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

Appendix U: Shawsheen River Basin

Commonwealth of Massachusetts
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Available Online

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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*.

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1. Introduction

This appendix to the Massachusetts Statewide Total Maximum Daily Load (TMDL) for Pathogen-Impaired Waterbodies provides additional information to support the determination of the TMDL for the pathogen-impaired segment in the Shawsheen River Basin hereinafter referred to as the Shawsheen River watershed (Figure 1-1). The core document and appendix together complete the TMDL for this pathogen-impaired segment.

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

This appendix also includes a summary of the allocation of the current indicator bacteria load into two categories: point sources (waste load allocation, WLA) and nonpoint sources (load allocation, LA), based on an analysis of watershed percent impervious cover. This appendix identifies the percent reduction in indicator bacteria pollutant load from current conditions required to meet the TMDL, based on the highest levels of indicator bacteria recorded in the monitoring data, if applicable. The TMDL for the Shawsheen River segment was calculated with the flow-based equation. Refer to Tables 1-1 and 1-2.

Finally, for the 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 Shawsheen River Watershed Overview section.

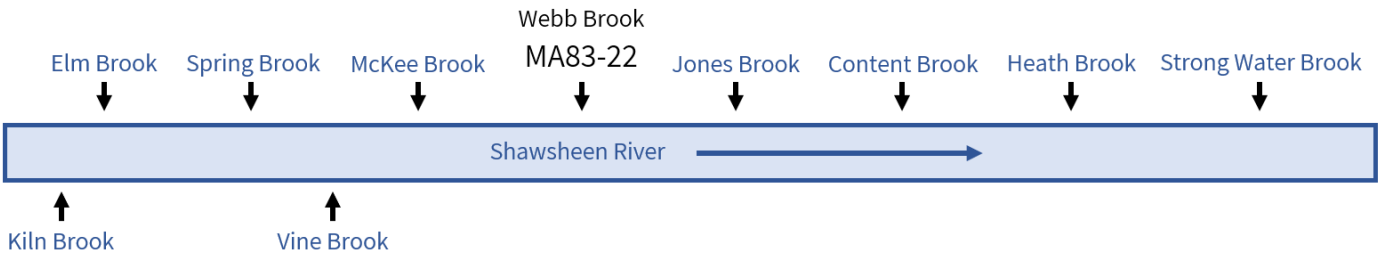


Figure 1-1. Conceptual diagram of water flow through the Shawsheen River watershed for the one pathogen-impaired segment. Connections between waterbodies are shown with black arrows. Not to scale. Impaired segments are shown with the assessment unit.

Table 1-1. ***E. Coli*** Total Maximum Daily Loads (TMDLs), the percent reductions needed to meet the TMDL target (126 CFU/100ml) based on the Massachusetts Surface Water Quality Standards (SWQS), and the flow-based TMDL allocations for pathogen-impaired **freshwater** assessment units in the Shawsheen 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)					
Webb Brook		R	126	4,606	97%	WLA (23%)	0.7	7.2	72.3	723.4	7,234.3	72,342.8
MA83-22	B			(90 day)		LA (77%)	2.4	23.6	235.9	2,359.3	23,592.5	235,925.2

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 Shawsheen 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)					
Webb Brook		P	35	NA	-	WLA (23%)	0.2	2.0	20.1	201.0	2,009.5	20,095.2
MA83-22	B					LA (77%)	0.7	6.6	65.5	655.3	6,553.5	65,534.8

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).*
Pathogen bacteria units are presented in colony-forming units or CFU per 100 milliliter or ml.
TMDL Type *identifies the restorative or protective action approach:*
- ***R*** *= Restorative TMDL addressing a pathogen impairment identified in the 2018/2020 Integrated List of Waters*
- ***R**** *= Restorative TMDL addressing a historic impairment of former indicator bacteria for which no current applicable criteria are available See Section 2.3 of the core document for summary of water quality criteria and designated uses.*
- ***P*** *= Protective TMDL addressing all applicable uses, regardless of impairment status, for the associated pathogen (refer to the Massachusetts SWQS:314 CMR 4.00)*

Target TMDL or Total Maximum Daily Load is presented as both SWQS-Based and Flow-Based.
- ***SWQS-Based TMDL Target*** *is the target concentration applicable to the TMDL pollutant indicator bacteria based on the Surface Water Quality Standards (314 CMR 4.00).*
- ***Flow-Based Target 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. Shawsheen River Watershed Overview

The Shawsheen River Watershed covers an area of approximately 78 square miles (mi^2) in northeastern Massachusetts (Figure 2-1). It includes the mainstem of the Shawsheen River, which flows northeast from Bedford to its confluence with the Merrimack River in Lawrence, MA, as well as numerous tributaries. Overall, the watershed contains 60.1 miles of named streams and 18 ponds that cover an area of 438 acres in the watershed (Kiras, 2003).

The mainstem of the Shawsheen River begins at its headwaters at Hanscom Air Force Base in Bedford and flows for 25 miles, dropping 70 feet in elevation, before reaching its confluence with the Merrimack River in Lawrence. Channel depth in the river ranges from one-half to five feet. Water-based infrastructure along the Shawsheen River includes the Shawsheen River Dam in Ballardvale Village and another dam by Stevens Street, both in Andover. The river flows through large floodplains and wetland areas that serve as habitat for beaver, mink, muskrat, and waterfowl (Kiras, 2003).

The Shawsheen River watershed overlaps a portion of 13 municipalities in Massachusetts. Of these municipalities, the majority of Andover, Bedford, Burlington, Lexington, and Tewksbury are contained within the watershed. See Figure 2-1 for a map showing impaired segments and watershed municipalities.

All municipalities in the watershed operate and maintain municipal separate storm sewer systems (MS4s) in urban areas. The networks of drains and pipes in MS4 systems convey polluted runoff from streets and developed areas to surface waters. In addition, these networks are sometimes subject to direct wastewater inflows through illegal cross-connections, leaks from sewer pipes or septic systems, dumping, or other unauthorized wastewater sources, and together these sources are termed illicit discharges.

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

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

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

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

- Regional stormwater coalitions operate within the RPAs, including MVPC's Merrimack Valley Stormwater Collaborative and NMCOG's Northern Middlesex Stormwater Collaborative.
- The MAPC utilizes the Integrated Water Management (IWM) approach to coordinate planning across the wastewater, drinking water, and stormwater sectors.
- The MAPC has developed two tools that assist MS4 regulated communities in fulfilling the requirements of the permit. These tools are:
    - Stormwater Utility/Funding Starting Kit (MAPC, 2014)
    - GIS toolkit to calculate MS4 outfall catchments, which is a requirement under the MS4 General Permit, created by MAPC and the Neponset River Watershed Association (MAPC, 2018).

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

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

- **Shawsheen River Watershed Association** (SRWA) is a 503(c)(3) non-profit that sponsors a river debris cleanup program, a public education program on river safety and paddling techniques, and a recreational canoe events program on the Shawsheen River (SRWA, 2022).
- **Trout Unlimited (TU)** operates three chapters in the geographic area of the Shawsheen watershed in Massachusetts, including the Greater Boston, Squan-A-Tissit and Nor'east. Their mission is to conserve, protect and restore our country's coldwater fisheries and their watersheds; some of their activities include river cleanups, scientific assessments (e.g., trout habitat, culvert connectivity) and restoration projects (TU, 2022).

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

- **Municipalities:** Continue to implement the MS4 permit, which includes specific requirements for waterbodies with an approved Bacteria/Pathogen TMDL, such as prioritization and reporting, enhanced BMPs, IDDE, and education (USEPA, 2020).
- **Regional Planning Agencies (RPAs) and municipalities:** Continue and expand collaboration on MS4 and stormwater issues. Cooperatively develop tools and share knowledge to reduce costs, increase innovation, and generate consistent and effective stream restoration efforts at the watershed scale.
- **USDA NRCS and landowners:** Develop comprehensive nutrient management plans for agriculture, reaching farmers through local connections.
- **Parks departments, schools, private landowners, and others** who maintain large, mowed fields with direct connections to surface water should consider maintaining a vegetated buffer along the shoreline. Buffers slow and filter stormwater runoff, provide a visual screen that can discourage large aggregations of waterfowl, and offer many other water quality benefits at low cost.

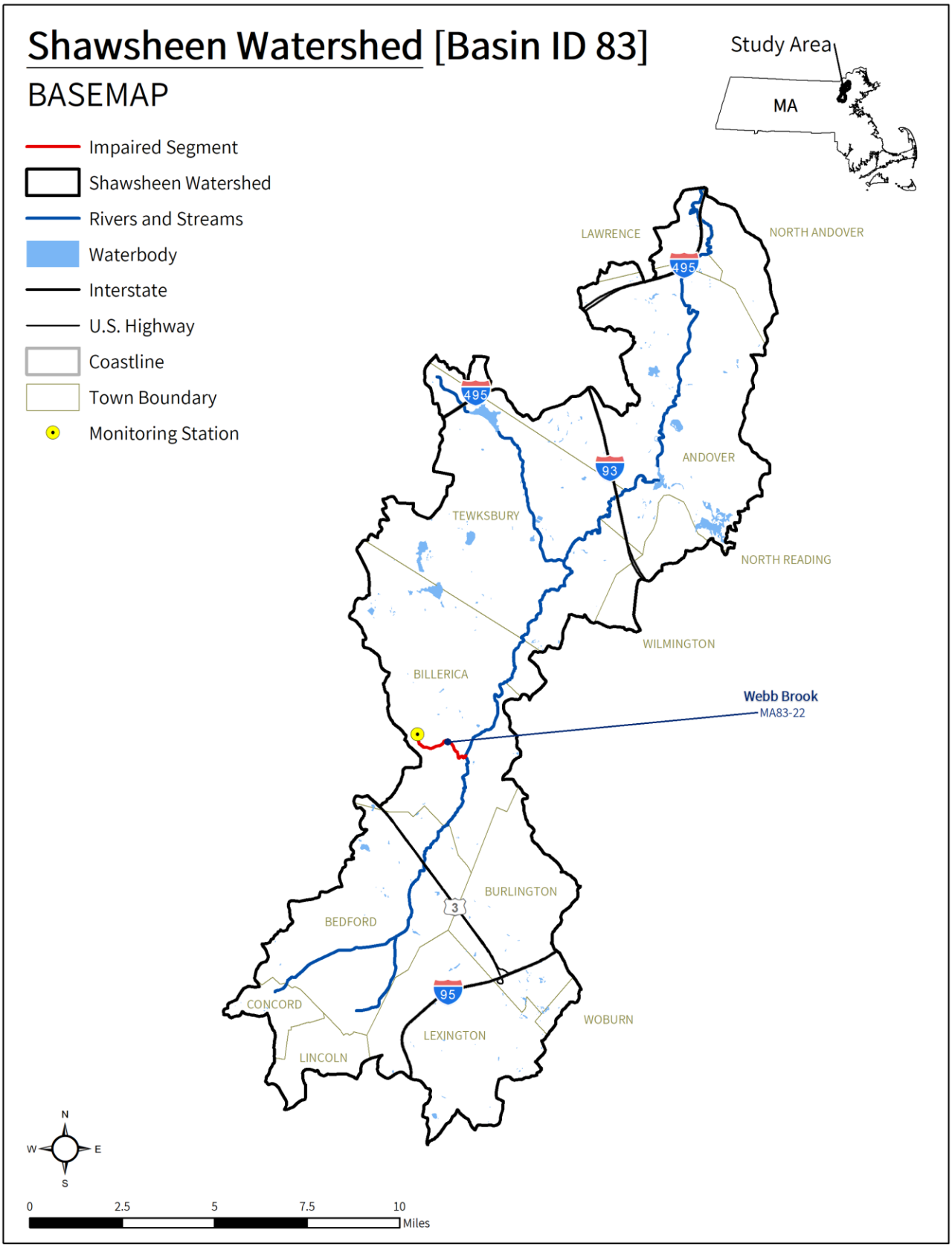


Figure 2-1: Map of pathogen-impaired segments and water quality monitoring stations in this TMDL, and all municipal borders, waterbodies, and major roads in the Shawsheen River watershed.

3. MA83-22 Webb Brook

3.1. Waterbody Overview

Webb Brook segment MA83-22 is 1.6 miles long and begins at its headwaters north of Webb Brook Road in Billerica, MA. The segment generally flows southeast before ending at its confluence with the Shawsheen River in Billerica, MA.

There are a few unnamed tributaries to the Webb Brook segment MA83-22. There are no lakes or ponds in the watershed. Therese are no dams on the segment. Much of the segment flows through wetland areas.

Key landmarks in the watershed include Cyril D. Lock Middle School; the Shops of Billerica and Town Plaza shopping centers; and Hillside Conserved Parcel and Shaloo Meadow Forest parks. From upstream to downstream, segment MA83-22 is crossed by Webb Brook Road, Everett Farmer Road, Allen Road, Ravine Road, Riverdale Road, and Marshbrook Road, all in Billerica.

Webb Brook (MA83-22) drains a total area of 1.2 square miles (mi^2), of which 0.28 mi^2 (23%) are impervious and 0.20 mi^2 (16%) are directly connected impervious area (DCIA). The watershed is partially served by a public sewer system in Billerica[1]; and the entire land area is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020). There are no NPDES permits on file governing point source discharges of pollutants to surface waters, MassDEP discharge-to-groundwater permits for on-site wastewater discharges, or combined sewer overflows (CSOs) within the watershed. There are no landfills or unpermitted land disposal dumping grounds within the watershed. See Figure 3-1.

The Webb Brook segment MA83-22 watershed is located in a highly-developed part of Massachusetts. Half of the watershed is covered by development (50%) consisting of medium density residential neighborhoods and commercial areas with large parking lots. There is a small amount of agriculture in the watershed (2%) consisting of cultivated fields. The remaining watershed is covered by forest and natural (39%) or wetland areas (9%).

Reduction from Highest Calculated Geomean: 97%

Watershed Area (Acres): 762

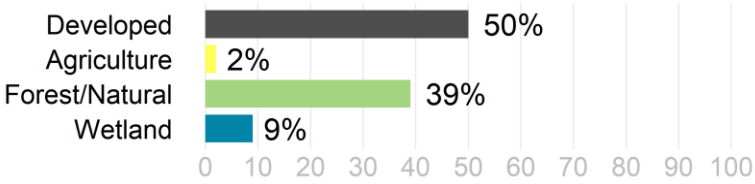
Segment Length (Miles): 1.6

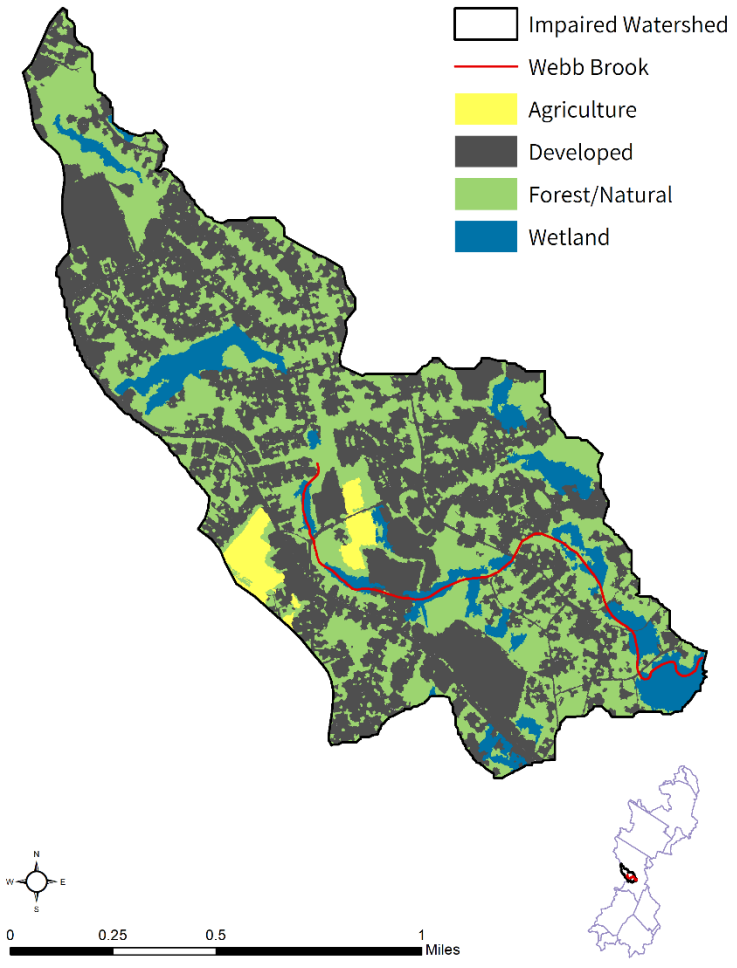
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifier): B

Impervious Area (Acres, %): 179 (23%)

DCIA Area (Acres, %): 126 (16%)





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

In the Webb Brook (MA83-22) watershed, under the Natural Heritage and Endangered Species Program, there are no Priority Habitats of Rare Species or Priority Natural Vegetation Communities. There are no acres under Public Water Supply protection, Areas of Critical Environmental Concern, or Outstanding Resource Waters. Overall, there are 55 acres (7%) of land protected in perpetuity[2], part of 61 acres (8%) of Protected and Recreational Open Space[3]. See Figure 3-1.

[2] Land protected in perpetuity includes conservation restrictions, agricultural preservation, private deed restrictions, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.
[3] All Protected and Recreational Open Space land is shown on the natural resources map.

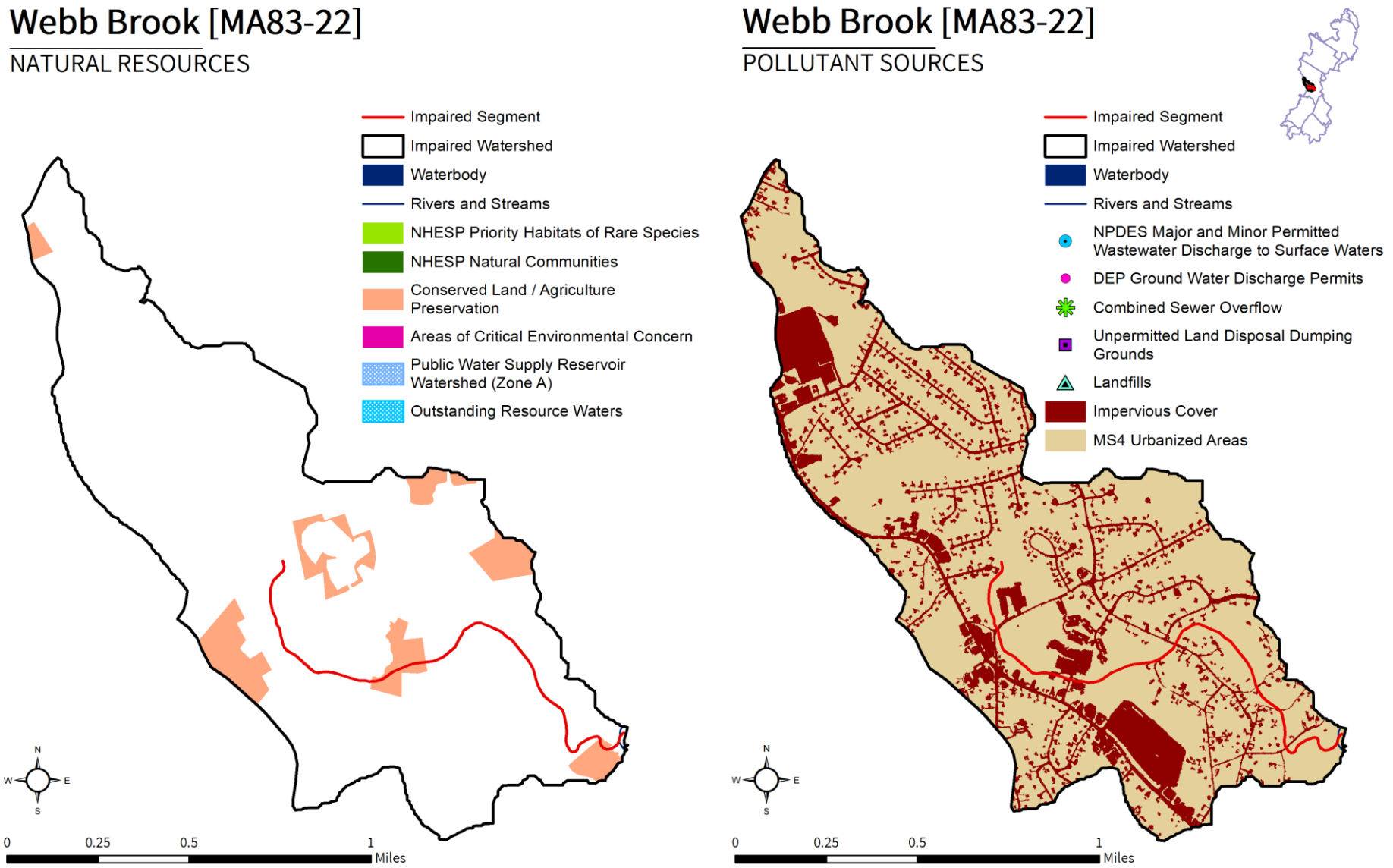


Figure 3-1. Natural resources and potential pollution sources draining to the Webb Brook segment MA83-22. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollutant sources, including impervious cover, MS4 areas, permitted facilities, etc.

3.2. Waterbody Impairment Characterization

Webb Brook (MA83-22) is a Class B Water (MassDEP, 2021a).

The Primary Contact Recreation use was assessed for attainment of SWQS at the station listed below (refer to Tables 3-1, 3-2; Figure 3-2) using the indicator bacteria *E. coli*. Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 90-day rolling basis.

- In 2010, six samples were collected at W2145; data indicated six days when the 90-day rolling geomean exceeded the criterion. Since there were no stations and years with more than 10 samples, the Statistical Threshold Value (STV) criterion was applied to single sample results. Out of six samples, six exceeded the STV criterion, three during wet weather and three during dry weather.

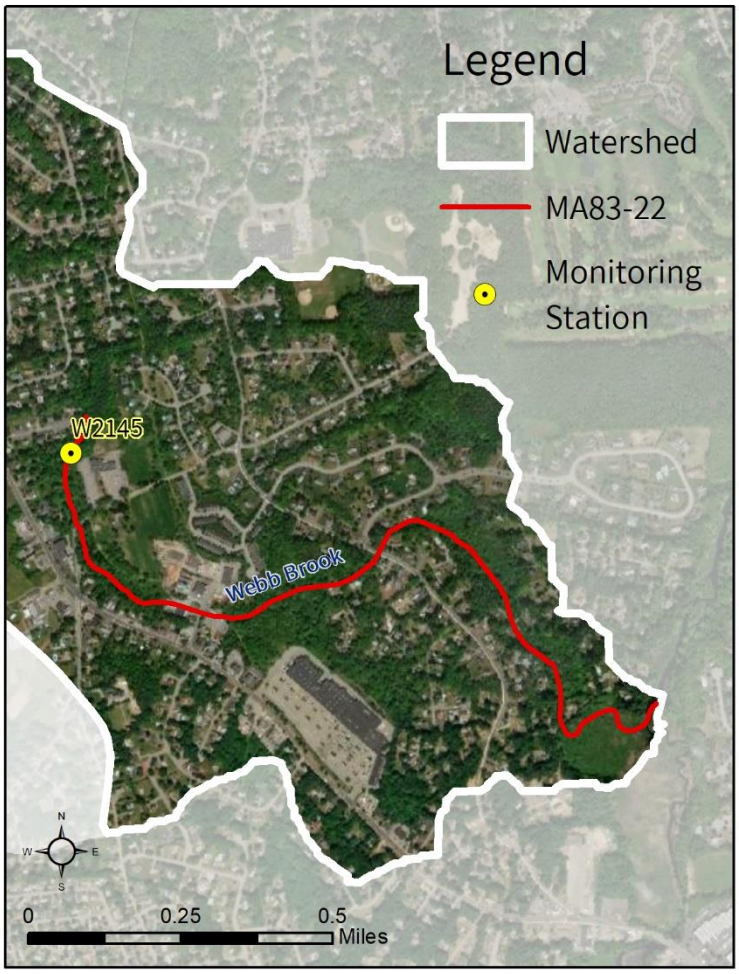


Figure 3-2. Location of monitoring station(s) along the impaired segment.

Table 3-1. Summary of indicator bacteria sampling results by station for Webb Brook (MA83-22). 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 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 site 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
W2145	5/18/2010	9/29/2010	6	4,606	6	6

Table 3-2. Indicator bacteria data by station, indicator, and date for Webb Brook (MA83-22). Each sample date was designated as representing wet or dry weather conditions with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text in the Results column highlights criteria exceedances of 410 CFU/100 mL (applied to single-sample "Result" since there were no more than 10 samples in a year to calculate the STV) for *E. coli* indicator bacteria; and red text in the Geomean column highlights exceedances of the 126 CFU/100 mL criterion (applied to rolling 90-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W2145	*E. coli*	5/18/2010	WET	2,000	2,000	
W2145	*E. coli*	6/10/2010	DRY	3,000	2,449	
W2145	*E. coli*	6/22/2010	DRY	6,700	3,426	
W2145	*E. coli*	7/27/2010	DRY	3,500	3,444	
W2145	*E. coli*	8/23/2010	WET	6,400	4,606	
W2145	*E. coli*	9/29/2010	WET	1,700	3,364	

3.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information that can be used to focus pollutant reduction activities. Pathogen levels (as estimated by indicator bacteria) are usually higher in wet weather conditions as storm sewer systems overflow and/or stormwater runoff carries fecal matter that has accumulated on the landscape to surface waters via overland flow and stormwater conduits. Wet weather sources include wildlife and domesticated animal waste (including pets), urban stormwater runoff (including MS4 areas), CSOs, and sanitary sewer overflows (SSOs). In other cases, dry weather pathogen and associated indicator bacteria concentrations can be high when there is a constant flow of pollutants during dry weather, which then becomes diluted 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 Webb Brook (MA83-22) were elevated during both wet and dry weather. Elevated results during wet weather are consistent with urban stormwater, pet waste, and wildlife pathogen sources, as are certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation. Elevated results during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be the major sources of pathogens.

Each potential pathogen source is described in further detail below.

Urban Stormwater: There is a substantial amount of development in the watershed (50%), consisting of residential areas and shopping centers with large parking lots. The entire land area is subject to MS4 permit conditions, 23% is classified as impervious area, and 16% is classified as DCIA. Stormwater runoff from urban areas is likely a significant source of pathogens.

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

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

Agriculture: Agricultural activities in the watershed account for a small portion (2%) of the total land use. This agricultural land consists of cultivated fields. Manure storage and spreading activities, if not properly conducted, are possible sources of pathogens to waterbodies.

Pet Waste: Residential neighborhoods and a few parks surround most of the impaired segment MA83-22. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths or residential neighborhoods are adjacent to rivers, ponds, or wetlands, represent possible sources of pathogens.

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

3.4. Existing Local Management

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

Town of Billerica

About 99% of Billerica is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (Permit ID # MAR041182), and the town has an EPA approved Notice of Intent (NOI). The town has mapped 100% of its MS4 system and the year-one and year-two Annual Reports have been submitted. Billerica has completed an illicit discharge detection and elimination (IDDE) plan, an erosion and sedimentation control (ESC) plan, and post-construction stormwater regulations, all in 2007. No pathogen-impaired waterbodies within the Shawsheen River watershed were reported on the town's NOI.

Billerica has the following ordinances and bylaws, mostly accessible online via the town website at https://www.town.billerica.ma.us/ (Town of Billerica, 2022):

- Wetland protection bylaw
- A stormwater bylaw
- Pet Waste Control bylaw: none found.
- Stormwater Utility: none found

Billerica has a 2002 Master Plan with a Natural Resources section, but it does not include an environmental inventory or analysis. Instead, this section identifies objectives relating to conserving the town's natural resources, specifically by completing an inventory of natural features. Billerica also has a 2018 Open Space and Recreation Plan which features a comprehensive inventory of water resources within the town. Stormwater runoff is identified as an environmental challenge and an area in which the town has the potential to improve water quality (Town of Billerica, 2022).

4. References

Kiras, S. D. (2003). *Shawsheen River Watershed: 2000 Water Quality Assessment Report*. CN 86.0. Massachusetts Department of Environmental Protection. Division of Watershed Management. Worcester, MA. July 2003. Available at: https://www.mass.gov/doc/shawsheen-river-watershed-2000-water-quality-assessment-report-0/download

MassDEP. (2021a). *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

MassDEP. (2021b). Water Utility Resilience Program. Retrieved from home page: https://www.mass.gov/guides/water-utility-resilience-program

MAPC. (2014). Metropolitan Area Planning Council. Retrieved from Stormwater Financing/Utility Starter Kit: https://www.mapc.org/resource-library/stormwater-financing-utility-starter-kit/

MAPC. (2018). Metropolitan Area Planning Council. Retrieved from MS4 Outfall Catchment Calculator: https://www.mapc.org/resource-library/ms4-outfall-catchment-calculator/

MAPC. (2021). Metropolitan Area Planning Council. Retrieved from home page: https://www.mapc.org/

MVPC. (2021). Merrimack Valley Planning Commission. Retrieved from home page: https://mvpc.org/

NMCOG. (2021). Northern Middlesex Council of Governments. Retrieved from home page: https://www.nmcog.org/

SRWA. (2022). Shawsheen River Watershed Association. Retrieved from home page: https://shawsheenriver.net/

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

Town of Billerica. (2022). Retrieved from Town of Billerica home page: https://www.town.billerica.ma.us/

TU. (2022). Trout Unlimited. Retrieved from Trout Unlimited Chapter Location page: https://www.tu.org/find-your-chapter/

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