicator bacteria sampling results by station for the Assabet River (MA82B-05). The maximum 30-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 Statistical Threshold Value (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 30-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 30-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
W0697	7/18/07	9/25/13	32	1990	21	13
W1476	5/3/06	9/25/06	5	370	4	0
W1477	5/3/06	9/25/06	5	200	2	0
W1478	5/3/06	9/25/06	5	130	1	0

Table 15-2. Indicator bacteria data by station, indicator, and date for the Assabet River (MA82B-05). Each sample date was designated wet or dry weather with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text 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 Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 30-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
W0697	*E. coli*	7/18/07	DRY	1730	1730	
W0697	*E. coli*	9/12/07	WET	1550	1550	
W0697	*E. coli*	11/7/07	WET	272	272	
W0697	*E. coli*	2/27/08	WET	56	56	
W0697	*E. coli*	4/23/08	DRY	51	51	
W0697	*E. coli*	6/18/08	WET	1200	1200	
W0697	*E. coli*	8/20/08	DRY	219	219	
W0697	*E. coli*	10/22/08	DRY	96	96	
W0697	*E. coli*	1/21/09	DRY	1550	1550	
W0697	*E. coli*	3/18/09	DRY	26	26	
W0697	*E. coli*	5/20/09	DRY	172	172	
W0697	*E. coli*	7/22/09	WET	1990	1990	
W0697	*E. coli*	9/29/09	WET	517	517	
W0697	*E. coli*	11/17/09	DRY	155	155	
W0697	*E. coli*	2/18/10	DRY	23	23	
W0697	*E. coli*	8/25/10	WET	1550	1550	
W0697	*E. coli*	10/20/10	DRY	225	225	
W0697	*E. coli*	1/19/11	WET	108	108	
W0697	*E. coli*	3/15/11	DRY	291	291	
W0697	*E. coli*	5/17/11	WET	613	613	
W0697	*E. coli*	7/20/11	DRY	613	613	
W0697	*E. coli*	9/21/11	DRY	178	178	
W0697	*E. coli*	11/16/11	DRY	105	105	
W0697	*E. coli*	2/22/12	DRY	49	49	
W0697	*E. coli*	4/11/12	DRY	488	488	
W0697	*E. coli*	6/20/12	DRY	687	687	
W0697	*E. coli*	10/24/12	DRY	548	548	
W0697	*E. coli*	1/28/13	DRY	75	75	
W0697	*E. coli*	3/20/13	WET	36	36	
W0697	*E. coli*	5/20/13	DRY	48	48	
W0697	*E. coli*	8/28/13	DRY	435	435	

Unique Station ID	Indicator	Date	Wet/Dry	Result	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
W0697	*E. coli*	9/25/13	DRY	387	387	
W1476	*E. coli*	5/3/06	WET	280	280	
W1476	*E. coli*	6/7/06	WET	370	370	
W1476	*E. coli*	7/19/06	DRY	210	210	
W1476	*E. coli*	8/23/06	DRY	84	84	
W1476	*E. coli*	9/25/06	DRY	150	150	
W1476	Fecal Coliform	5/3/06	WET	220		
W1476	Fecal Coliform	6/7/06	WET	340		
W1476	Fecal Coliform	7/19/06	DRY	230		
W1476	Fecal Coliform	8/23/06	DRY	26		
W1476	Fecal Coliform	9/25/06	DRY	130		
W1477	*E. coli*	5/3/06	WET	200	200	
W1477	*E. coli*	6/7/06	WET	150	150	
W1477	*E. coli*	7/19/06	DRY	120	120	
W1477	*E. coli*	8/23/06	DRY	32	32	
W1477	*E. coli*	9/25/06	DRY	90	90	
W1477	Fecal Coliform	5/3/06	WET	280		
W1477	Fecal Coliform	6/7/06	WET	120		
W1477	Fecal Coliform	7/19/06	DRY	90		
W1477	Fecal Coliform	8/23/06	DRY	32		
W1477	Fecal Coliform	9/25/06	DRY	71		
W1478	*E. coli*	5/3/06	WET	100	100	
W1478	*E. coli*	6/7/06	WET	130	130	
W1478	*E. coli*	7/19/06	DRY	45	45	
W1478	*E. coli*	8/23/06	DRY	19	19	
W1478	*E. coli*	9/25/06	DRY	13	13	
W1478	Fecal Coliform	5/3/06	WET	160		
W1478	Fecal Coliform	6/7/06	WET	120		
W1478	Fecal Coliform	7/19/06	DRY	52		
W1478	Fecal Coliform	8/23/06	DRY	6		
W1478	Fecal Coliform	9/25/06	DRY	7		

15.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present and 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 SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants, which then becomes diluted during periods of 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).

For the Assabet River (MA82B-05), elevated indicator bacteria at the downstream site (W0697) occurred during both dry and wet weather conditions. Elevated indicator bacteria during wet weather indicate possible 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 wet weather indicator bacteria levels. Elevated indicator bacteria during dry weather indicate baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, may be present.

Each potential pathogen source is described in further detail below.

Urban Stormwater: The Assabet River (MA82B-05) watershed has 61% of the land area in MS4, 7% as DCIA, and some low and medium density residential neighborhoods along the segment. Near the downstream end, the segment flows through high density commercial and residential neighborhoods in downtown Maynard. Stormwater runoff from urban areas is likely the most significant source of pathogens.

Illicit Sewage Discharges: With a portion of the land area in sewer service and most (61%) of the watershed designated as MS4 area, leaky sewer lines and illicit connections are possible sources. Sewer related risks include leaking infrastructure (pipes, pump stations, etc.) and sanitary sewer overflows, 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 drains are also a risk.

On-Site Wastewater Disposal Systems: There are two (not in the immediate drainage area) groundwater discharge permits for on-site wastewater discharge, which are large-capacity septic systems (non-residential). Much of the residential development in the watershed uses septic systems for wastewater treatment; it is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: There are over 3,400 acres of agricultural land, including large orchards and croplands along the upstream half of 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 are over 14,000 acres of Protected and Recreational Open Space in the watershed. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: Conservation and recreational lands with large open mowed areas with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water.

15.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Hudson. see Section 14.4.

Town of Maynard

All of Maynard is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Maynard (Permit ID#MAR041208) has an EPA approved Notice of Intent (NOI) and has mapped all of its MS4 stormwater system, with a map on its stormwater webpage. It adopted IDDE, ESC, and post-construction stormwater regulations in 2007-09. Maynard reports 74 outfalls to the Assabet River MA82B-05 and upstream wetlands.

Stormwater page: https://www.townofmaynard-ma.gov/dpw/stormwater-management/ (Town of Maynard, 2021)

Maynard has the following ordinances and bylaws:

- Stormwater Ordinance or Bylaws: https://www.townofmaynard-ma.gov/wp-content/uploads/2010/07/maynard-stormwater-regulations-20170801.pdf (Town of Maynard, N.d.)
- Stormwater Utility (or similar): None found.
- Title 5 Supplemental Regulations or Bylaws: None found.
- Wetlands: https://www.townofmaynard-ma.gov/wp-content/uploads/2010/07/Regulations-_2007_-revised.pdf (Town of Maynard, N.d.)
- Pet Waste: https://www.townofmaynard-ma.gov/2020/03/30/scoop-the-poop/ (Town of Maynard, 2020b)

- Contact Recreation Regulations or Bylaws: None found.

Maynard's previous Master Plan was created in 1991, and the process of creating a new one is underway. See: http://maynardmp.com/ (Town of Maynard, 2020a) and https://www.townofmaynard-ma.gov/gov/master-plan/ (Town of Maynard, 2020a)

2004 Open Space and Recreation Plan: https://www.townofmaynard-ma.gov/wp-content/uploads/2010/07/osrp.pdf (Town of Maynard, 2004)

Maynard is part of the Minuteman Advisory Group on Interlocal Coordination within the Metropolitan Area Planning Council (MAPC, http://www.mapc.org/). (MAPC, 2021).

Town of Stow

Most of Stow is US Census defined "Urban Area" and is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Stow (Permit ID#MAR041223) has an EPA approved Notice of Intent (NOI).The Assabet River MA82B-05 is mostly within the MS4 area, and Elizabeth Brook MA82B-12 is outside. Its NOI states that it has mapped none of its MS4 stormwater system when the NOI was filed, with completion set for July 2019, although a link is provided to map of approximate outfall locations, https://www.stow-ma.gov/sites/g/files/vyhlif1286/f/uploads/ms4_map_legend.pdf (Town of Stow, 2018) IDDE regulations were slated for adoption in May 2019, and ESC and post-construction stormwater regulations were adopted in 2005. Stow reports two outfalls to the Assabet River MA82B-05.

Stormwater webpage: https://www.stow-ma.gov/highway-department/pages/stormwater-matters (Town of Stow, n.d., a)

SWMP: Not found

Stow has the following ordinances and bylaws:

- Stormwater Ordinance or Bylaws: Stormwater management in subdivision rules and regulations, section 7.9, page 39: https://www.stow-ma.gov/sites/g/files/vyhlif1286/f/uploads/subdivision_rules_and_regs_-_revised_april_18_2017_.pdf (Town of Stow, 2017)
- Stormwater Utility (or similar): None found.
- Title 5 Supplemental Regulations or Bylawshttps://www.stow-ma.gov/sites/g/files/vyhlif1286/f/uploads/town_of_stow_septic_regulations.pdf (Town of Stow, 2005)
- Wetlands:https://www.stow-ma.gov/conservation-commission/pages/guide-wetland-permitting-stow (Town of Stow, n.d., b)
- Pet Waste: https://www.stow-ma.gov/sites/g/files/vyhlif1286/f/uploads/stow_conservation_land_regulations.pdf (Town of Stow, 2016b)

Stow's 2010 Master Plan contains an extensive description of the Assabet River, including its impairment status and mentions the Town's stormwater plan. The Open Space and Recreation Plan has an updated natural resource inventory and cites the work of OARS in the Elizabeth River watershed.

https://www.stow-ma.gov/system/files/uploads/final_plan.pdf (Town of Stow, 2010)

Stow's 2016 Open Space and Recreation Plan: https://www.stow-ma.gov/conservation-commission/pages/open-space-recreation-plan (Town of Stow, 2016a)

Stow is part of the Minuteman Advisory Group on Interlocal Coordination within the Metropolitan Area Planning Council (MAPC, http://www.mapc.org/). (MAPC, 2021).

16. MA82B-07 Assabet River

16.1. Waterbody Overview

The Assabet River segment MA82B-07 is 6.4 miles long and begins at Powdermill Dam (NATID: MA00128) in Acton, then crossing in and out of Concord twice, before flowing northeast through Concord to end at its confluence with the Sudbury River, forming the headwaters of the Concord River in Concord near Egg Rock. It is bound upstream by the impounded Assabet River MA82B-06 above Powdermill Dam and downstream by the Concord River MA82A-07, which is pathogen-impaired. Its tributaries include Second Division Brook draining Kennedys Pond, Fort Pond Brook draining Warners Pond, and Spencer Brook draining Angiers Pond.

Major landmarks include Harrington Park, Cousins Park, Thoreau Elementary School, West Concord village in Concord, MCI-Concord prison, Barretts Mill Farmland (farm and adjacent conservation land), and Egg Rock and surrounding wooded conservation land in Concord. Road crossings include Powdermill Road in Acton, and Main Street (three times), Pine Street, and Elm Street in Concord.

The Assabet River segment MA82B-07 drains an area of 178 square miles, of which 20 mi^2 (11%) is impervious and 10 mi^2 (6%) is directly connected impervious area (DCIA). The watershed is partially[38] served by public sewer, and 61% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are three NPDES wastewater treatment facility permits on file governing point source discharges of pollutants to surface waters in the immediate drainage area to the impaired segment (Table 16-1). There are also eight MassDEP discharge to groundwater permits for on-site wastewater discharge within the immediate drainage area (Table 16-2). See Figure 16-1.

Reduction from Highest Calculated Geomean: 91%

Watershed Area (Acres): 113,674

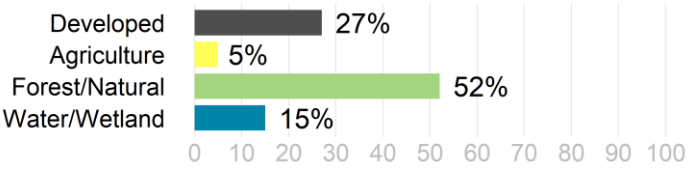
Segment Length (Miles): 6.4

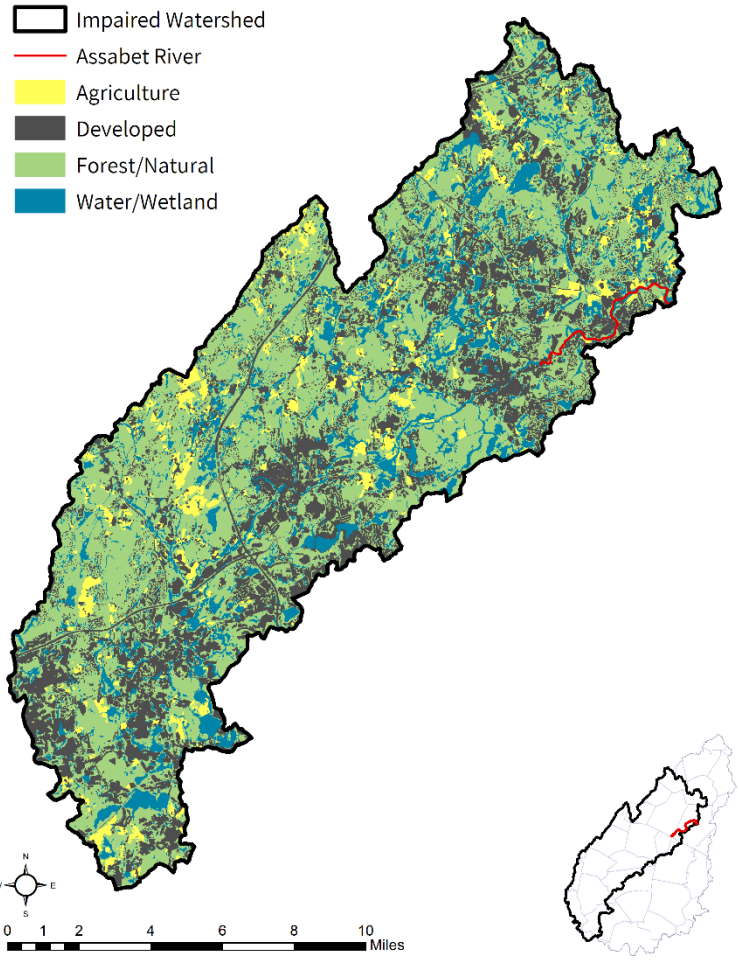
Impairment(s): *E. coli*, fecal coliform (Primary Contact Recreation)

Class (Qualifier): B (Warm Water)

Impervious Area (Acres, %): 12,974 (11%)

DCIA Area (Acres, %): 6,552 (6%)





[38] 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 https://www.mass.gov/guides/water-utility-resilience-program(MassDEP, 2020), MS4 reports, and local knowledge.

Table 16-1. National Pollutant Discharge Elimination System (NPDES) permits in the segment watershed. Only permits unique to this segment watershed are shown. Wastewater Treatment Facilities (WWTF) are identified as either municipal (MUN) or other (OTH), if applicable.

NPDES ID	NAME	TOWN	WWTF
MA0101001	MAYNARD WWTF	MAYNARD	MUN
MA0102245	MCI - CONCORD	CONCORD	
MA0102466	MIDDLESEX SCHOOL WWTP	CONCORD	OTH

Table 16-2. 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)
656-2	TOWN OF ACTON WWTF	ACTON	Sanitary Discharge	250,000
644-2	TECH CENTRAL PARK	BOXBOROUGH	Sanitary Discharge	24,375
686-2	BOXBOROUGH MEADOWS	BOXBOROUGH	Sanitary Discharge	15,840
783-1	CARLISLE PUBLIC SCHOOLS	CARLISLE	Sanitary Discharge	13,500
646-3	CAMP THOREAU	CONCORD	Sanitary Discharge	20,117
888-0	CONCORD MEWS	CONCORD	Sanitary Discharge	66,000
704-2	MEETING HOUSE AT STOW CONDOMINIUM TRUST	STOW	Sanitary Discharge	12,000
837-1	STOW SHOPPING PLAZA	STOW	Sanitary Discharge	38,000

The watershed and river corridor are characterized by small areas of high-density commercial development at the upstream end and at West Concord village, and the remaining areas alternate between forest and medium to high density residential areas. A wooded riparian corridor is mostly intact throughout the segment.

The watershed of the Assabet River (MA82B-07) contains an Area of Critical Environmental Concern, "Miscoe, Warren and Whitehall Watersheds," 2.8 acres (0.002%). Under the Natural Heritage and Endangered Species Program, there are 37 acres (0.03%) of Priority Natural Vegetation Communities and 9,557 acres (8%) of Priority Habitats of Rare Species. Over 5,958 acres (5%) of land protected in perpetuity[39] exist within the segment watershed, which is part of a total of 27,847 acres (24%) of Protected and Recreational Open Space[40]. There are 3,780 acres (3%) under Public Water Supply protection and no areas identified as Outstanding Resource Waters. See Figure 16-1.

[39] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetlands restrictions, aquifer protection, historic preservation, etc. Refer to MassGIS metadata for the Protected and Recreational Open Space data layer. Land protected in perpetuity reflect watershed-wide estimates (including for watersheds that extend outside of the State of Massachusetts).

[40] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside of the State of Massachusetts).

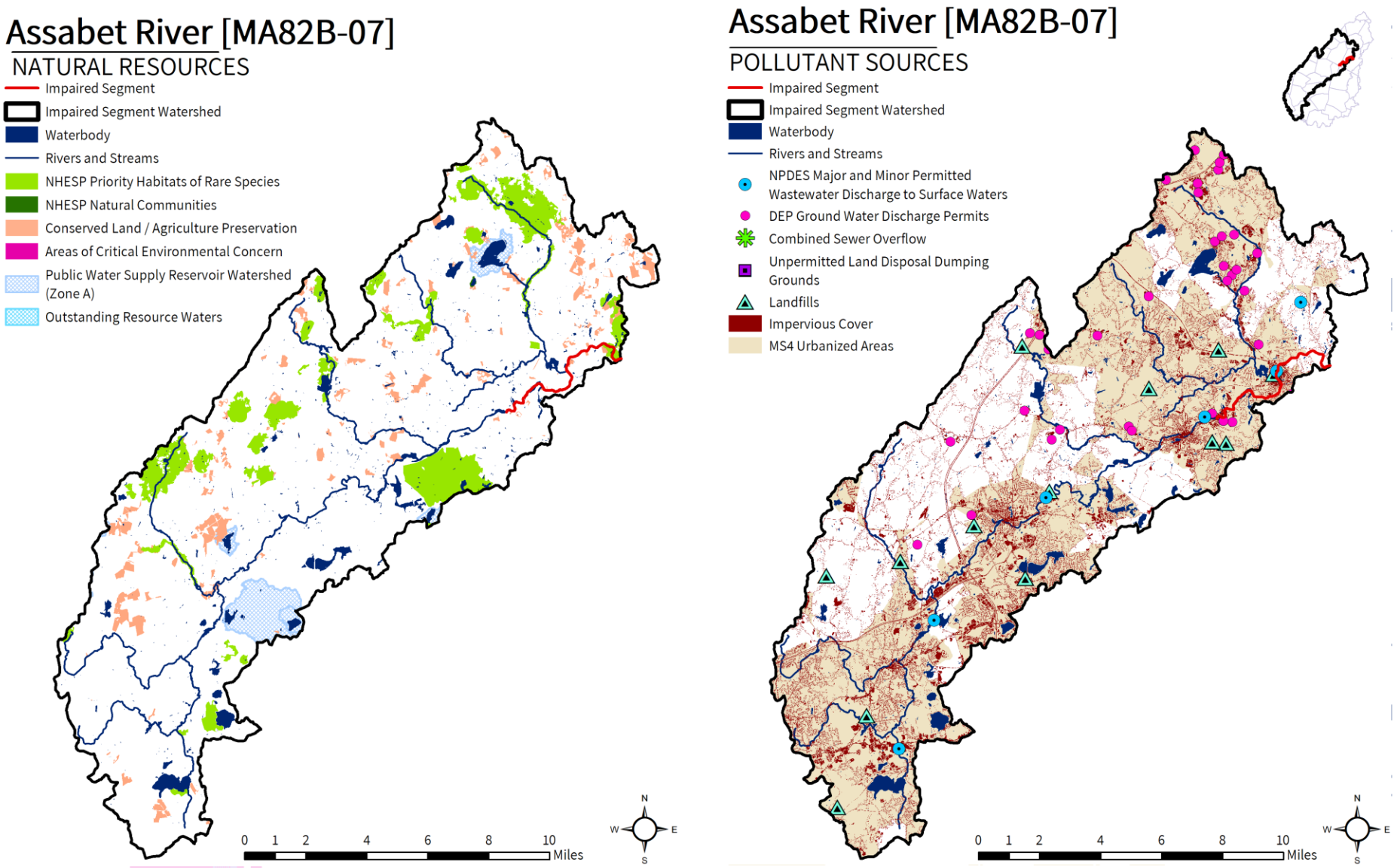


Figure 16-1. Natural resources and potential pollution sources draining to the Assabet River segment MA82B-07. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, permitted facilities.

16.2. Waterbody Impairment Characterization

The Assabet River (MA82B-07) is a Class B, Warm Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* and fecal coliform at the stations listed below (refer to Tables 16-3, 16-4; Figure 16-2). 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, 30-day rolling basis.

- In 2006, five samples were collected at W0843, resulting in five days when the 30-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 wet weather.
- In 2006, five samples were collected at W1479, resulting in five days when the 30-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, four exceeded the STV criterion during both wet and dry weather.

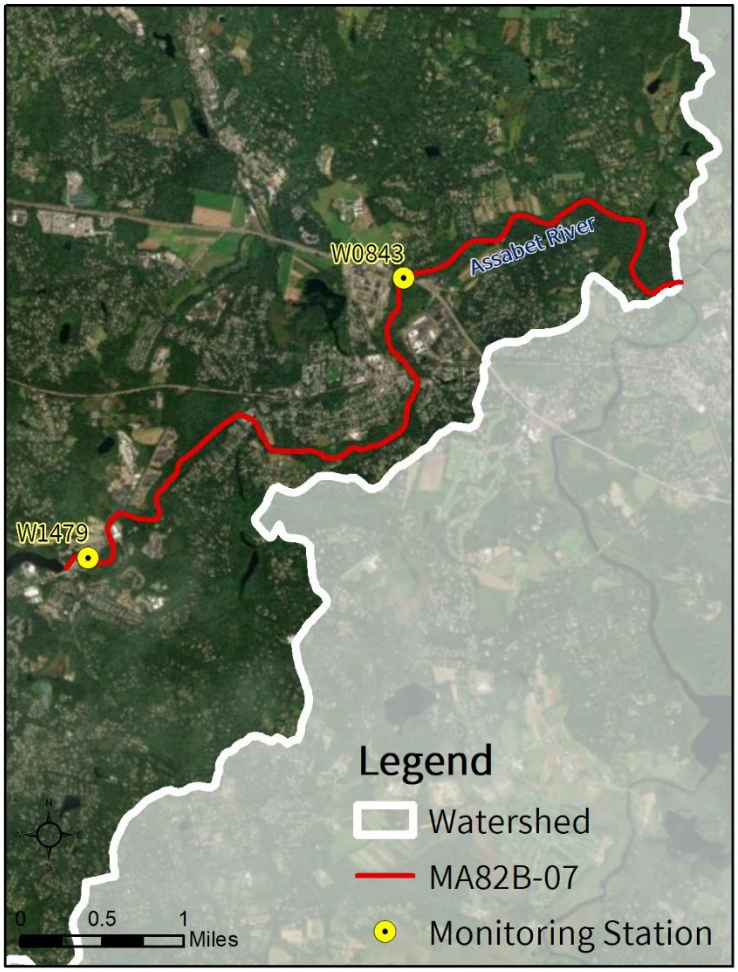


Figure 16-2. Location of monitoring station(s) along the impaired river segment.

Table 16-3. Summary of indicator bacteria sampling results by station for the Assabet River (MA82B-07). The maximum 30-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 Statistical Threshold Value (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 30-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 30-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
W0843	5/3/06	9/25/06	5	470	5	1
W1479	5/3/06	9/25/06	5	1400	5	4

Table 16-4. Indicator bacteria data by station, indicator, and date for the Assabet River (MA82B-07). Each sample date was designated wet or dry weather with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text 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 Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 30-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
W0843	*E. coli*	5/3/06	WET	280	280	
W0843	*E. coli*	6/7/06	WET	470	470	
W0843	*E. coli*	7/19/06	DRY	370	370	
W0843	*E. coli*	8/23/06	DRY	370	370	
W0843	*E. coli*	9/25/06	DRY	400	400	
W0843	Fecal Coliform	5/3/06	WET	140		
W0843	Fecal Coliform	6/7/06	WET	380		
W0843	Fecal Coliform	7/19/06	DRY	340		
W0843	Fecal Coliform	8/23/06	DRY	390		
W0843	Fecal Coliform	9/25/06	DRY	400		
W1479	*E. coli*	5/3/06	WET	350	350	
W1479	*E. coli*	6/7/06	WET	450	450	
W1479	*E. coli*	7/19/06	DRY	840	840	
W1479	*E. coli*	8/23/06	DRY	1400	1400	
W1479	*E. coli*	9/25/06	DRY	960	960	
W1479	Fecal Coliform	5/3/06	WET	260		
W1479	Fecal Coliform	6/7/06	WET	450		
W1479	Fecal Coliform	7/19/06	DRY	840		
W1479	Fecal Coliform	8/23/06	DRY	2400		
W1479	Fecal Coliform	9/25/06	DRY	900		

16.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present and 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 SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants, which then becomes diluted during periods of 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).

The indicator bacteria data for the Assabet River (MA82B-07) were elevated during wet weather at each of the two sampling stations, suggesting 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 wet weather indicator bacteria levels.

Elevated indicator bacteria during dry weather indicate that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, may be present. The most upstream station (W1479) had elevated dry weather indicator bacteria levels and is located downstream of Maynard's downtown and the impounded Assabet River (MA82B-06) above Powdermill Dam. Wastewater infrastructure and illicit discharges in that area should be a focus of additional monitoring and pathogen source tracking.

Each potential pathogen source is described in further detail below.

Urban Stormwater: Portions of the Assabet River (MA82B-07) watershed are highly developed, with 61% of the land area in MS4 and 6% as DCIA. In some areas, the river is flanked by large commercial properties with expansive parking lots, and in others, there is a dense residential street network. Stormwater runoff from urban areas is likely the most significant source of pathogens.

Illicit Sewage Discharges: With a portion of the land area in sewer service and most (61%) of the watershed designated as MS4 area, leaky sewer lines and illicit connections are also possible sources. Sewer related risks include leaking infrastructure (pipes, pump stations, etc.) and sanitary sewer overflows, 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 drains are also a risk.

On-Site Wastewater Disposal Systems: There are 33 (eight in the immediate drainage area) groundwater discharge permits for on-site wastewater discharge, which are large-capacity septic systems (non-residential). Much of the residential development in the watershed uses septic systems for wastewater treatment. It is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Agriculture, including row crops and greenhouses, are close to the river in several locations. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: There are many conservation tracts along the river, as well as a few parks and ballfields. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: Conservation and recreational lands with large open mowed areas with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water.

16.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Acton

Almost all of Acton is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Acton (Permit ID#MAR041238) has an EPA approved Notice of Intent (NOI) and has mapped all of its MS4 stormwater system, submitting a hardcopy map along with its NOI. It adopted IDDE regulations in 2010, and ESC and post-construction stormwater regulations in 2017, which within two years had already covered three major and multiple minor construction projects which otherwise would not have had any erosion controls or stormwater BMPs. All commercial and industrial properties must obtain annual permits for discharges to the municipal stormwater system, generating revenue for stormwater monitoring. There are seven reported stormwater outfalls to the Assabet River MA82B-07, and 49 to the Nashoba Brook MA82B-14 (not indicated as pathogen-impaired on the NOI).

Acton Stormwater page: http://www.acton-ma.gov/339/Stormwater (Town of Acton, 2016)

SWMP: http://www.acton-ma.gov/DocumentCenter/View/5488/20181101-Town-of-Acton---SWMP (Town of Acton, 2018)

Acton has the following ordinances and bylaws:

- Stormwater Ordinance: "Discharge to Municipal Storm Drain System" Chapter U and "Stormwater Management and Erosion & Sediment Control" Chapter X in Town Bylaws: http://www.acton-ma.gov/DocumentCenter/View/614/2018-General-Bylaws?bidId= (Town of Acton, 2019a)

- Town of Action General Bylaws state that septic systems must meet Title V regulations, F4.4 page 40: http://www.acton-ma.gov/DocumentCenter/View/614/2018-General-Bylaws?bidId= (Town of Acton, 2019b)
- Open Space Development, Town of Acton Bylaw, page 42: http://www.acton-ma.gov/DocumentCenter/View/659/2018-Zoning-Bylaws?bidId= (Town of Acton, 2020)
- Wetland Protection Bylaw: Bylaws of the Town of Acton > Environmental Protection > Wetland Protection, page 35: http://www.acton-ma.gov/DocumentCenter/View/614/2018-General-Bylaws?bidId= (Town of Acton, 2019c)
- Pet waste: None found.

Acton's Master Plan includes a section on Surface Water Resources (p. 130). It mentions the MS4 program in two places: (1) Ensure Environmental Sustainability > Objective 2.1 Protect the quality and quantity of Acton's water, pp. 65-66. (2) Existing Conditions > Facilities and Services > Stormwater Management, p. 157. The plan also specifically mentions the Assabet River's pathogen-impaired status, and its uses for recreation (p. 79) and wildlife (p. 131). In addition, there is a section on Water Supply and Wastewater Management, and Action has a Comprehensive Water Resource Management Plan. http://www.acton-ma.gov/documentcenter/view/109 (Town of Acton, 2020)

Acton's 2012 Comprehensive Water Resource Management Plan: https://www.acton-ma.gov/139/Comprehensive-Water-Resource-Management- (Town of Acton, 2020)

Acton's 2014-2021 Open Space and Recreation Plan, which cites the impaired status of the Assabet River, http://doc.acton-ma.gov/dsweb/Get/Document-50377/2015%20Acton%20OpenSpace.pdf (Town of Acton, 2014)

Acton is part of the Minuteman Advisory Group on Interlocal Coordination within the Metropolitan Area Planning Council (MAPC, http://www.mapc.org/). (MAPC, 2021).

Town of Concord. see Section 5.4.

17. MA82B-12 Elizabeth Brook

17.1. Waterbody Overview

Elizabeth Brook segment MA82B-12 is 3.7 miles long, located entirely within the Town of Stow. It begins at the outlet of an unnamed pond west of Harvard Road, then flows southeast to end at the inlet of Fletchers Pond. Elizabeth Brook is bound at its upstream point by the Delaney Flood Control Site, also called the "Delaney Project" or "Delaney Complex", which is an impoundment of Elizabeth Brook, and at the downstream point by Fletchers Pond. This segment contains the impoundments of (Lower) Delaney Pond and Wheeler Pond, and tributaries of Hiley Meadows wetland and several unnamed streams draining small ponds or wetlands.

Major landmarks are the expansive mowed fields and trails by the Delaney Project outfall, a large solar panel installation next to Lower Delaney Pond, and Stow Acres Country Club and Butternut Farm Golf Club, both of which abut the segment at the Wheeler Pond impoundment. Road crossings include Delaney Street, Hiley Brook Road, Great Road, Wheeler Road, and Gleasondale Road. A portion of the watershed is also located in Bolton.

Elizabeth Brook (MA82B-12) drains an area of 18 square miles, of which 1.1 mi^2 (6%) is impervious and 0.4 mi^2 (2%) is directly connected impervious area (DCIA). The watershed does not appear to have any areas served by public sewer, and 12% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are no additional NPDES permits on file. There are seven MassDEP discharge to groundwater permits for on-site wastewater discharge within this watershed (Table 17-1). See Figure 17-1.

Reduction from Highest Calculated Geomean: 43%

Watershed Area (Acres): 11,341

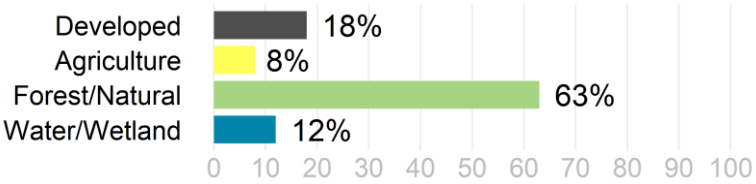
Segment Length (Miles): 3.7

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

Class: B

Impervious Area (Acres, %): 715 (6%)

DCIA Area (Acres, %): 259 (2%)



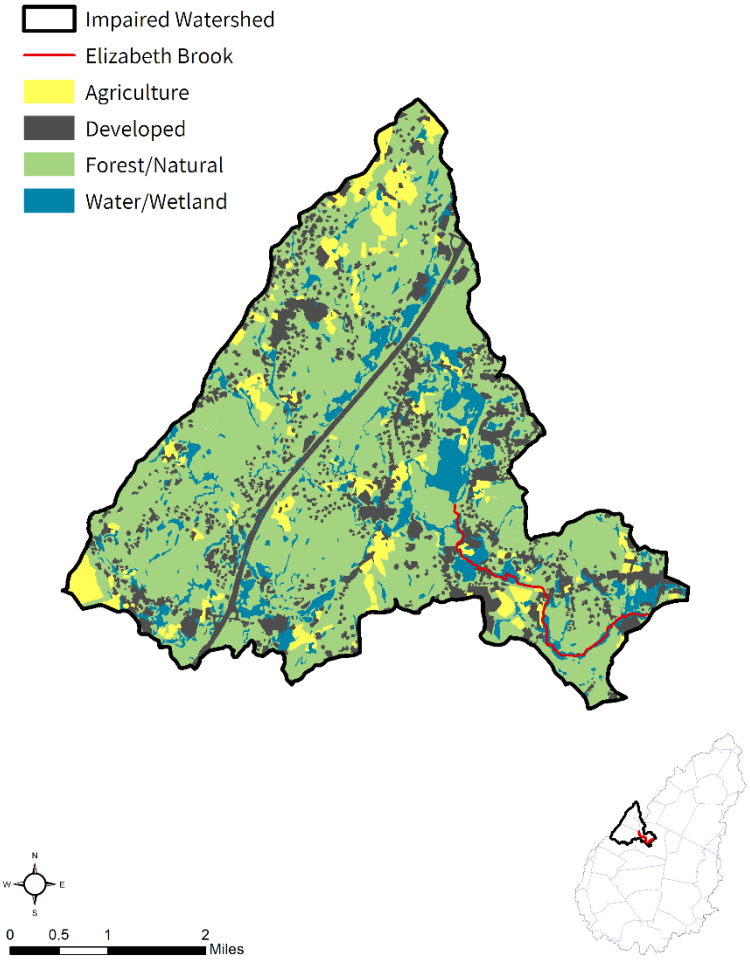


Table 17-1. Groundwater discharge permits in the segment watershed. Only permits unique to this segment watershed are shown. PERR = permit number plus renewal number. TYPE = type of groundwater discharge. Flow = permitted effluent in gallons per day (gpd).

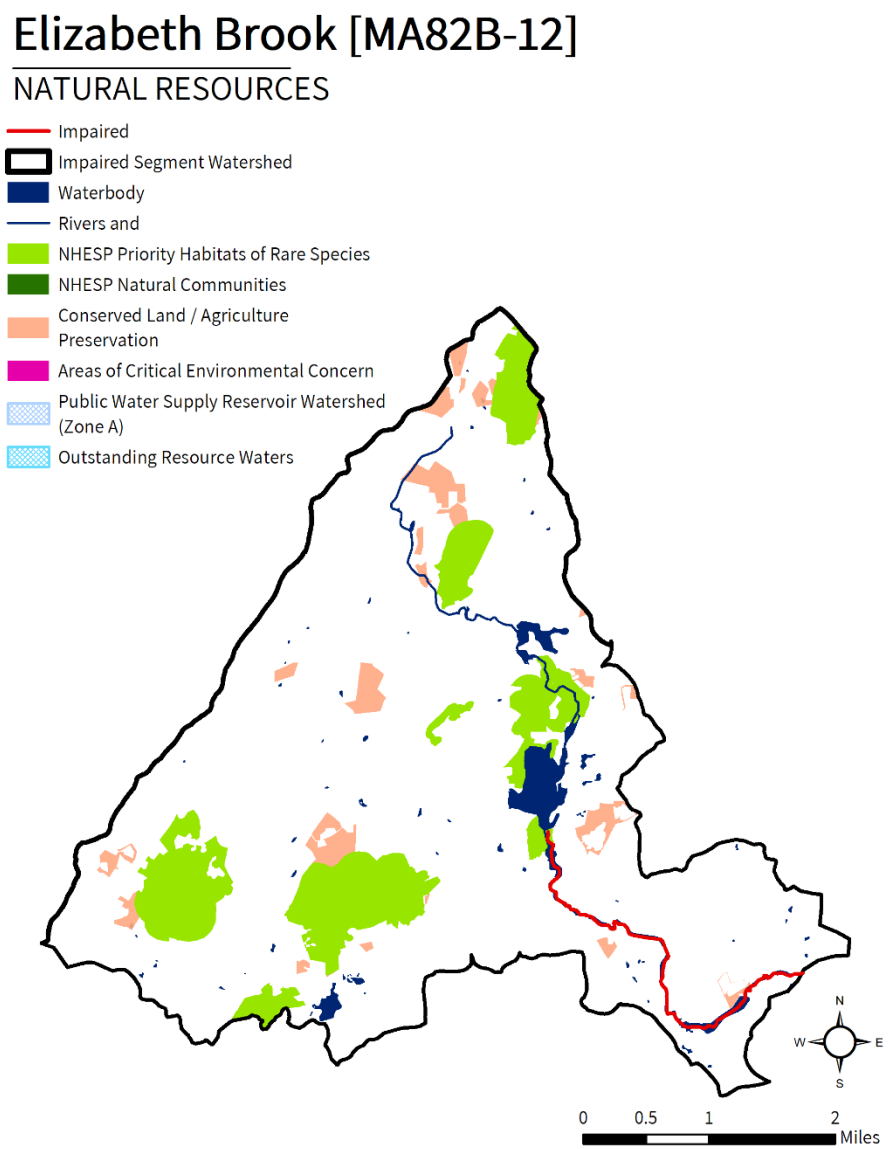
PERR	NAME	TOWN	TYPE	FLOW (GPD)
833-1	EMERSON & FLORENCE-SAWYER SCHOOL	BOLTON	Sanitary Discharge	38,000
937-0	PARAGON HOLDINGS, LLC	BOLTON	Sanitary Discharge	16,000
460-3	BOXBORO REGENCY	BOXBOROUGH	Sanitary Discharge	40,000
718-2	CISCO SYSTEMS - NEDC SITE I	BOXBOROUGH	Sanitary Discharge	25,000
842-0	CODMAN HILL CONDOMINIUM	BOXBOROUGH	Sanitary Discharge	19,800
299-5	BOSE CORPORATION	STOW	Sanitary Discharge	48,000
786-1	STOW VILLAGES, LLC	STOW	Sanitary Discharge	34,000

The watershed and river corridor are characterized by large, wooded areas, low density residential development, some fringing emergent wetlands, and the fields and golf course cited above. There are sparse commercial sites and fields scattered through the watershed.

In the watershed of Elizabeth Brook (MA82B-12), under the Natural Heritage and Endangered Species Program, there are 1,324 acres (12%) of Priority Habitats of Rare Species. Over 557 acres (5%) of land protected in perpetuity[41] exist within the segment watershed, which is part of a total of 3,027 acres (27%) of Protected and Recreational Open Space[42]. There are no Areas of Critical Environmental Concern, no areas under Public Water Supply protection, and no areas identified as Outstanding Resource Waters. See Figure 17-1.

[41] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetlands restrictions, aquifer protection, historic preservation, etc. Refer to MassGIS metadata for the Protected and Recreational Open Space data layer. Land protected in perpetuity reflect watershed-wide estimates (including for watersheds that extend outside of the State of Massachusetts).

[42] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside of the State of Massachusetts).



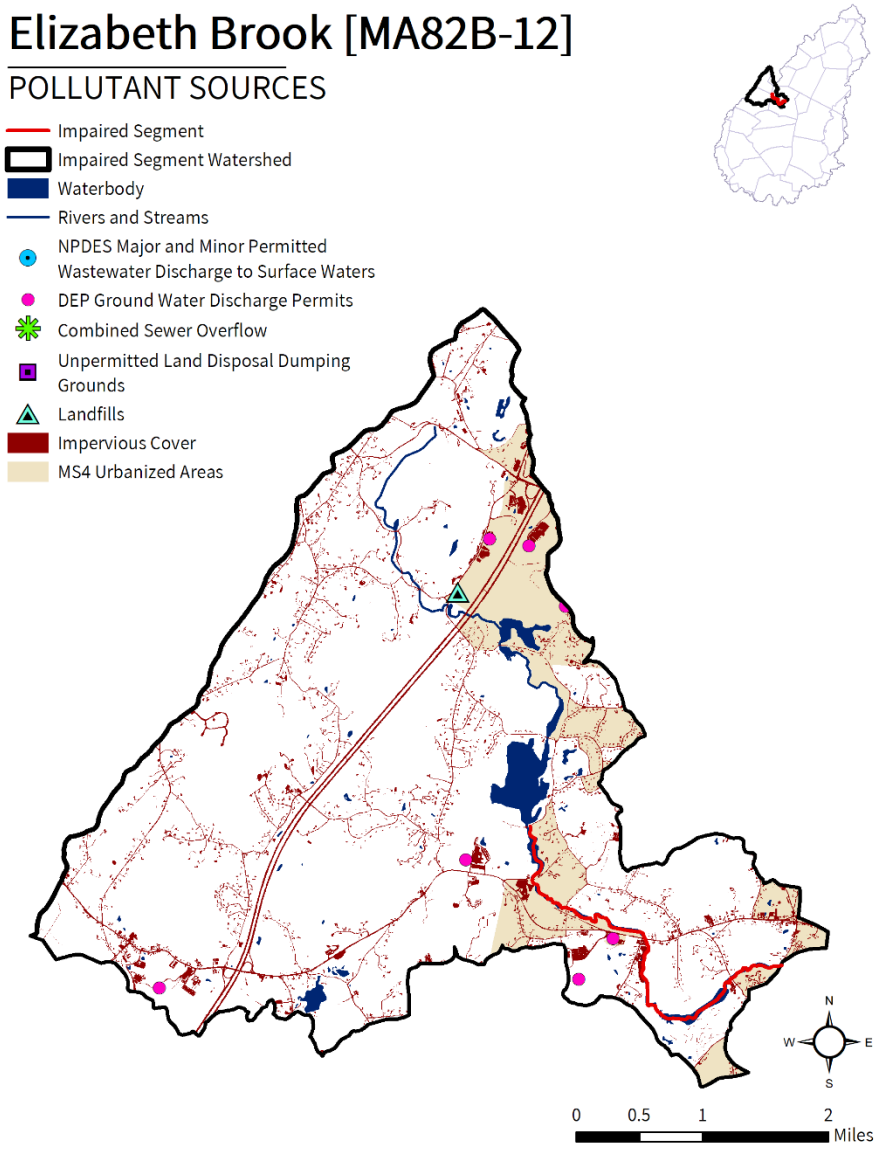


Figure 17-1. Natural resources and potential pollution sources draining to the Elizabeth Brook segment MA82B-12. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, permitted facilities.

17.2. Waterbody Impairment Characterization

Elizabeth Brook (MA82B-12) is a Class B Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* at the stations listed below (refer to Tables 17-2, 17-3; Figure 17-2). 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 2010, six samples were collected at W2134, resulting in four 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 six samples, one exceeded the STV criterion during wet weather.
- In 2010, six samples were collected at W2138, resulting in no 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 six samples, none exceeded the STV criterion.

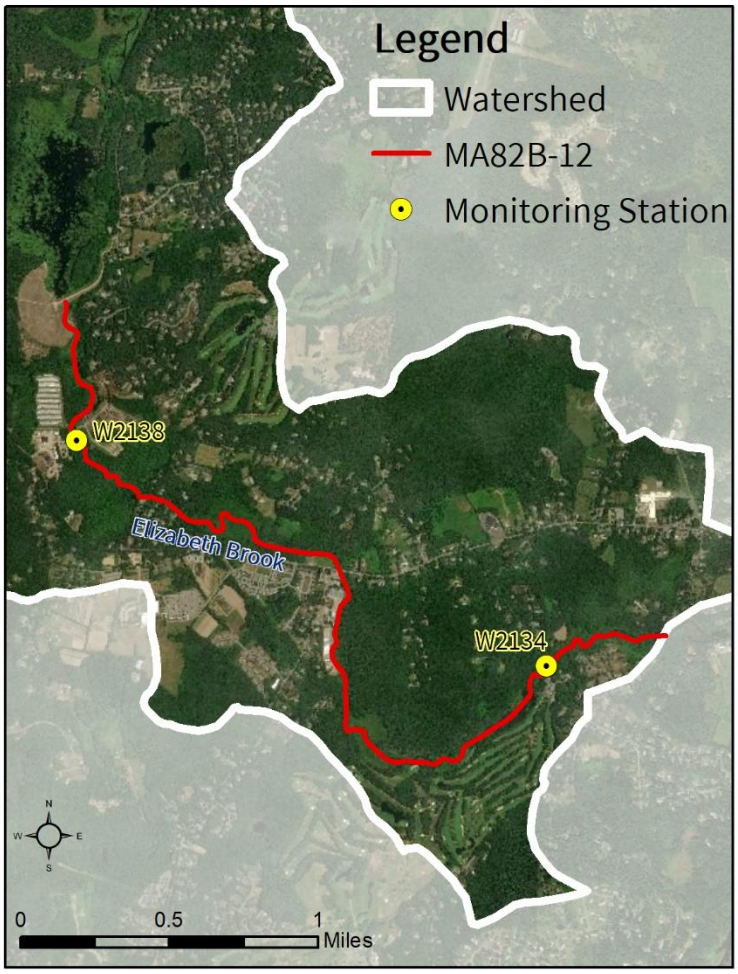


Figure 17-2. Location of monitoring station(s) along the impaired river segment.

Table 17-2. Summary of indicator bacteria sampling results by station for Elizabeth Brook (MA82B-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 Statistical Threshold Value (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
W2134	5/11/10	9/21/10	6	220	4	1
W2138	5/11/10	9/21/10	6	112	0	0

Table 17-3. Indicator bacteria data by station, indicator, and date for Elizabeth Brook (MA82B-12). Each sample date was designated wet or dry weather with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text 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 Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 90-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W2134	*E. coli*	5/11/10	DRY	40	40	
W2134	*E. coli*	6/15/10	DRY	200	89	
W2134	*E. coli*	7/1/10	DRY	300	134	
W2134	*E. coli*	7/20/10	WET	620	196	
W2134	*E. coli*	8/16/10	DRY	57	215	
W2134	*E. coli*	9/21/10	DRY	220	220	
W2138	*E. coli*	5/11/10	DRY	50	50	
W2138	*E. coli*	6/15/10	DRY	70	59	
W2138	*E. coli*	7/1/10	DRY	52	57	
W2138	*E. coli*	7/20/10	WET	81	62	
W2138	*E. coli*	8/16/10	DRY	150	82	
W2138	*E. coli*	9/21/10	DRY	250	112	

17.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present and 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 SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants, which then becomes diluted during periods of 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 Elizabeth Brook (MA82B-12) were elevated during wet weather, indicating possible 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 large precipitation events, may also result in elevated wet weather indicator bacteria levels. The presence of large commercial greenhouses adjacent to Elizabeth Brook just upstream of station W2134 also suggests that agricultural runoff is a possible source.

Each potential pathogen source is described in further detail below.

Urban Stormwater: Portions of the Elizabeth Brook (MA82B-12) watershed are highly developed, with 12% of the land area in MS4 and 2% as DCIA. Although the development density is relatively light, there are low density residential neighborhoods and some large commercial properties. Stormwater runoff from urban areas is likely the most significant source of pathogens.

Illicit Sewage Discharges: While there does not appear to be any public sewer service within the watershed, 12% of the land area is designated as MS4 area. Given the relatively light pattern of development, the most likely type of Illicit connections is from on-site wastewater systems to stormwater drains, such as leaky building drain lines and illicit connections to stormwater pipes or drains. In addition, illicit discharges may be caused by undersized infrastructure, blockages, or excessive infiltration of groundwater or rainwater into pipes, exceeding system capacity.

On-Site Wastewater Disposal Systems: There are seven groundwater discharge permits for on-site wastewater discharge, which are large-capacity septic systems (non-residential). Much of the residential

development in the watershed uses septic systems for wastewater treatment. It is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Some large agricultural fields dedicated to row crops and orchards are visible in the watershed. 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, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: Conservation and recreational lands with large open mowed areas with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water.

17.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Bolton

The Town of Bolton contains very little "Urban Area" as defined by the US Census and is covered by an MS4 General Permit waiver from NPDES II / MS4 program.

Bolton has the following ordinances and bylaws:

- Stormwater Management is partially regulated under Town of Bolton Subdivision Rules and Regulations > Utility Design > Chapter 5233, page 29: https://www.ecode360.com/BO3017/laws/LF867678.pdf (Town of Bolton, 2015b)
- There is no specific Title 5 bylaw, but obligation to adhere to Title 5 is stated Town of Bolton Code, Chapter 147-1: https://www.ecode360.com/14850095?highlight=septic&searchId=87252791418898#14850095 (Town of Bolton, 2015a)
- Wetland Bylaws: https://www.townofbolton.com/conservation-commission/pages/wetland-bylaw-regulations (Town of Bolton, 2013)
- Pet waste, only for town owned conservation land with public access: https://www.townofbolton.com/sites/g/files/vyhlif2836/f/uploads/dogsbrochure2.27.2018.pdf (Town of Bolton, 2018)
- Farmland and Open Space Planned Residential Development (FOSPRD), a specific development type aimed at integrating open space conservation land into new developments, Town of Bolton Code, Chapter 250-14: https://www.ecode360.com/14848474 (Town of Bolton, 1996)
- Stormwater Utility (or similar): None found.

Bolton's 2006 Master Plan includes a water resources land cover map (p.24), and stormwater is mentioned in goals to strengthen site plan review bylaw (p. 59). Wastewater is discussed regarding the need to create a treatment plant to serve two schools, which was under construction at the time of the plan and allowing for common septic systems in FOSPRD plans. The plan also mentions Bolton Town Beach under the Recreation section, page 71.

Master Plan https://www.townofbolton.com/planning-board/files/bolton-master-plan (Town of Bolton, 2006)

Bolton's 2017 draft Open Space and Recreation Plan https://www.townofbolton.com/conservation-commission/files/2017-open-space-and-recreation-plan-draft (Town of Bolton, 2017)

Bolton is part of the Minuteman Advisory Group on Interlocal Coordination within the Metropolitan Area Planning Council (MAPC, http://www.mapc.org/). (MAPC, 2021).

Town of Stow. see Section 15.4.

18. MA82B-14 Nashoba Brook

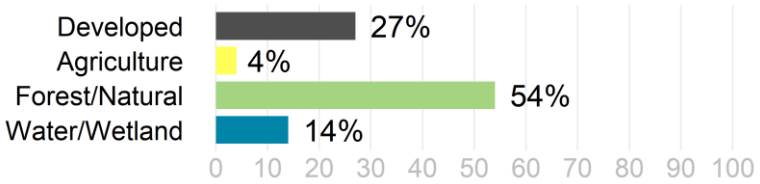
18.1. Waterbody Overview

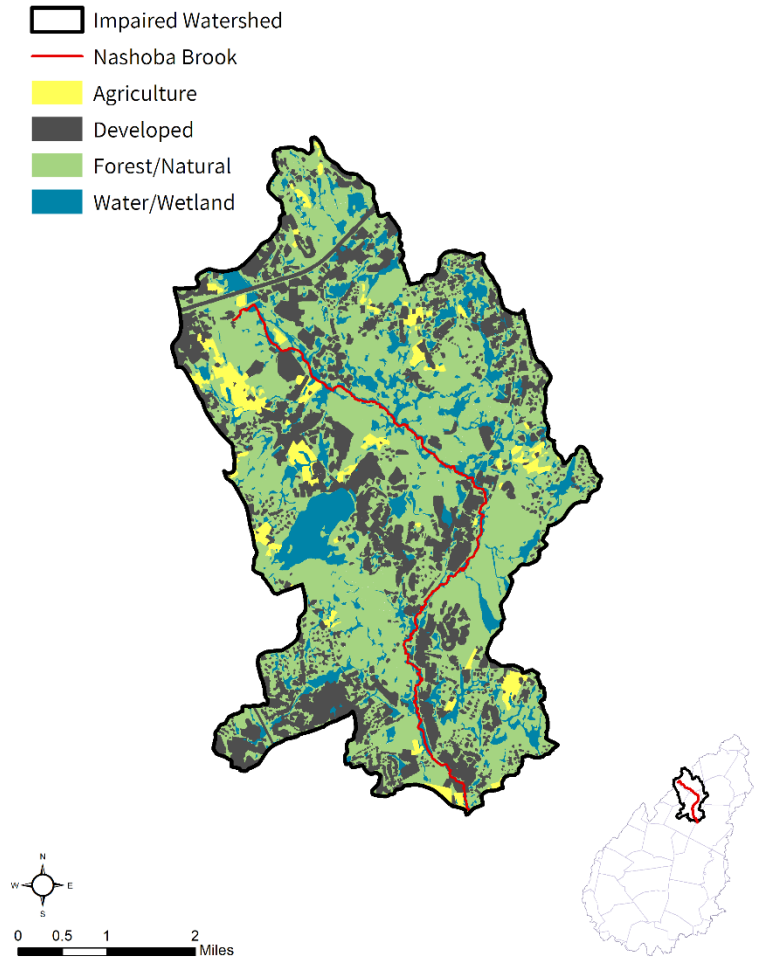
Nashoba Brook segment MA82B-14 is 9.4 miles long and begins just south of Route 110 in Westford, then flowing southeast into Action, then flowing south through Acton into Concord, and ending at its confluence with Fort Pond Brook (through Ice House Pond; formerly segment MA82066), about 0.25 miles beyond the Concord border. Nashoba Brook segment MA82B-14 is bound on the upstream end by a short section of Nashoba Brook draining nearby wetlands around I-495 and MA-110 and on the downstream end by Fort Pond Brook entering Warners Pond. Tributaries include Nonset Brook and Nagog Brook. A portion of the watershed is also located in Littleton.

Major landmarks include Nashoba Valley Ski Area, Nashoba Brook Wildlife Sanctuary, Emmet Conservation lands, Butter Brook Golf Club, the forested conservation land of Nashoba Brook Reservoir, the paved Bruce Freeman Rail Trail with several river crossings south of Main Street/MA-27 and which follows the lower half of the segment. Road crossings include Power Road and an unnamed dirt road in Westford; Main Street/MA-27, Carlisle Road, Great Road/MA-2A/MA-119, Brook Street, Concord Road, and Weatherbee Street in Acton; and the divided highway Union Turnpike/MA-111/MA-2 in Concord.

Nashoba Brook (MA82B-14) drains an area of 21 square miles, of which 2.5 mi^2 (12%) is impervious and 1.3 mi^2 (6%) is directly connected impervious area (DCIA). The watershed is partially[43] served by public sewer, and 77% of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are 17 MassDEP discharge to groundwater permits for on-site wastewater discharge within this watershed (Table 18-1). See Figure 18-1.

Reduction from Highest Calculated Geomean: 89%
Watershed Area (Acres): 13,512
Segment Length (Miles): 9.4
Impairment(s): *E. coli* (Primary Contact Recreation)
Class: B
Impervious Area (Acres, %): 1,603 (12%)
DCIA Area (Acres, %): 821 (6%)





[43] 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 https://www.mass.gov/guides/water-utility-resilience-program(MassDEP, 2020), MS4 reports, and local knowledge.

Table 18-1. 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).

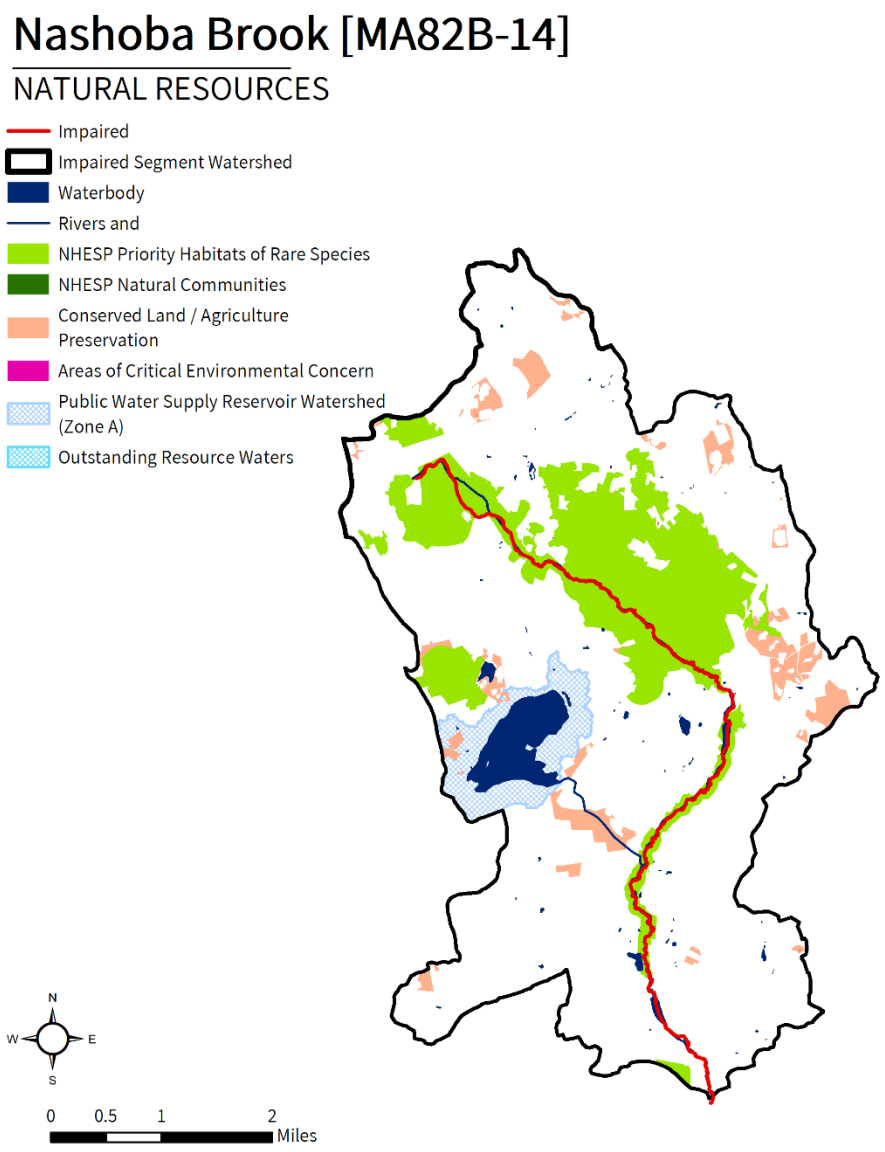
PERR	NAME	TOWN	TYPE	FLOW (GPD)
18-3	NAGOG TREATMENT FACILITY, LLC	ACTON	Sanitary Discharge	200,000
259-4M1	GREAT ROAD CONDOMINIUMS	ACTON	Sanitary Discharge	27,720
288-4	ACORN PARK CONDO. TRUST	ACTON	Sanitary Discharge	39,750
571-3	SUBURBAN MANOR REHAB & NURSING	ACTON	Sanitary Discharge	24,500
655-2	ACTON RETIREMENT COMMUNITY	ACTON	Sanitary Discharge	34,520
831-1	SPRING HILL COMMONS APTS.	ACTON	Sanitary Discharge	20,570
928-0	RESIDENCES AT QUAIL RIDGE	ACTON	Sanitary Discharge	35,000
95-4	FARMBROOK CONDO. TRUST	ACTON	Sanitary Discharge	216,000
936-0	VILLAGE GREEN	LITTLETON	Sanitary Discharge	55,000
386-5	HITCHIN' POST GREENS CONDO	WESTFORD	Sanitary Discharge	80,500
634-2	NASHOBA VIEW II	WESTFORD	Sanitary Discharge	39,900
671-2M1	PRIMROSE PARK	WESTFORD	Sanitary Discharge / Car Wash	35,000
699-2	ONE WESTFORD TECH PARK WEST	WESTFORD	Sanitary Discharge	10,000
795-1	LAUREL HILL PRIVATE SEWER TREATMENT FACILITY	WESTFORD	Sanitary Discharge	95,000
856-0	CORNERSTONE SQUARE	WESTFORD	Sanitary Discharge	41,000
87-5	WESTFORD REGENCY HOTEL	WESTFORD	Sanitary Discharge	40,600
93-5	HILDRETH HILLS CONDO.	WESTFORD	Sanitary Discharge	44,700

The watershed and river corridor are characterized by extensive wetland and forested buffer areas, interrupted by scattered and often large commercial development. The lower portion of the segment along Great Road/MA-2A/MA-119 is across the street from a nearly continuous strip of large commercial development, buffered somewhat by the Bruce Freeman Rail Trail and associated tree cover along the riverbank.

In the watershed of Nashoba Brook (MA82B-14), under the Natural Heritage and Endangered Species Program, there are 2,459 acres (18%) of Priority Habitats of Rare Species. Over 957 acres (7%) of land protected in perpetuity[44] exist within the segment watershed, which is part of a total of 3,327 acres (25%) of Protected and Recreational Open Space[45]. There are no Areas of Critical Environmental Concern and no areas identified as Outstanding Resource Waters. There are 778 acres (6%) under Public Water Supply protection. Figure 18-1.

[44] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetlands restrictions, aquifer protection, historic preservation, etc. Refer to MassGIS metadata for the Protected and Recreational Open Space data layer. Land protected in perpetuity reflect watershed-wide estimates (including for watersheds that extend outside of the State of Massachusetts).

[45] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside of the State of Massachusetts).



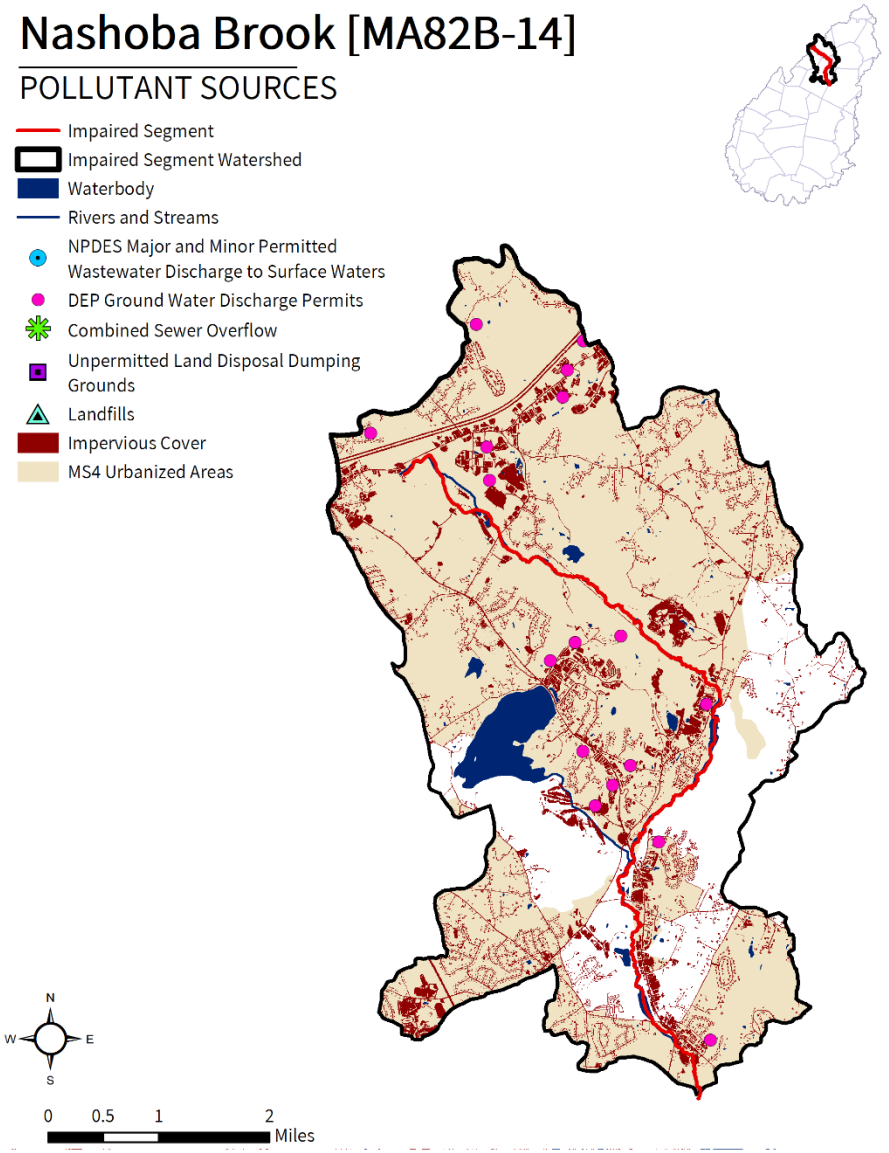


Figure 18-1. Natural resources and potential pollution sources draining to the Nashoba Brook segment MA82B-14. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, permitted facilities.

18.2. Waterbody Impairment Characterization

Nashoba Brook (MA82B-14) is a Class B Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* at the stations listed below (refer to Tables 18-2, 18-3; Figure 18-2). 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

- From 2007-2013, 33 samples were collected at W0698, resulting in seven 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 33 samples, four exceeded the STV criterion during wet weather.
- In 2010, six samples were collected at W2133, resulting in six 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 six samples, one exceeded the STV criterion during wet weather.

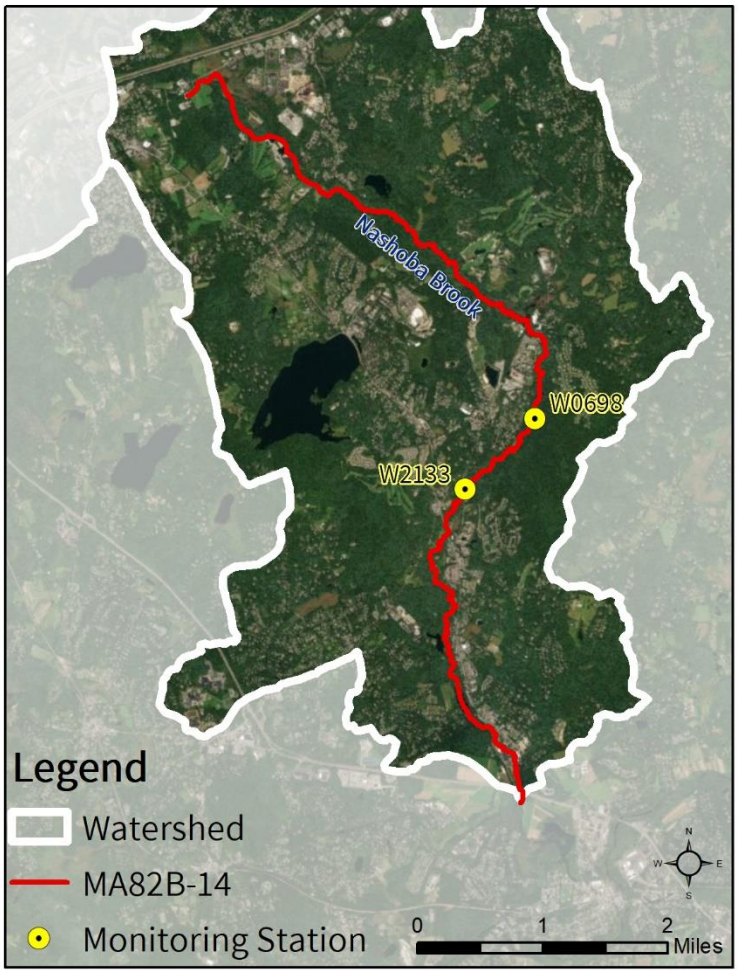


Figure 18-2. Location of monitoring station(s) along the impaired river segment.

Table 18-2. Summary of indicator bacteria sampling results by station for Nashoba Brook (MA82B-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 Statistical Threshold Value (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
W0698	7/18/07	9/25/13	33	1119	7	4
W2133	5/11/10	9/21/10	6	220	6	1

Table 18-3. Indicator bacteria data by station, indicator, and date for Nashoba Brook (MA82B-14). Each sample date was designated wet or dry weather with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text 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 Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 90-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W0698	*E. coli*	7/18/07	DRY	22	22	
W0698	*E. coli*	9/12/07	WET	2420	231	
W0698	*E. coli*	11/7/07	WET	517	1119	
W0698	*E. coli*	2/27/08	WET	17	17	
W0698	*E. coli*	4/23/08	DRY	36	25	
W0698	*E. coli*	6/18/08	WET	46	41	
W0698	*E. coli*	8/20/08	DRY	25	34	
W0698	*E. coli*	10/22/08	DRY	39	31	
W0698	*E. coli*	1/21/09	DRY	4	4	
W0698	*E. coli*	3/18/09	DRY	4	4	
W0698	*E. coli*	5/20/09	DRY	186	27	
W0698	*E. coli*	7/22/09	WET	345	253	
W0698	*E. coli*	9/29/09	WET	308	326	
W0698	*E. coli*	11/17/09	DRY	115	188	
W0698	*E. coli*	2/18/10	DRY	22	22	
W0698	*E. coli*	8/25/10	WET	921	921	
W0698	*E. coli*	10/20/10	DRY	82	275	
W0698	*E. coli*	1/19/11	WET	15	15	
W0698	*E. coli*	3/15/11	DRY	17	16	
W0698	*E. coli*	5/17/11	WET	461	89	
W0698	*E. coli*	7/20/11	DRY	29	116	
W0698	*E. coli*	9/21/11	DRY	55	40	
W0698	*E. coli*	11/16/11	DRY	21	34	
W0698	*E. coli*	2/22/12	DRY	9	9	
W0698	*E. coli*	4/11/12	DRY	12	10	
W0698	*E. coli*	6/20/12	DRY	64	28	
W0698	*E. coli*	8/22/12	DRY	62	63	
W0698	*E. coli*	10/24/12	DRY	23	38	
W0698	*E. coli*	1/28/13	DRY	11	11	
W0698	*E. coli*	3/20/13	WET	5	7	
W0698	*E. coli*	5/20/13	DRY	58	17	
W0698	*E. coli*	8/28/13	DRY	89	89	
W0698	*E. coli*	9/25/13	DRY	44	63	
W2133	*E. coli*	5/11/10	DRY	180	180	
W2133	*E. coli*	6/15/10	DRY	270	220	
W2133	*E. coli*	7/1/10	DRY	71	151	
W2133	*E. coli*	7/20/10	WET	410	194	
W2133	*E. coli*	8/16/10	DRY	200	199	
W2133	*E. coli*	9/21/10	DRY	52	132	

18.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present and 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 SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants, which then becomes diluted during periods of 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).

For Nashoba Brook (MA82B-14), both stations exhibited elevated indicator bacteria during wet weather, indicating possible 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 wet weather indicator bacteria levels. The stream corridor near the two stations is impacted by residential and commercial development with large swaths of woods and wetlands.

Each potential pathogen source is described in further detail below.

Urban Stormwater: Portions of Nashoba Brook (MA82B-14) watershed are highly developed, with 77% of the land area in MS4 and 6% as DCIA. While the level of development is moderate, much of the commercial land use, including large parking lots and arterial roads, is concentrated along the river corridor. Stormwater runoff from urban areas is likely the most significant source of pathogens.

Illicit Sewage Discharges: With some portion of the land area in sewer service and most (77%) of the watershed designated as MS4 area, leaky sewer lines and illicit connections are also possible sources. Sewer related risks include leaking infrastructure (pipes, pump stations, etc.) and sanitary sewer overflows, 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 drains are also a risk.

On-Site Wastewater Disposal Systems: There are 17 groundwater discharge permits for on-site wastewater discharge, which are large-capacity septic systems (non-residential). Much of the residential development in the watershed uses septic systems for wastewater treatment; it is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Agriculture accounts for 4% of land area and includes row crops, horse stables, and pasture. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: There are several ballfields and trails along the river corridor. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: Conservation and recreational lands with large open mowed areas with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water.

18.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Acton. see Section 16.4.

Town of Concord. see Section 5.4.

Town of Littleton

Most of Littleton is US Census defined “Urban Area” and is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Littleton (Permit ID#MAR041204) has an EPA approved Notice of Intent (NOI) and has mapped all of its MS4 stormwater system, with a map attached to its NOI. It adopted IDDE, ESC, and post-construction stormwater regulations in 2016. Littleton reports one outfall to Beaver Brook MA84B-02, and six outfalls to its wetlands/tributaries; six outfalls to wetlands/tributaries to Unnamed Tributary (Reedy Meadow Brook) MA84B-01, plus four to its wetlands/tributaries,

Stormwater page: https://www.littletonma.org/stormwater (Town of Littleton, 2018)

SWMP: https://www.littletonma.org/home/news/stormwater-management-plan-draft (Town of Littleton, 2019)

Littleton has the following ordinances and bylaws:

- Stormwater Ordinance or Bylaws: https://www.littletonma.org/sites/g/files/vyhlif806/f/uploads/littleton_stormwater_regulations_final_7-13-2017_0.pdf (Town of Littleton, 2017)
- Stormwater Utility (or similar): None found.
- Title 5 Supplemental Regulations or Bylaws: https://www.littletonma.org/sites/g/files/vyhlif806/f/uploads/septic_regs_updated_january_2011.pdf (Town of Littleton, 2013)
- Wetlands Protection Ordinance: https://ecode360.com/32928685 (Town of Littleton, 2003)
- Pet Waste: https://www.littletonma.org/sites/g/files/vyhlif806/f/uploads/littletongenerallegislation_v.51.pdf (Town of Littleton, 2016a)

Littleton's 2017 Master Plan has a Water Resources section (p. 124), mentions stormwater in several sections, sets a goal of establishing stormwater training for those working in land development, and refers to Beaver Brook throughout the plan.
https://www.littletonma.org/sites/g/files/vyhlif806/f/uploads/littleton_mp_final_reducedsize.pdf (Town of Littleton, 2017)

The Master Plan also refers to a Littleton Common Sewer Strategic Plan, referred in some press releases as Littleton Common Smart Sewer, which refers generally to a proposal to provide sewer to the downtown Littleton area. Planning is underway, with construction expected in 2020-21. See:
https://www.littletonma.org/sites/g/files/vyhlif806/f/uploads/littleton_mp_final_reducedsize.pdf (Town of Littleton, 2017)
Littleton's 2016 updated Open Space and Recreation Plan:
https://www.littletonma.org/sites/g/files/vyhlif806/f/uploads/approved_littleton_osrp_with_appendices.pdf (Town of Littleton, 2016b)

Littleton is within the service area of Metropolitan Area Planning Council (MAPC, http://www.mapc.org/). (MAPC, 2021).

Town of Westford. see Section 11.4.

19. MA82B-22 Coles Brook

19.1. Waterbody Overview

Coles Brook segment MA82B-22 is two miles long, located entirely within the Town of Acton, beginning at its headwaters east of Francine Road, flowing east, and ending at its confluence with Fort Pond Brook (MA82B-13). It has several unnamed tributaries draining small ponds and wetlands.

Major landmarks include the Victor School and Luther Conant School, with a ballfield called MacPherson Field, which is about 50 meters from the brook. Road crossings include the divided highway Massachusetts Avenue/MA-2/MA-111 (twice), Barker Road, Taylor Road, Sandalwood Road, Robinwood Road, Hosmer Street, and School Street.

Coles Brook (MA82B-22) drains an area of two square miles, of which 0.4 mi^2 (18%) is impervious and 0.2 mi^2 (11%) is directly connected impervious area (DCIA). The watershed is partially[46] served by public sewer, and the entire watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are no additional NPDES permits on file. See Figure 19-1.

The watershed and river corridor are characterized by medium density residential development and a few large commercial developments with expansive parking lots. Most of the riparian corridor maintains a wooded buffer zone.

In the watershed of Coles Brook (MA82B-22), under the Natural Heritage and Endangered Species Program, there are 16 acres (1%) of Priority Habitats of Rare Species. Over 14 acres (1%) of land protected in perpetuity[47] exist within the segment watershed, which is part of a total of 327 acres (26%) of Protected and Recreational Open Space[48]. See Figure 19-1.

Reduction from Highest Calculated Geomean: 83%

Watershed Area (Acres): 1,277

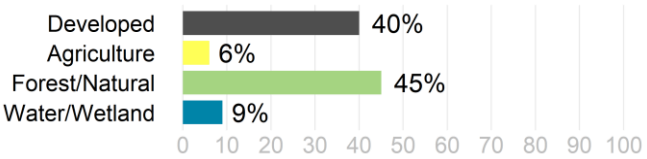
Segment Length (Miles): 2.0

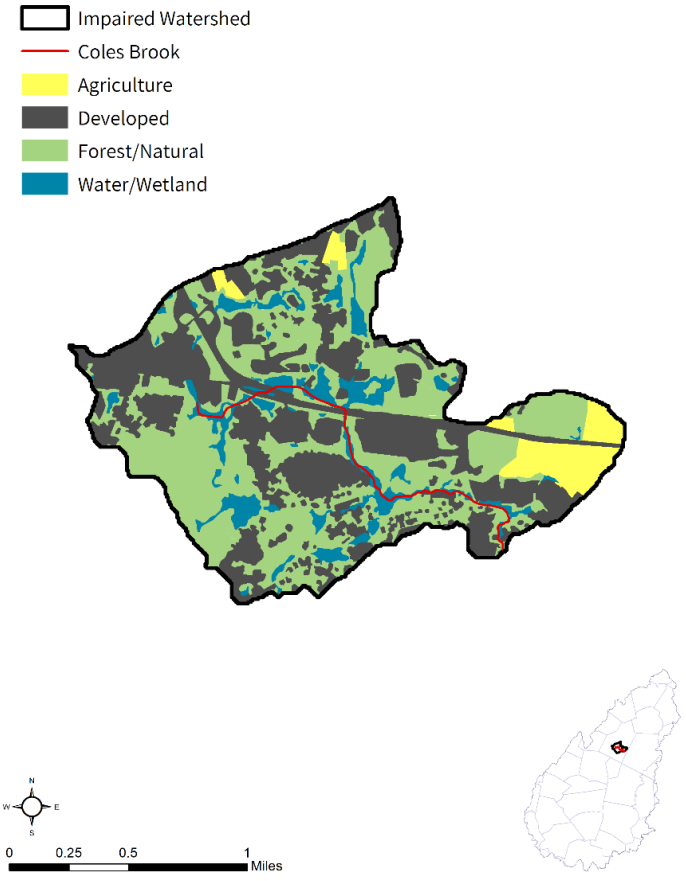
Impairment(s): *E. coli* (Primary Contact Recreation)

Class: B

Impervious Area (Acres, %): 227 (18%)

DCIA Area (Acres, %): 142 (11%)

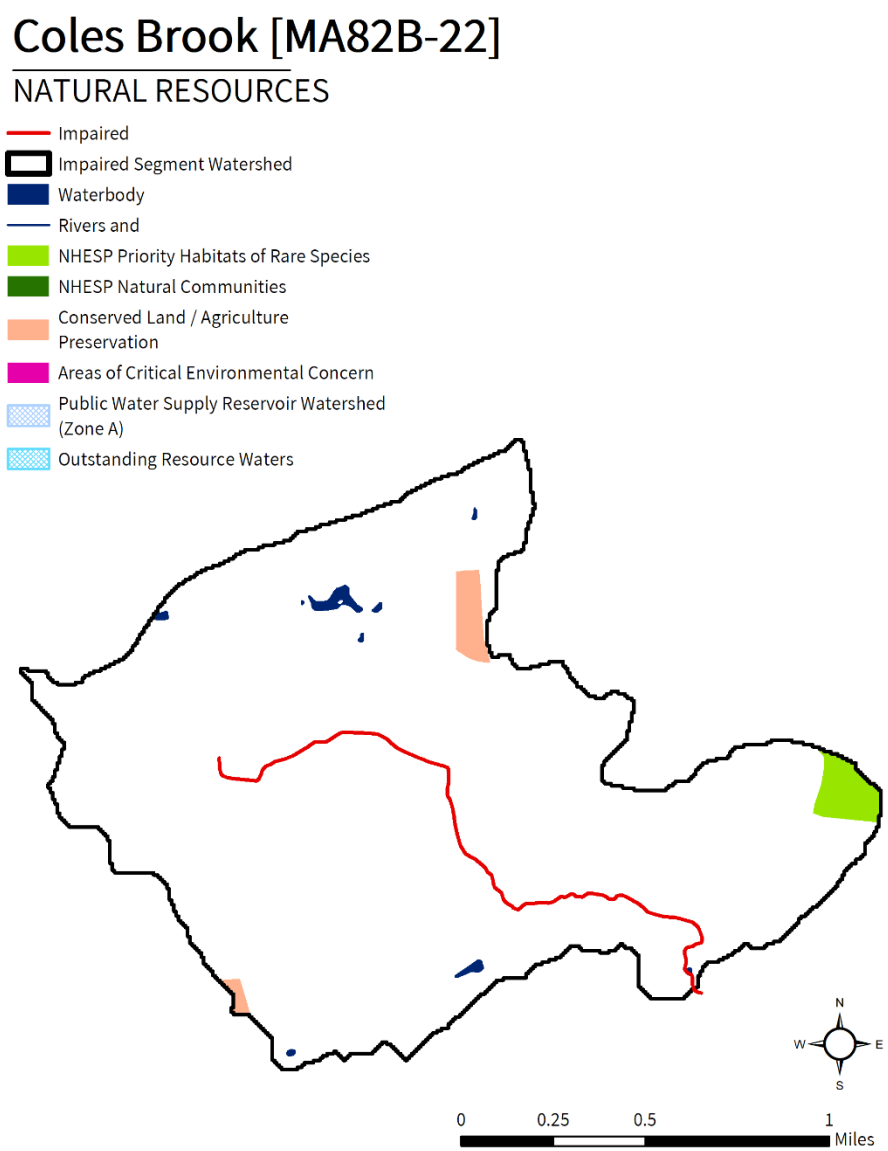




[46] Estimated percentage of developed areas with wastewater infrastructure in the watershed was based on available information: MWRA service areas, MassDEP's Water Utility Infrastructure Mapping Project https://www.mass.gov/guides/water-utility-resilience-program(MassDEP, 2020), MS4 reports, and local knowledge.

[47] Land protected in perpetuity include several interests such as conservation restriction, agricultural preservation, private deed restrictions, wetlands restrictions, aquifer protection, historic preservation, etc. Refer to MassGIS metadata for the Protected and Recreational Open Space data layer. Land protected in perpetuity reflect watershed-wide estimates (including for watersheds that extend outside of the State of Massachusetts).

[48] Only land protected in perpetuity is shown on the natural resources map. Protected and Recreational Open Space estimates reflect areas in the State of Massachusetts only (and thus reflect only a portion of the total open space for watersheds that extend outside of the State of Massachusetts).



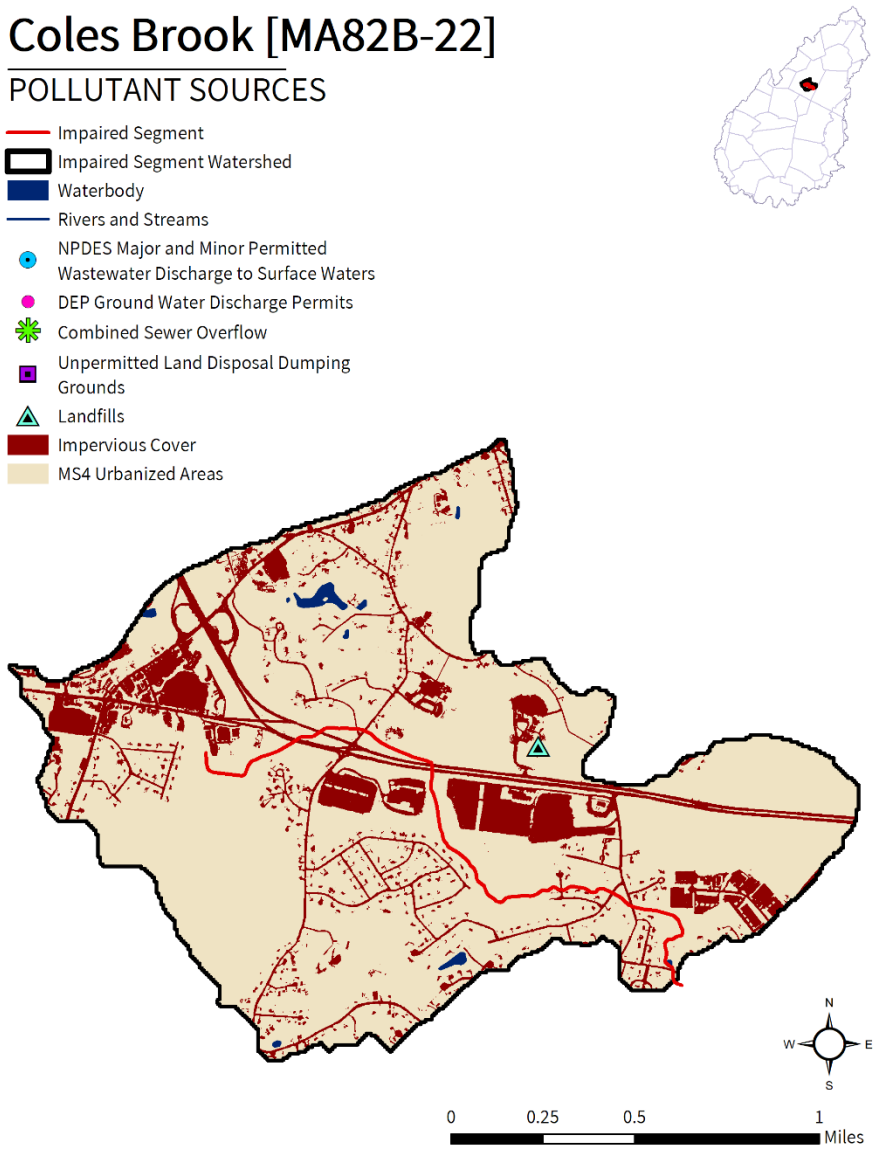


Figure 19-1. Natural resources and potential pollution sources draining to the Coles Brook segment MA82B-22. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, permitted facilities.

19.2. Waterbody Impairment Characterization

Coles Brook (MA82B-22) is a Class B Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS using the indicator bacteria *E. coli* at the station listed below (refer to Tables 19-1, 19-2; Figure 19-2). 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 2010, six samples were collected at W2137, resulting in 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 six samples, four exceeded the STV criterion during both wet and dry weather.

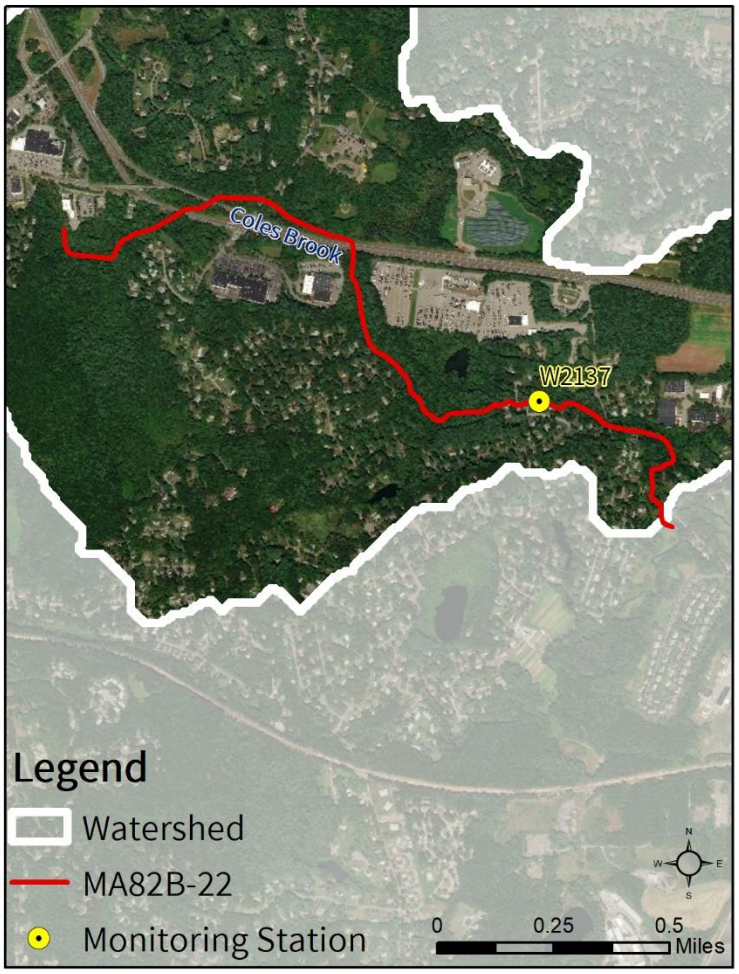


Figure 19-2. Location of monitoring station(s) along the impaired river segment.

Table 19-1. Summary of indicator bacteria sampling results by station for Coles Brook (MA82B-22). 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 Statistical Threshold Value (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
W2137	5/11/10	9/21/10	6	746	5	4

Table 19-2. Indicator bacteria data by station, indicator, and date for Coles Brook (MA82B-22). Each sample date was designated wet or dry weather with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text 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 Statistical Threshold Value or STV) and 126 CFU/100 mL (applied to rolling 90-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W2137	*E. coli*	5/11/10	DRY	80	80	
W2137	*E. coli*	6/15/10	DRY	280	150	
W2137	*E. coli*	7/1/10	DRY	470	219	
W2137	*E. coli*	7/20/10	WET	3000	422	
W2137	*E. coli*	8/16/10	DRY	510	670	
W2137	*E. coli*	9/21/10	DRY	430	746	

19.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present and 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 SSOs. In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants, which then becomes diluted during periods of 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 from Coles Brook (MA82B-22) showed elevated counts during both wet and dry weather, indicating a possible combination of urban stormwater, pet waste, wildlife pathogen sources, as well as baseflow sources. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during large precipitation events, may also result in elevated wet weather indicator bacteria levels. Elevated indicator bacteria during dry weather indicate that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, may be present.

Each potential pathogen source is described in further detail below.

Urban Stormwater: Coles Brook (MA82B-22) watershed is largely developed, with all its land area in MS4, 11% as DCIA, and residential neighborhoods and large commercial parking lots adjacent to the segment in some locations. Stormwater runoff from urban areas is likely the most significant source of pathogens.

Illicit Sewage Discharges: With a portion of the land area in sewer service and the entire watershed designated as MS4 area, leaky sewer lines and illicit connections are also possible sources. Sewer related risks include leaking infrastructure (pipes, pump stations, etc.) and sanitary sewer overflows, 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 drains are also a risk.

On-Site Wastewater Disposal Systems: With some of the watershed served by septic systems, it is likely that a portion of septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Agriculture accounts for 6% of land area, including areas of row crops and orchards. Agricultural activities related to manure storage and spreading, if not well managed, are a possible source of pathogens to waterbodies.

Pet Waste: There are conservation and recreational lands and ballfields in the watershed. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent a possible source of pathogens.

Wildlife Waste: Conservation and recreational lands with large open mowed areas with a clear sightline to a waterbody may attract excessive waterfowl and elevate indicator bacteria counts in the water.

19.4. Existing Local Management

This section identifies the municipalities immediately surrounding the impaired segment and its sub-basin or the portion of the impaired segment watershed not shared with upstream impaired segments. For a complete view of upstream municipalities and waterbodies, see the map in Figure 2-1.

Town of Acton. see Section 16.4.

20. References

City of Framingham. (2005) [online]. *Framingham Wetlands Protection Bylaw.* As amended at the April 26, 2005 Annual Town Meeting. Available at https://www.framinghamma.gov/DocumentCenter/View/421/Wetlands-Protection-Bylaw?bidId=

City of Framingham. (2014) [online]. *Framingham Master Plan.* Framingham, MA. September 2014. Available at https://www.framinghamma.gov/294/Framingham-Master-Plan

City of Framingham. (2015) [online]. *Framingham Open Space and Recreation Plan.* Framingham, MA. October 2013. Updated 6/19/2015. Available at https://www.framinghamma.gov/DocumentCenter/View/12753/Final-OSRP-2013-Complete?bidId=

City of Framingham. (2019) [online]. *Zoning By-Law.* Framingham Planning Board. August, 2019. Available at https://webapps.framinghamma.gov/WebLink/ElectronicFile.aspx?docid=1247234&dbid=0&repo=Framingham

City of Framingham. (2020) [online]. *Stormwater Management.* Framingham, MA. Available at https://www.framinghamma.gov/1133/Stormwater-Management

City of Lowell. (2003) [online]. *Chapter 290 Wetlands.* City of Lowell, MA / The Code / Part II: General Legislation. Adopted by the City Council of the City of Lowell 12-16-2003 (Ch. 5, Art. VI of the 1988 Code). Available at https://ecode360.com/12360663

City of Lowell. (2012) [online]. *Sustainable Lowell 2025.* Office of the City Manager, Lowell, MA. Available at https://www.lowellma.gov/DocumentCenter/View/1517/Sustainable-Lowell-2025-PDF?bidId=

City of Lowell. (2013) [online]. *Article I Dogs.* City of Lowell, MA / The Code / Part II: General Legislation / Animals. Sec, 104-25 Animal Waste. This ordinance stated that it would be retroactive and effective as of 10-31-2012. It also repealed former Art. I, Dogs, adopted 4-26-1988 as Ch. 4, Art. **II**, of the 1988 Code, as amended. Available at https://ecode360.com/27625195

City of Lowell. (2018) [online]. *Part 6 Management of Stormwater.* City of Lowell, MA / The Code / Part II: General Legislation / Water and Sewers. Sec. 272-111. Added 07-24-2018. Available at https://ecode360.com/34304419

City of Lowell. (2019) [online]. *Open Space Plan*. Draft Open Space and Recreation Plan. 2019-2023. Lowell, MA. Available at https://www.lowellma.gov/765/Open-Space-Plan

CMRPC. (2021) [online]. *Central Massachusetts Regional Planning Commission.* Available at http://www.cmrpc.org/

City of Marlborough. (n.d., a) [online]. *MS4 Stormwater Management.* Marlborough, MA. Available at https://www.marlborough-ma.gov/engineering-division/pages/ms4-stormwater-management

City of Marlborough. (n.d., b) [online]. *Welcome to CAI's AxisGIS.* Marlborough, MA. Available at https://www.axisgis.com/marlboroughma/

City of Marlborough. (1991) [online]. *Chapter 627 Wetlands.* City of Marlborough, MA / The Code / Part II, General Legislation. Adopted by the City Council of the City of Marlborough 12-30-1991. Available at https://ecode360.com/9216851

City of Marlborough. (2004) [online]. *Chapter 250 Animals.* Sec. 25—5 Removal of Dog Waste. City of Marlborough, MA / The Code / Part II, General Legislation. Adopted by the City Council of the City of Marlborough as indicated in article histories. Available at https://ecode360.com/9210023

City of Marlborough. (2009) [online]. *Chapter 271 Stormwater Management.* City of Marlborough, MA / The Code / Part II, General Legislation. Adopted by the City Council of the City of Marlborough 11-23-2009. Available at https://ecode360.com/15931519

City of Marlborough. (2009) [online]. *In City Council.* Marlborough, MA. November 23, 2009. Available at https://www.ecode360.com/documents/MA1056/source/346020.pdf

City of Marlborough. (2011) [online]. *Open Space and Recreation Plan 2011 – 2018.* City of Marlborough. Available at https://www.marlborough-ma.gov/sites/g/files/vyhlif3411/f/uploads/osrp_2011-2018.pdf

Hop Brook Protection Association. (2020) [online]. *Hop Brook Protection Association.* Available at https://hopbrook.org/index.html

MAPC. (2014) [online]. *Stormwater Financing/Utility Starter Kit*. Prepared by Metropolitan Area Planning Council. March 23, 2014. Available at https://www.mapc.org/resource-library/stormwater-financing-utility-starter-kit/

MAPC. (2018) [online]. *MS4 Outfall Catchment Calculator.* Metropolitan Area Planning Council. May 22, 2018. Available at https://www.mapc.org/resource-library/ms4-outfall-catchment-calculator/

MAPC. (2021) [online]. *Metropolitan Area Planning Council.* Available at *https://www.mapc.org/*

MassDEP. (n.d.) [online]. *310 CMR: Department of Environmental Protection*. 310 CMR 15:000. Available at https://concordma.gov/DocumentCenter/View/1960/Title-5-Regulations-PDF?bidId=

MassDEP. (2005) [online]. *SuAsCo Watershed 2001 Water Quality Assessment Report*. August 2005. CN 92.0. Available at https://www.mass.gov/lists/water-quality-assessment-reports-merrimack-through-weymouth-weir-watersheds#suasco-watershed---2001-

MassDEP. (2016) [online]. *Concord River Watershed SMART Monitoring Program 2011-2013*. Technical Memorandum CN 418.0. Available at https://www.mass.gov/doc/concord-river-watershed-smart-monitoring-program-2011-2013

MassDEP. (2020) [online]. *Water Utility Resilience Program.* Adapting to Climate Change. Massachusetts Department of Environmental Protection. Available at https://www.mass.gov/guides/water-utility-resilience-program

MassDEP. (2021). *314 CMR 4.00: Massachusetts Surface Water Quality Standards.* Massachusetts Department of Environmental Protection. Boston, MA. Available at https://www.mass.gov/regulations/314-CMR-4-the-massachusetts-surface-water-quality-standards#current-regulations

MRPC. (2021) [online]. *Montachusett Regional Planning Commission.* Available at https://www.mrpc.org/

NMCOG. (2021) [online]. *Northern Middlesex Council of Governments.* Available at https://www.nmcog.org/

National Wild and Scenic Rivers Systems (NWSRS). Accessed June 6, 2019. https://rivers.gov/rivers/suasco.php

Stormwater Collaborative. (n.d.). Retrieved from Contact Us: http://www.nmstormwater.org/contact-us-stormwater

Think Blue Massachusetts. Accessed. (2019). https://www.thinkbluemassachusetts.org/about-us

Town of Acton. (2014) [online]. *Open and Recreation Plan.* Town of Acton. 2014-2021. Available at http://doc.acton-ma.gov/dsweb/Get/Document-50377/2015%20Acton%20OpenSpace.pdf

Town of Acton. (2016) [online]. *Stormwater.* Town of Acton, Massachusetts. Available at https://www.acton-ma.gov/339/Stormwater

Town of Acton. (2018). [online]. *Stormwater Management Program Plan.* Town of Acton, Massachusetts. Available at https://www.acton-ma.gov/DocumentCenter/View/5488/20181101-Town-of-Acton---SWMP

Town of Acton. (2019a) [online]. *General Bylaws of the Town of Acton.* Discharge to Municipal Storm Drain System" Chapter U and "Stormwater Management and Erosion & Sediment Control" Chapter X in Town Bylaws. Town of Acton, Massachusetts. Updated April 2019. Available at https://www.acton-ma.gov/DocumentCenter/View/614/2019-General-Bylaws?bidId=

Town of Acton. (2019b) [online]. *General Bylaws of the Town of Acton.* Chapter F. F4.4 Septic Systems Meeting State Title V. Page 40. Town of Acton, Massachusetts. Updated April 2019. Available at https://www.acton-ma.gov/DocumentCenter/View/614/2019-General-Bylaws?bidId=

Town of Acton. (2019c) [online]. *General Bylaws of the Town of Acton.* Chapter F. Wetlands Protection. Page 35. Town of Acton, Massachusetts. Updated April 2019. https://www.acton-ma.gov/DocumentCenter/View/614/2019-General-Bylaws?bidId=

Town of Acton. (2020) [online]. *Acton 2020 Comprehensive Community Plan.* Prepared for the Town of Acton. Prepare by the Collaborative Inc., and Community Circle. April 2012. Available at https://www.acton-ma.gov/DocumentCenter/View/109/Acton-2020-Comprehensive-Community-Plan?bidId=

Town of Acton. (2020) [online]. *Zoning Bylaw.* Section 4 – Overlay Districts. Open Space Development 4.2. page 42. Town of Acton, Massachusetts. Amended through September 2020. Available at https://www.acton-ma.gov/DocumentCenter/View/659/2020-Zoning-Bylaws?bidId=

Town of Ashland. (n.d., a) [online]. *NPDES-MS4 – National Pollutant Discharge Elimination System – Municipal Separate Storm Sewer System.* Ashland, MA. Available at https://www.ashlandmass.com/524/Stormwater---NPDES

Town of Ashland. (n.d., b) [online]. *Article IV Design Standards.* Sec 344-16 Open Spaces. Town of Ashland, MA / Division 2: Town Meeting Enactments / Division 6: Miscellaneous Regulations / Subdivision of Land. Available at https://ecode360.com/12612537

Town of Ashland. (2000) [online]. *Chapter 235 Sewer Betterment Assessment.* Town of Ashland, MA / Division 2: Town Meeting Enactments / Part II: General Legislation. Adopted by the Town of Ashland 5-10-2000. Available at https://ecode360.com/13018238

Town of Ashland. (2007) [online]. *Final Ashland Stormwater By-Law.* Chapter 247 Stormwater Management. Adopted by Ashland Town Meeting, May 2, 2007. Available at https://www.ashlandmass.com/DocumentCenter/View/501/Stormwater-Management-Bylaw-PDF?bidId=

Town of Ashland. (2009) [online]. *Chapter 280 Wetlands Protection.* Town of Ashland, MA / Division 2: Town Meeting Enactments / Part II: General Legislation. Adopted by the Town of Ashland Annual Town Meeting 5-6-2009. Available at https://ecode360.com/13018248

Town of Ashland. (2010a) [online]. *Chapter 303 Sewage Disposal Systems.* Town of Ashland, MA / Division 2: Town Meeting Enactments / Division 4: Board of Health. Adopted by the Board of Health of the Town of Ashland. Available at https://ecode360.com/13018257

Town of Ashland. (2010b) [online]. *Planning for Change: Growing a Greener Community.* Ashland Open Space and Recreation Plan. February 2010. Available at http://www.ashlandopenspace.org/docs/Ashland_OSRP_2010.pdf

Town of Ashland. (2013) [online]. *Chapter 97 Animal Control.* Sec 87-14 Dog Waste Disposal. Town of Ashland, MA / Division 2: Town Meeting Enactments / Part II: General Legislation. Available at https://ecode360.com/12609861

Town of Ashland. (2016) [online]. *Resources.* Ashland, MA. Available at https://www.ashlandmass.com/513/Resources

Town of Ashland. (2018) [online]. *Stormwater Enterprise Fund Stormwater Management Utility.* Stormwater Advisory Committee. Ashland Town Meeting, November 28, 2018. Available at https://www.ashlandmass.com/DocumentCenter/View/4206/11-28-2018-Stormwater-Utility-Presentation?bidId=

Town of Ashland. (2020) [online]. *Stormwater Advisory Committee.* Ashland, MA. Available at https://www.ashlandmass.com/306/Stormwater-Advisory-Committee

Town of Bedford. (n.d.) [online}. *Pet Waste Pollutes Bedford... We need your help!* Bedford, MA. Available at https://www.bedfordma.gov/sites/g/files/vyhlif2781/f/uploads/pet_waste_flyer.pdf

Town of Bedford. (2004) [online]. *Open Space and Recreation Plan*.Bedford, MA. Available at https://www.bedfordma.gov/conservation-commission/pages/open-space-and-recreation-plan

Town of Bedford. (2013) [online]. *Comprehensive Plan 2013.* Bedford, MA. Available at https://www.bedfordma.gov/planning/pages/comprehensive-plan-2013

Town of Bedford. (2016) [online]. *Town of Bedford Wetlands Protection Bylaw.* Bylaw adopted at Annual Town Meeting 1987 with revisions through Annual Town Meeting of 2016. Available at https://www.bedfordma.gov/sites/g/files/vyhlif2781/f/u80/approved_wetlands_bylaw_2016.pdf

Town of Bedford. (2018a) [online]. *The Charter and The General Bylaws.* Article 51. Sewer Systems. Page 85. Bedford, MA. Amended through Annual Town Meeting 2018. Available at https://www.bedfordma.gov/sites/g/files/vyhlif2781/f/uploads/charter_and_bylaws_updated_thru_stm_2018.pdf

Town of Bedford. (2018b) [online]. *The Charter and The General Bylaws.* Article 55. Stormwater Management. Page 109. Bedford, MA. Amended through Annual Town Meeting 2018. Available at https://www.bedfordma.gov/sites/g/files/vyhlif2781/f/uploads/charter_and_bylaws_updated_thru_stm_2018.pdf

Town of Bedford. (2020) [online]. *Stormwater Management Program.* Bedford, MA. Available at https://www.bedfordma.gov/department-of-public-works/webforms/stormwater-management-program

Town of Berlin. (2011) [online]. *Open Space and Recreation Plan.* 2011-2018. Berlin, MA. Berlin Conservation Commission. Available at https://www.townofberlin.com/sites/g/files/vyhlif4156/f/uploads/osrp_final_october_2011.pdf

Town of Berlin. (2013) [online]. *Master Plan.* Town of Berlin. July 2013. Available at https://www.townofberlin.com/sites/g/files/vyhlif4156/f/uploads/berlin-mp-w-appendices.pdf

Town of Billerica. (n.d.) [online]. *Article XXV Stormwater Management By-Law.* Billerica, MA. Available at https://www.town.billerica.ma.us/DocumentCenter/View/315/Stormwater-Management-Bylaw-Article-XXV?bidId=

Town of Billerica. (2007) [online]. *Stormwater Bylaws.* Billerica, MA. Available at https://www.town.billerica.ma.us/246/Stormwater-Bylaws

Town of Billerica. (2008a) [online]. *Dischargers to the Municipal Storm Sewer Systems.* Article XXVI. Billerica Board of Health. (Run: 04/25/2008). Available at https://www.town.billerica.ma.us/DocumentCenter/View/314/Discharges-to-the-Municipal-Storm-Sewer-System-Article-XXVI?bidId=

Town of Billerica. (2008b) [online]. *Wetlands Protection Regulations.* Billerica Conservation Commission. Adopted 6/25/08. Available at https://www.town.billerica.ma.us/DocumentCenter/View/2973/Wetland-Protection-Regulations-Adopted-6-25-08

Town of Billerica. (2013) [online]. *Maps Online.* Billerica, MA Public. Available at https://www.mapsonline.net/billericama/public.html

Town of Billerica. (2015) [online]. *General By-Laws of the Town of Billerica.* Re-codified and amended under Article 26 of the Annual Fall Town Meeting of October 2007 and amended through October, 2015. Article VII Animals. 2. Regulations of Dogs. 2.6 Nuisances. B. Page vii – 2. Available at https://www.town.billerica.ma.us/ArchiveCenter/ViewFile/Item/528

Town of Billerica. (2018a) [online]. *Billerica Open Space and Recreation Plan.* April 1, 2018. Available at https://www.town.billerica.ma.us/DocumentCenter/View/7505/Open-Space-Recreation-Plan

Town of Billerica. (2018b) [online]. *2018 Master Plan.* Billerica, MA. Prepared for: Town of Billerica. Prepared by: vhb/NMCOG. April 2018. Available at https://www.town.billerica.ma.us/DocumentCenter/View/7658/Master-Plan_FINAL_04_4-18pdf

Town of Billerica. (2018c) [online]. *Stormwater Management.* Billerica, MA. Available at https://www.town.billerica.ma.us/214/Stormwater-Management

Town of Billerica. (2020a) [online]. *Sanitary Sewer Rules and Regulations.* Billerica, MA. Additional Proposed Revisions, January 6, 2020. https://www.town.billerica.ma.us/DocumentCenter/View/294/Sewer-Rules-and-Regulations?bidId=

Town of Billerica. (2020b) [online]. *Stormwater Management Plan.* Tighe & Bond. Prepared for Town of Billerica. June 2018. Updated October 2020. Available at https://www.town.billerica.ma.us/DocumentCenter/View/8035/Billerica-Stormwater-Management-Plan?bidId=

Town of Bolton (1996). *Article III Zoning District Regulations.* Town of Bolton, MA / Division 1: Bylaws / Part III, Zoning Bylaws / Zoning. Sec 250-14 Farmland and open space planning residential development. Added 5-1-1989 amended 6-10-1996. Available at https://www.ecode360.com/14848474

Town of Bolton. (2006) [online]. *Master Plan 2006.* Town of Bolton, Massachusetts. 2005-2025. Available at https://www.townofbolton.com/sites/g/files/vyhlif2836/f/uploads/masterplan.pdf

Town of Bolton. (2013) [online]. *Wetland Bylaw Regulations.* Town of Bolton, MA. 2013 Updates. Available at https://www.townofbolton.com/conservation-commission/pages/wetland-bylaw-regulations

Town of Bolton. (2015a). [online]. *Chapter 147 Groundwater Protection.* Town of Bolton, MA / Division 1: Bylaws / Part II: General Legislation. Sec 147-1 Permit required; exceptions; authority of Board of Health. Available at https://www.ecode360.com/14850095?highlight=septic&searchId=87252791418898#14850095

Town of Bolton. (2015b) [online]. *Subdivision Rules and Regulations.* Utility Design. 5322 Stormwater Management page 29. Town of Bolton Planning Board. Last Amended November18, 2015. Available at https://www.ecode360.com/BO3017/laws/LF867678.pdf

Town of Bolton. (2017) [online]. *2017 Bolton Open Space and Recreation Plan.* Town of Bolton, Massachusetts. Available at https://www.townofbolton.com/sites/g/files/vyhlif2836/f/uploads/ftob2017osrp_0.pdf

Town of Bolton. (2018) [online]. *Walking Your Dog in Bolton.* Provided by the Bolton Conservation Commission. Town of Bolton. Revised Feb. 2018. Available at https://www.townofbolton.com/sites/g/files/vyhlif2836/f/uploads/dogsbrochure2.27.2018.pdf

Town of Carlisle. (2013) [online]. *Open Space and Recreation Plan*. Carlisle, MA. November 1, 2014. Approved through September 2020. Available at https://www.carlislema.gov/DocumentCenter/View/929/Carlisle-2013-Open-Space-and-Recreation-Plan---Entire-Document-PDF

Town of Carlisle. (2015) [online]. *Carlisle Non-zoning Wetland Bylaw.* Carlisle, MA. Revised 2015. Available at https://www.carlislema.gov/DocumentCenter/View/922/Carlisle-NonZoning-Wetland-Bylaw-PDF?bidId=

Town of Carlisle. (2019a) [online]. *General Bylaws.* Carlisle, MA. August 27, 2019. Article XIV Miscellaneous. Sec. 14.6.2.2. Available at https://www.carlislema.gov/DocumentCenter/View/205/General-Bylaws-PDF?bidId=

Town of Carlisle. (2019b) [online]. *Supplementary Regulations for Sewage Disposals Systems.* Carlisle, MA. January 16, 2019. Available at https://www.carlislema.gov/DocumentCenter/View/723/Septic-Regulations-PDF

Town of Chelmsford. (n.d., a) [online]. *Maps.* Chelmsford, MA. Available at https://chelmsfordma.mapgeo.io/datasets/properties?abuttersDistance=300&latlng=42.601692%2C-71.356016

Town of Chelmsford. (n.d., b) [online]. *Residential Grinder Pump Emergency Assistance Pump Down Policy.* Department of Public Works, Sewer Division, Chelmsford, MA. Available at

https://www.townofchelmsford.us/DocumentCenter/View/8637/RESIDENTIAL-GRINDER-PUMP-EMERGENCY-PUMP-DOWN-POLICY----published?bidId=

Town of Chelmsford. (n.d.) [online. *Residential Sewer Grinder Pump Operation and Maintenance Manual.* Town of Chelmsford Department of Public Works. Available at http://www.townofchelmsford.us/DocumentCenter/View/4830/Grinder-Pump-Flyer?bidId=

Town of Chelmsford. (1995) [online]. *Article VI Subsurface Sewage and Wastewater Disposal; Groundwater Protection.* Town of Chelmsford, MA / The Code / Part II, Regulations / Health Regulations. Added 4-10-1987; amended 4-3-1995. Available at https://ecode360.com/8275342

Town of Chelmsford. (2006) [online]. *Chapter 11 Animals.* Town of Chelmsford, MA / The Code / Part I, Bylaws. Sec 11-7 Nuisances. Amended 10-16-2006. Available at https://www.ecode360.com/8273592?highlight=&searchId=89913796297612#8273592

Town of Chelmsford. (2010a) [online]. *Article I General Provisions.* Town of Chelmsford, MA / The Code / Part I, Bylaws/ Street / Sideways. Sec 142-6 Discharge of water to public ways or sidewalks, dischargers to storm sewer system. Added 1973 ATM by Art. 54; amended 4-26-2010 ATM by Art. 13. Available at https://www.ecode360.com/8274116

Town of Chelmsford. (2010b) [online]. *Current Planning.* Chelmsford, MA. Available at https://www.townofchelmsford.us/146/Current-Planning

Town of Chelmsford. (2014) [online]. *Grinder Pumps.* Chelmsford, MA. September 22, 2014. Available at https://www.townofchelmsford.us/535/Grinder-Pumps

Town of Chelmsford. (2017) [online]. *Open Space and Recreation Plan.* Chelmsford, MA. Update 2017. Available at https://www.townofchelmsford.us/AgendaCenter/ViewFile/Item/1791?fileID=2878

Town of Chelmsford. (2019) [online]. *Chelmsford Stormwater Utility F A Q.* Chelmsford, MA. Available at http://www.townofchelmsford.us/DocumentCenter/View/9473/What-Is-a-Stormwater-Utility-FAQ-2019

Town of Chelmsford. (2020) [online]. *Stormwater.* Chelmsford, MA. Available at https://www.townofchelmsford.us/375/Stormwater

Town of Concord. (2007) [online]. *Dog Bylaw.* Town of Concord Massachusetts. Article 42, Annual Town Meeting, April 2007 (Amended Section 4). Available at https://concordma.gov/DocumentCenter/View/4173/Dog-Bylaw-PDF

Town of Concord. (2011a) [online]. *Stormwater Management Program (MS4).* Concord, MA. Available at https://concordma.gov/175/Stormwater-Management-Program-MS4

Town of Concord. (2011b) [online]. *Storm Water Regulations.* Town of Concord, Concord Public Works. March 15, 2011. Available at https://concordma.gov/DocumentCenter/View/96/Concord-Storm-Water-Regulations-PDF

Town of Concord. (2013) [online]. *Wetlands Bylaw.* Town of Concord Massachusetts. Article 58, Annual Town Meeting, April 2013. Available at https://concordma.gov/DocumentCenter/View/2233/Concord-Wetlands-Bylaw?bidId=

Town of Concord. (2015) [online]. *2015 Open Space and Recreation Plan.* Concord, MA. Available at https://concordma.gov/738/Open-Space-Recreation-Plan

Town of Concord. (2018) [online]. *Comprehensive Long Range Plan*. Concord, MA. July 30, 2018. Available at https://www.concordma.gov/2281/Comprehensive-Long-Range-Plan

Town of Hopkinton. (2007) [online]. Master Plan 2007. Hopkinton, MA. January 22, 2007. Available at https://www.hopkintonma.gov/Businesses/eGovernment/Minutes%20&%20Documents/Hopkinton%20Master%20Plan%202007.pdf

Town of Hopkinton. (2008) [online]. *Stormwater Regulations.* Town of Hopkinton. Adopted October 20, 2008. Available at http://www.mapc.org/wp-content/uploads/2017/11/Hopkinton-Stormwater-Regulations-2008-Final-Adopted.pdf

Town of Hopkinton. (2013a) [online]. *Open Space and Recreation Plan.* Hopkinton, MA. June 26, 2013. Available at https://drive.google.com/file/d/12lF7pM8pFm4-grJK6sQSL8NxbYeaWqYk/view

Town of Hopkinton. (2013b) [online]. *Wetlands Protection Regulations for Applying the Hopkinton Wetlands Protection Bylaw.* Hopkinton, MA. February 11, 2013. Available at https://www.hopkintonma.gov/Departments/Land%20Use%20Planning%20&%20Permitting/Conservation%20Commission/Town%20of%20Hopkinton%20Wetlands%20Protection%20Regulations%20February%2011,%202013.pdf

Town of Hopkinton. (2016) [online]. *Stormwater.* Hopkinton, MA. Available at https://www.hopkintonma.gov/departments/department_of_public_works/Stormwater.php

Town of Hopkinton. (2018) [online]. *General Bylaws.* Printed October 2018. Chapter 172. Stormwater Management and Erosion Control. page 151. Hopkinton, MA. Available at https://www.hopkintonma.gov/General%20Bylaw%20Book%202018%20%5bFinal%5d.pdf

Town of Hudson. (2014) [online]. *Hudson Master Plan.* 2014. Hudson, MA. Available at https://www.townofhudson.org/master-plan-steering-committee/pages/hudson-master-plan

Town of Hudson. (2016) [online]. *Open Space and Recreation Plan.* Town of Hudson, Massachusetts. 2016. Available at https://www.townofhudson.org/sites/g/files/vyhlif3281/f/uploads/open_space_recreation_plan_2016.pdf

Town of Hudson. (2020) [online]. *Stormwater Management Program Plan.* Updated June 2020. Town of Hudson. Available at https://www.townofhudson.org/sites/g/files/vyhlif3281/f/uploads/2020.06.30_hudson_swmp-signed.pdf

Town of Littleton. (2003) [online]. *Chapter 171 Wetlands Protection.* Town of Littleton, MA / Division 1: Town Meeting Enactments / Part II: General Legislation. Adopted 5-5-2003 Annual Town Meeting. Available at https://ecode360.com/32928685

Town of Littleton. (2013). [online]. *Board of Health Regulations Requirements for the Subsurface Disposal of Sanitary Sewage.* Town of Littleton, Massachusetts. Adopted September 3, 2013. Available at https://www.littletonma.org/sites/g/files/vyhlif806/f/uploads/septic_regs_updated_january_2011.pdf

Town of Littleton. (2016a) [online]. *Code of the Town of Littleton, Massachusetts v51, updated 8-11-2016.* Chapter 84, Dogs and Other Animals. ARTICLE IV, Public Nuisances. Sec 84-7. J. Available at https://www.littletonma.org/sites/g/files/vyhlif806/f/uploads/littletongenerallegislation_v.51.pdf

Town of Littleton. (2016b) [online]. *Littleton Open Space and Recreation Plan.* 2016 Update. Available at https://www.littletonma.org/sites/g/files/vyhlif806/f/uploads/approved_littleton_osrp_with_appendices.pdf

Town of Littleton. (2017) [online]. *Littleton Master Plan.* Cultivating the Future. April 20, 2017.Prepared for: Littleton Planning Board Master Plan Update Steering Committee. RKG in association with Dodson & Flinker Community Circle Community Opportunities Group, Inc. Water Resources section page 124. Available at https://www.littletonma.org/sites/g/files/vyhlif806/f/uploads/littleton_mp_final_reducedsize.pdf

Town of Littleton. (2017) [online]. *Stormwater Management and Erosion Control Regulations.* Littleton Planning Board. Adopted 7-13-2017. Available at https://www.littletonma.org/sites/g/files/vyhlif806/f/uploads/littleton_stormwater_regulations_final_7-13-2017_0.pdf

Town of Littleton. (2018) [online]. *Stormwater.* Littleton, Massachusetts. Available at https://www.littletonma.org/stormwater

Town of Littleton. (2019) [online]. *Stormwater Management Plan.* Littleton, Massachusetts. Posted on June 3, 2019. Available at https://www.littletonma.org/home/news/stormwater-management-plan

Town of Maynard. (n.d.) [online]. *Stormwater Management Regulations.* Town of Maynard Conservation Commission. Available at https://www.townofmaynard-ma.gov/wp-content/uploads/2010/07/maynard-stormwater-regulations-20170801.pdf

Town of Maynard. (2004) [online]. *Town of Maynard's 2004 Open Space and Recreation Plan.* Maynard, MA. Created on 5/10/04. Available at https://www.townofmaynard-ma.gov/wp-content/uploads/2010/07/osrp.pdf

Town of Maynard. (2007). [online]. *Maynard Wetlands Protection Regulations*. Town of Maynard Conservation Commission. Effective date July 1, 2007. Available at https://www.townofmaynard-ma.gov/wp-content/uploads/2010/07/Regulations-_2007_-revised.pdf

Town of Maynard. (2020a) [online]. *Master Plan.* Town of Maynard, MA. Prepared by VHB in Association with Landwise. May, 2020. Available at http://maynardmp.com/pdf/Maynard%20MP_Master%20Plan_FINAL.pdf?v=1.1

Town of Maynard. (2020b) [online]. *Town of Maynard Encourages Residents to do their Civic "Doody" by Scooping the Poop.* Town of Maynard, MA. March 30, 2020. Available at https://www.townofmaynard-ma.gov/2020/03/30/scoop-the-poop/

Town of Maynard. (2021) [online]. *Stormwater Management.* Town of Maynard, Massachusetts. Available at https://www.townofmaynard-ma.gov/dpw/stormwater-management/

Town of Northborough. (n.d., a) [online]. Pooper Scooper Regulations. 2-24-090 Canine waste removal/disposal; penalties and authorized enforcement personnel. Northborough, MA. Available at https://www.town.northborough.ma.us/sites/g/files/vyhlif3571/f/uploads/pooperscooperexcerpt.pdf

Town of Northborough. (n.d., b) [online]. *Septic Systems and Title V.* Northborough, MA. Available at https://www.town.northborough.ma.us/health-department/pages/septic-systems-title-v

Town of Northborough. (2000) [online]. *Wetlands Bylaw.* (Ch. 6 of the Municipal Code) & Regulations. Town of Northborough. Regulations Effective December 1, 1993 Amendments to the Regulations Effective January 1, 2000 and September 21, 2019. Available at https://www.town.northborough.ma.us/sites/g/files/vyhlif3571/f/uploads/wetlands_bylaw_and_regs_voted2019.06.10.pdf

Town of Northborough. (2016) [online]. *Stormwater / Drainage.* Northborough, MA. Available at https://www.town.northborough.ma.us/engineering-department/pages/stormwater-drainage

Town of Northborough. (2020a) [online]. *Northborough Master Plan.* Approved by the Northborough Town Planning Board in March of 2020. Revised June 2020. Available at http://northboromp.com/default.asp

Town of Northborough. (2020b) [online]. *Northborough Open Space and Recreation Plan Update 2020.* Northborough, MA. Available at https://www.town.northborough.ma.us/open-space-committee/pages/northborough-open-space-recreation-plan-2020-update

Town of Southborough. (n.d., a) [online]. *Article II General Requirements.* Town of Southborough, MA / Division 1, Town Meeting Enactments / Division 3, Board of Health Legislation / Sewage Disposal. Available at https://ecode360.com/9540880

Town of Southborough. (n.d., b) [online]. *Article III Use Regulations.* Town of Southborough, MA / Division 1, Town Meeting Enactments / Part II, General Legislation / Zoning. Sec 174-13.5 Stormwater and Erosion Control. Available at https://ecode360.com/9540541

Town of Southborough. (n.d., c) [online]. *Stormwater Management Information.* Southborough, MA. Available at https://www.southboroughtown.com/highway/pages/stormwater-management-information

Town of Southborough. (1995) [online]. *Chapter 170 Wetlands Protection.* Town of Southborough, MA / Division 1, Town Meeting Enactments / Part II, General Legislation. Adopted by the Town Meeting of the Town of Southborough 4-10-1995. Available at https://ecode360.com/9539470

Town of Southborough. (2003) [online]. *Stormwater Management Plan.* Town of Southborough, Massachusetts. August 2003. Available at https://www.southboroughtown.com/sites/g/files/vyhlif1231/f/uploads/southborough_final_plan.pdf

Town of Southborough. (2008) [online]. *Master Plan / Documents.* 2008 Master Plan. Southborough, MA. Available at https://www.southboroughtown.com/planning/pages/master-plandocuments

Town of Southborough. (2015a) [online]. *174-13.3 Lower Impact Development Zoning Code*. Town of Southborough. Accepted September 21, 2015. Available at https://www.southboroughtown.com/sites/g/files/vyhlif1231/f/uploads/lid_bylaw2015.pdf

Town of Southborough. (2015b) [online]. *Rules and Regulations for Lower Impact Development (LID) Special Permits.* Southborough, MA. Adopted by Southborough Planning Board: September 21, 2015. Available at https://www.southboroughtown.com/sites/g/files/vyhlif1231/f/uploads/final_southborough_lid_regulations.pdf

Town of Southborough. (2016) [online]. *Chapter 81 Dogs and Other Animals.* Town of Southborough, MA / Division 1, Town Meeting Enactments / Part II, General Legislation. Sec 81-11 Removal of dog litter. Adopted 4-12-2016. Available at https://ecode360.com/31593892

Town of Stow. (n.d., a) [online]. *Stormwater Matters.* Stow, Massachusetts. Available at https://www.stow-ma.gov/highway-department/pages/stormwater-matters

Town of Stow. (n.d., b) [online]. *A Guide to Wetland Permitting in Stow.* Stow, MA. Available at https://www.stow-ma.gov/conservation-commission/pages/guide-wetland-permitting-stow

Town of Stow. (2005) [online]. *Board of Health Regulations.* Town of Stow. Adopted January 20, 2005. Available at https://www.stow-ma.gov/sites/g/files/vyhlif1286/f/uploads/town_of_stow_septic_regulations.pdf

Town of Stow. (2010) [online]. *Stow Master Plan Update.* Stow, MA. Adopted by the Planning Board, November 7, 2010. Available at https://www.stow-ma.gov/system/files/uploads/final_plan.pdf

Town of Stow. (2016a) [online]. *Open Space and Recreation Plan.* Stow, MA. Available at https://www.stow-ma.gov/conservation-commission/pages/open-space-recreation-plan

Town of Stow. (2016b) [online]. *Stow Conservation Land Regulations.* Stow Conservation Commission. 4/7/16. Available at https://www.stow-ma.gov/sites/g/files/vyhlif1286/f/uploads/stow_conservation_land_regulations.pdf

Town of Stow. (2017) [online]. *Rules and Regulations Governing the Subdivision of Land.* Section 7.9, page 39. Stow, MA. Adopted June 15, 1956 Including Amendments through April 18, 2017. Available at https://www.stow-ma.gov/sites/g/files/vyhlif1286/f/uploads/subdivision_rules_and_regs_-_revised_april_18_2017_.pdf

Town of Stow. (2018) [online]. *MS4 Outfall Locations.* Preliminary Mapping. October 1, 2018. Town of Stow. Available at https://www.stow-ma.gov/sites/g/files/vyhlif1286/f/uploads/ms4_map_legend.pdf

Town of Sudbury. (n.d.) [online]. *Publics Stormwater Maps Online.* Sudbury, MA. Available at https://www.mapsonline.net/sudburyma/stormwater.html#x=-7945914.636432,5221812.549915,-7945532.451291,5221994.685022

Town of Sudbury. (2009) [online]. *2009 – 2013 Open Space and Recreation Plan.* Sudbury, MA. June 2009. Available at https://s3-us-west-2.amazonaws.com/cdn.sudbury.ma.us/wp-content/uploads/sites/326/2014/08/OSRPCFINALJune2009nomaps.pdf?version=2747a707d5240ebc37e394b0fcba20ba

Town of Sudbury. (2013) [online]. *Stormwater Management Bylaw Regulations.* Sudbury, MA. Adopted September 9, 2009 Revised January 23, 2013. Available at https://sudbury.ma.us/planning/wp-content/uploads/sites/328/2014/08/SudburySWRegsRevised2013.pdf?version=abc2458ab7a235e57cc5f137ba179ce7

Town of Sudbury. (2015) [online]. *Route 20 Sewer Frequently Asked Questions.* Published August 25, 2015 | Sewer Assessment Technical Committee. Sudbury, MA. Available at https://sudbury.ma.us/sewertechcommittee/route-20-sewer-frequently-asked-questions/

Town of Sudbury. (2017) [online]. *Sudbury Wetlands Administration Bylaw Regulations.* Revised: September 25, 2017. Sudbury, MA. Available at https://s3-us-west-2.amazonaws.com/cdn.sudbury.ma.us/wp-

content/uploads/sites/272/2017/10/Wetlands-Bylaw-Regulation-Amendment-170925.pdf?version=18d2af56918f837c61fd50801a467313

Town of Sudbury. (2018) [online]. *Bylaws Articles I – XXXV & Civil Defense.* July 19, 2018. Article V Public Safety. Sec. 3-14 Dog Waste Disposal Page 17. Sudbury, MA. Available at https://s3-us-west-2.amazonaws.com/cdn.sudbury.ma.us/wp-content/uploads/sites/270/2018/07/2018-General-Bylaws-Articles-I-%E2%80%93-XXXII.pdf?version=7dfdc5a23807d729792a24131acdd6b8

Town of Sudbury. (2019) [online]. *Sudbury Master Plan 2001.* Published July 16, 2001 | Planning & Community Development | Updated February 21, 2019. Sudbury, MA. Available at https://sudbury.ma.us/pcd/substainable-sudbury-master-plan-acrobat/

Town of Wayland. (n.d.) [online]. *Chapter 91 Animals.* Sec. 91-5 Conduct of Dogs. Town of Wayland, MA / Division 1: Bylaws / Part II: General Legislation. Available at https://ecode360.com/12285287

Town of Wayland. (2002) [online]. *Chapter 194 Wetlands and Water Resources Protection.* Town of Wayland, MA / Division I : Bylaws / Part II: General Legislation. Adopted by the Annual Town Meeting of the Town of Wayland 5-1-2002 by Art. 27. Available at https://ecode360.com/12285685

Town of Wayland. (2004) [online]. *Master Plans.* Wayland. MA. August, 2004). Available at https://www.wayland.ma.us/planning-board-department/pages/master-plans

Town of Wayland. (2016) [online]. *Open Space and Recreation Plan 2016 Draft.* Town of Wayland, MA. Conservation Commission and Recreation Department. Weston & Sampson. Available at http://waylandrec.com/wp-content/uploads/2016/06/Wayland-DRAFT-OSRP-2016-Submission-low-1-1.pdf

Town of Wayland. (2020) [online]. *Stormwater Management.* Wayland, MA. Available at https://www.wayland.ma.us/department-public-works/pages/stormwater-management

Town of Westborough. (2003) [online]. *2003 Master Plan.* Westborough, MA. Available at https://www.town.westborough.ma.us/planning/pages/2003-master-plan

Town of Westborough. (2012) [online]. *Wetlands Protection Regulations.* Implementing Town of Westborough, Massachusetts Non-Zoning Wetlands Protection Bylaw (Article 45 of the Special Town Meeting of October 20, 2008) Adopted as Policy: February 9, 2010 Amended: May 8, 2012. Available at https://www.town.westborough.ma.us/sites/g/files/vyhlif5176/f/uploads/westboroughwetlandsregulations_amended_05082012.pdf

Town of Westborough. (2018) [online]. *Approved Open Space and Recreation Plan.* Westborough, MA. Posted on February 15, 2018 – 12:00PM. Available at https://www.town.westborough.ma.us/conservation-commission/news/approved-open-space-and-recreation-plan

Town of Westborough. (2019a) [online]. *General Bylaws.* Westborough, MA. As Amended 2019 Annual Town Meeting. Available at https://www.town.westborough.ma.us/sites/g/files/vyhlif5176/f/uploads/general_bylaws_through_atm_2019_final.pdf

Town of Westborough. (2019b) [online]. *Stormwater Information.* Westborough, MA. Available at https://www.town.westborough.ma.us/town-engineer/pages/stormwater-information

Town of Westford. (2008) [online]. *Chapter 147: Stormwater Management.* General Bylaws of the Town of Westford, Massachusetts. Adopted May 9, 2008 Effective August 5, 2008. Available at https://westfordma.gov/DocumentCenter/View/830/Bylaws-Chapter-147---Stormwater-Management-PDF

Town of Westford. (2009) [online]. *Westford Comprehensive Master Plan.* Final Report. Westford Planning Board, Westford Comprehensive Master Plan Committee. April 2009. Available at https://westfordma.gov/DocumentCenter/View/728/2009-Comprehensive-Master-Plan-PDF?bidId=

Town of Westford. (2012) [online]. *Chapter 171 Wetlands.* Town of Westford Non-Zoning Wetlands Bylaws. Updated 4-17-12. Available at https://www.westfordma.gov/DocumentCenter/View/2577/Wetlands-Bylaw-PDF?bidId=

Town of Westford. (2015) [online]. *Stormwater Management Master Plan.* Project Fact Sheet. Westford, MA. Summer 2015. Available at https://westfordma.gov/DocumentCenter/View/4236/c-Summer2015FactSheet?bidId=

Town of Westford. (2018a) [online]. *Open Space and Recreation Plan.* Draft. 2018-2025. Westford Conservation Commission. Westford Parks and Recreation Commission. July 2018. Available at https://westfordma.gov/DocumentCenter/View/6721/2018-Open-Space-and-Recreation-Plan---DRAFT

Town of Westford. (2018b) [online]. *Stormwater.* Westford, MA. Available at https://westfordma.gov/183/Stormwater

Town of Westford. (2019) [online]. *Septic Systems & Title 5.* Westford, MA. Available at https://westfordma.gov/281/Septic-Systems-Title-5

Town of Westford. (2020) [online]. *Pet Waste Disposal.* Westford, MA. Posted on August 6, 2020. Available at https://www.westfordma.gov/CivicAlerts.aspx?AID=861

USEPA (2020). General Permits for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems in Massachusetts, United States Environmental Protection Agency. Region 1. National Pollutant Discharge Elimination System (NPDES). Issued April 4, 2016. Modified December 7, 2020. Available at: https://www3.epa.gov/region1/npdes/stormwater/ma/2016fpd/final-2016-ma-sms4-gp-mod.pdf

USGPO (1999). Public Law 106–20. Sudbury, Assabet and Concord Wild and Scenic River Act. 106th Congress. 9 April 1999. United States Government Printing Office. Washington, DC. Accessed June 6, 2019. http://www.gpo.gov/fdsys/pkg/PLAW-106publ20/pdf/PLAW-106publ20.pdf.