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

Appendix G: Chicopee River Basin

Commonwealth of Massachusetts
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December 2024

CN 515.1.07

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December 2024

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Suggested Citation
MassDEP. 2024. Final Massachusetts Statewide Total Maximum Daily Load for Pathogen-Impaired Waterbodies. CN 515.1, Massachusetts Department of Environmental Protection, Bureau of Water Resources, Division of Watershed Management, Watershed Planning Program. Worcester, MA.

Available Online

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

Massachusetts Department of Environmental Protection

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

Watershed Planning Program

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

Acknowledgements

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

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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 Chicopee 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 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 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 Tables 1-1 and 1-2.

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 Chicopee River Watershed Overview section.

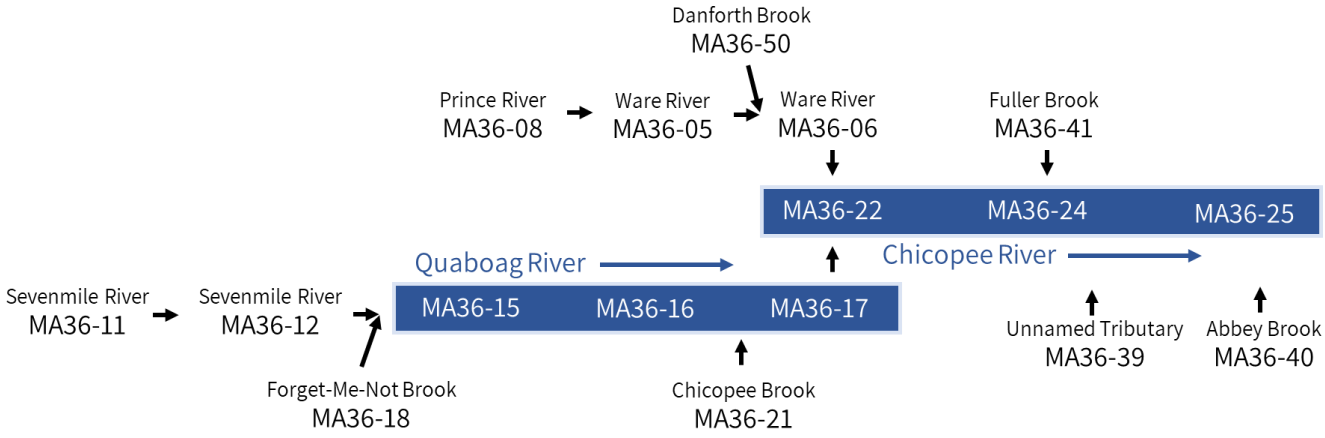


Figure 1-1. Conceptual diagram of water flow routing through the Chicopee River watershed for the 17 pathogen-impaired river segments. Mainstem segments of major rivers (i.e., Chicopee River and Quaboag River) are

highlighted in blue. Tributary segments to the major rivers are shown with black arrows to the 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 Chicopee 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)					
Ware River		R	126	900	86%	WLA (3%)	0.1	0.9	9.3	93.3	933.4	9,334.4
MA36-05	B (WW)			(30 day)		LA (97%)	3.0	29.9	298.9	2,989.3	29,893.4	298,933.6
Ware River		R	126	1,050	88%	WLA (3%)	0.1	1.1	10.6	106.3	1,063.0	10,629.5
MA36-06	B (WW)			(30 day)		LA (97%)	3.0	29.8	297.6	2,976.4	29,763.8	297,638.5
Prince River		R	126	320	61%	WLA (4%)	0.1	1.2	12.4	124.5	1,244.7	12,447.5
MA36-08	B (CW, HQW)			(90 day)		LA (96%)	3.0	29.6	295.8	2,958.2	29,582.1	295,820.5
Sevenmile River		R	126	495	75%	WLA (6%)	0.2	1.8	17.8	177.7	1,777.0	17,769.6
MA36-11	B (WW, HQW)			(90 day)		LA (94%)	2.9	29.0	290.5	2,905.0	29,049.8	290,498.5
Sevenmile River		R	126	449	72%	WLA (6%)	0.2	1.9	18.6	186.2	1,862.1	18,621.5
MA36-12	B (WW)			(30 day)		LA (94%)	2.9	29.0	289.6	2,896.5	28,964.7	289,646.6
Quaboag River		R	126	2,420	95%	WLA (5%)	0.1	1.4	14.1	141.0	1,410.3	14,103.3
MA36-15	B (WW)			(30 day)		LA (95%)	2.9	29.4	294.2	2,941.6	29,416.5	294,164.8
Quaboag River		R	126	800	84%	WLA (4%)	0.1	1.4	13.5	135.4	1,354.2	13,542.0
MA36-16	B (WW)			(30 day)		LA (96%)	2.9	29.5	294.7	2,947.3	29,472.6	294,726.0
Quaboag River		R	126	399	68%	WLA (5%)	0.1	1.5	14.8	147.9	1,478.6	14,786.3
MA36-17	B (WW)			(30 day)		LA (95%)	2.9	29.3	293.5	2,934.8	29,348.2	293,481.8
Forget-Me-Not Brook		R	126	291	57%	WLA (11%)	0.3	3.4	34.1	341.3	3,412.7	34,127.2
MA36-18	B (CW, HQW)			(90 day)		LA (89%)	2.7	27.4	274.1	2,741.4	27,414.1	274,140.9
Chicopee Brook		R	126	359	65%	WLA (5%)	0.2	1.5	15.0	150.5	1,504.5	15,045.2
MA36-21	B (CW)			(90 day)		LA (95%)	2.9	29.3	293.2	2,932.2	29,322.3	293,222.8
Chicopee River		R	126	900	86%	WLA (3%)	0.1	1.0	10.4	103.7	1,036.9	10,369.5
MA36-22	B (WW, CSO)			(30 day)		LA (97%)	3.0	29.8	297.9	2,979.0	29,789.9	297,898.6
Chicopee River		R	126	160	21%	WLA (4%)	0.1	1.3	13.2	132.5	1,324.6	13,246.1
MA36-24	B (WW, CSO)			(30 day)		LA (96%)	3.0	29.5	295.0	2,950.2	29,502.2	295,021.9
Chicopee River		R	126	693	82%	WLA (5%)	0.1	1.4	14.5	144.9	1,449.0	14,489.8
MA36-25	B (WW, CSO)			(30 day)		LA (95%)	2.9	29.4	293.8	2,937.8	29,377.8	293,778.2
Unnamed Tributary		R	126	152	17%	WLA (43%)	1.3	13.4	133.8	1,338.4	13,384.2	133,842.1
MA36-39	B			(90 day)		LA (57%)	1.7	17.4	174.4	1,744.3	17,442.6	174,425.9
Abbey Brook		R	126	NA	-	WLA (41%)	1.3	12.7	127.1	1,270.5	12,705.2	127,052.2
MA36-40	B					LA (59%)	1.8	18.1	181.2	1,812.2	18,121.6	181,215.8
Fuller Brook		R	126	NA	-	WLA (13%)	0.4	3.9	38.6	386.3	3,862.9	38,629.2
MA36-41	B					LA (87%)	2.7	27.0	269.6	2,696.4	26,963.9	269,638.8
Danforth Brook		R	126	242	48%	WLA (3%)	0.1	1.0	10.1	100.9	1,008.8	10,087.7
MA36-50	B			(90 day)		LA (97%)	3.0	29.8	298.2	2,981.8	29,818.0	298,180.3

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 Chicopee 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)					
Ware River		P	35	NA	-	WLA (3%)	-	0.3	2.6	25.9	259.3	2,592.9
MA36-05	B (WW)					LA (97%)	0.8	8.3	83.0	830.4	8,303.7	83,037.1
Ware River		P	35	NA	-	WLA (3%)	-	0.3	3.0	29.5	295.3	2,952.6
MA36-06	B (WW)					LA (97%)	0.8	8.3	82.7	826.8	8,267.7	82,677.4
Prince River		P	35	NA	-	WLA (4%)	-	0.3	3.5	34.6	345.8	3,457.6
MA36-08	B (CW, HQW)					LA (96%)	0.8	8.2	82.2	821.7	8,217.2	82,172.4
Sevenmile River		P	35	NA	-	WLA (6%)	-	0.5	4.9	49.4	493.6	4,936.0
MA36-11	B (WW, HQW)					LA (94%)	0.8	8.1	80.7	806.9	8,069.4	80,694.0
Sevenmile River		P	35	NA	-	WLA (6%)	0.1	0.5	5.2	51.7	517.3	5,172.6
MA36-12	B (WW)					LA (94%)	0.8	8.0	80.5	804.6	8,045.7	80,457.4
Quaboag River		P	35	NA	-	WLA (5%)	-	0.4	3.9	39.2	391.8	3,917.6
MA36-15	B (WW)					LA (95%)	0.8	8.2	81.7	817.1	8,171.2	81,712.4
Quaboag River		P	35	NA	-	WLA (4%)	-	0.4	3.8	37.6	376.2	3,761.7
MA36-16	B (WW)					LA (96%)	0.8	8.2	81.9	818.7	8,186.8	81,868.3
Quaboag River		P	35	NA	-	WLA (5%)	-	0.4	4.1	41.1	410.7	4,107.3
MA36-17	B (WW)					LA (95%)	0.8	8.2	81.5	815.2	8,152.3	81,522.7
Forget-Me-Not Brook		P	35	NA	-	WLA (11%)	0.1	0.9	9.5	94.8	948.0	9,479.8
MA36-18	B (CW, HQW)					LA (89%)	0.8	7.6	76.2	761.5	7,615.0	76,150.2
Chicopee Brook		P	35	NA	-	WLA (5%)	-	0.4	4.2	41.8	417.9	4,179.2
MA36-21	B (CW)					LA (95%)	0.8	8.1	81.5	814.5	8,145.1	81,450.8
Chicopee River		P	35	NA	-	WLA (3%)	-	0.3	2.9	28.8	288.0	2,880.4
MA36-22	B (WW, CSO)					LA (97%)	0.8	8.3	82.7	827.5	8,275.0	82,749.6
Chicopee River		P	35	NA	-	WLA (4%)	-	0.4	3.7	36.8	367.9	3,679.5
MA36-24	B (WW, CSO)					LA (96%)	0.8	8.2	82.0	819.5	8,195.1	81,950.5
Chicopee River		P	35	NA	-	WLA (5%)	-	0.4	4.0	40.2	402.5	4,025.0
MA36-25	B (WW, CSO)					LA (95%)	0.8	8.2	81.6	816.1	8,160.5	81,605.0
Unnamed Tributary		P	35	NA	-	WLA (43%)	0.4	3.7	37.2	371.8	3,717.8	37,178.4
MA36-39	B					LA (57%)	0.5	4.8	48.5	484.5	4,845.2	48,451.6
Abbey Brook		P	35	NA	-	WLA (41%)	0.4	3.5	35.3	352.9	3,529.2	35,292.3
MA36-40	B					LA (59%)	0.5	5.0	50.3	503.4	5,033.8	50,337.7
Fuller Brook		P	35	NA	-	WLA (13%)	0.1	1.1	10.7	107.3	1,073.0	10,730.3
MA36-41	B					LA (87%)	0.7	7.5	74.9	749.0	7,490.0	74,899.7
Danforth Brook		P	35	NA	-	WLA (3%)	-	0.3	2.8	28.0	280.2	2,802.2
MA36-50	B					LA (97%)	0.8	8.3	82.8	828.3	8,282.8	82,827.9

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).*
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)*
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 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. Chicopee River Watershed Overview

The Chicopee River watershed covers approximately 721 square miles in central Massachusetts (Figure 2-1). It includes the Swift, Ware, and Quaboag rivers (flowing from Belchertown/Ware to Palmer, from Barre to Palmer, and from West Brookfield to Palmer, respectively), which converge to become the Chicopee River in Palmer, MA. Overall, there are 136 named rivers, approximately 1,200 total river miles including many smaller unnamed streams, and 174 lakes, ponds, and impoundments in the watershed (Reardon, 2008).

The Swift River watershed covers approximately 215 square miles in the western portion of the Chicopee River watershed and generally flows to the south. Beginning at the outlet of the Quabbin Reservoir near the town border of Belchertown and Ware, the Swift River flows 9.8 miles towards Palmer and its confluence with the Ware River. The flow of the Swift River is controlled by the release of water for flood control and water supply from the Quabbin Reservoir, which is controlled by the Massachusetts Department of Conservation and Recreation (MassDCR) (MassDEP, 2016). There are no municipal WWTF discharges to the Swift River. There is a permitted discharge from the McLaughlin state fish hatchery. There are no pathogen-impaired river segments along the Swift River.

The Ware River begins in Barre at the confluence of the East and West branches of the Ware River and flows generally to the southwest in the central part of the Chicopee River watershed. The Ware River watershed drains 218 square miles, flowing about 34 miles before meeting the Quaboag River in Palmer. The river is controlled by the Barre Falls Dam flood control project operated by the U.S. Army Corps of Engineers, who primarily manage a “dry bed reservoir (no recreational pool maintained) in a run-of-river mode” (MassDEP, 2016). There are several municipal NPDES discharges within the Ware River watershed, including Barre, Hardwick/Wheelwright, Hardwick/Gilbertville, and Ware. There are two pathogen-impaired segments on the Ware River and one additional pathogen-impaired segment on Danforth Brook within the watershed.

The Quaboag River begins at the outlet of Quaboag Pond in Brookfield and flows generally southwest in the southern portion of the Chicopee River watershed. The Quaboag River watershed drains 212 square miles, flowing about 26 miles until its confluence with the Ware River in Palmer. Other major rivers within the Quaboag River watershed include the Sevenmile and Cranberry Rivers. There are three municipal NPDES discharges within the Quaboag watershed, including Spencer, North Brookfield and Warren. There are five pathogen-impaired segments within the Quaboag River watershed: three along the Quaboag River and two along the Sevenmile River.

From the convergence of the Swift, Ware, and Quaboag Rivers in Palmer, MA the Chicopee River flows 17.9 miles west to its confluence with the Connecticut River in Chicopee, MA. The Chicopee River watershed contains the Quabbin Reservoir and the Chicopee Valley Aqueduct; the latter provides drinking water to the towns of Chicopee, South Hadley Fire District #1, and Wilbraham (MWRA, 2019). Ninety-seven streams within this portion of the watershed have been identified by MassDFG as Coldwater Fish Resources (CFR), though none along the Chicopee River itself. Alluvial plains, rolling hills, and many lakes can be found within the watershed. Dams in th downstream portion of the Chicopee River watershed created impoundments used as drinking water supplies, and for the production of hydropower (MassDEP, 2016). The Palmer Water Pollution Control Facility (WPCF), in addition to eight CSOs, constitute the municipal NPDES discharges within the lower Chicopee River watershed.

The Chicopee River watershed encompasses all or part of 39 municipalities. Of these, 20 were identified as direct sources of pathogen loading to the impaired river segments noted in this TMDL. The efforts of these municipalities to reduce 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 included. 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. Towns which may not meet the above characteristics, but which have land area in the sub-basin near the impaired segment, 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 can be subject to direct wastewater inflows through illegal cross-connections, leaks from sewer pipes or septic systems, dumping, or other unauthorized wastewater sources; together, these sources are termed illicit discharges.

EPA and MassDEP jointly issue the General Permit for Stormwater Discharges from MS4s, the latest permit taking effect on 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 2016; Appendix F).

In addition to municipalities, there are two Regional Planning Agencies (RPAs) active in the Chicopee River watershed:

- Central Massachusetts Regional Planning Commission (CMRPC), http://www.cmrpc.org/ (CMRPC, 2020) and
- Metropolitan Area Planning Council (MAPC), http://www.mapc.org/ (MAPC, 2020)

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 is especially valuable on watershed issues such as pathogen pollution and stormwater that cross town boundaries. 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 (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 (MAPC, 2018).

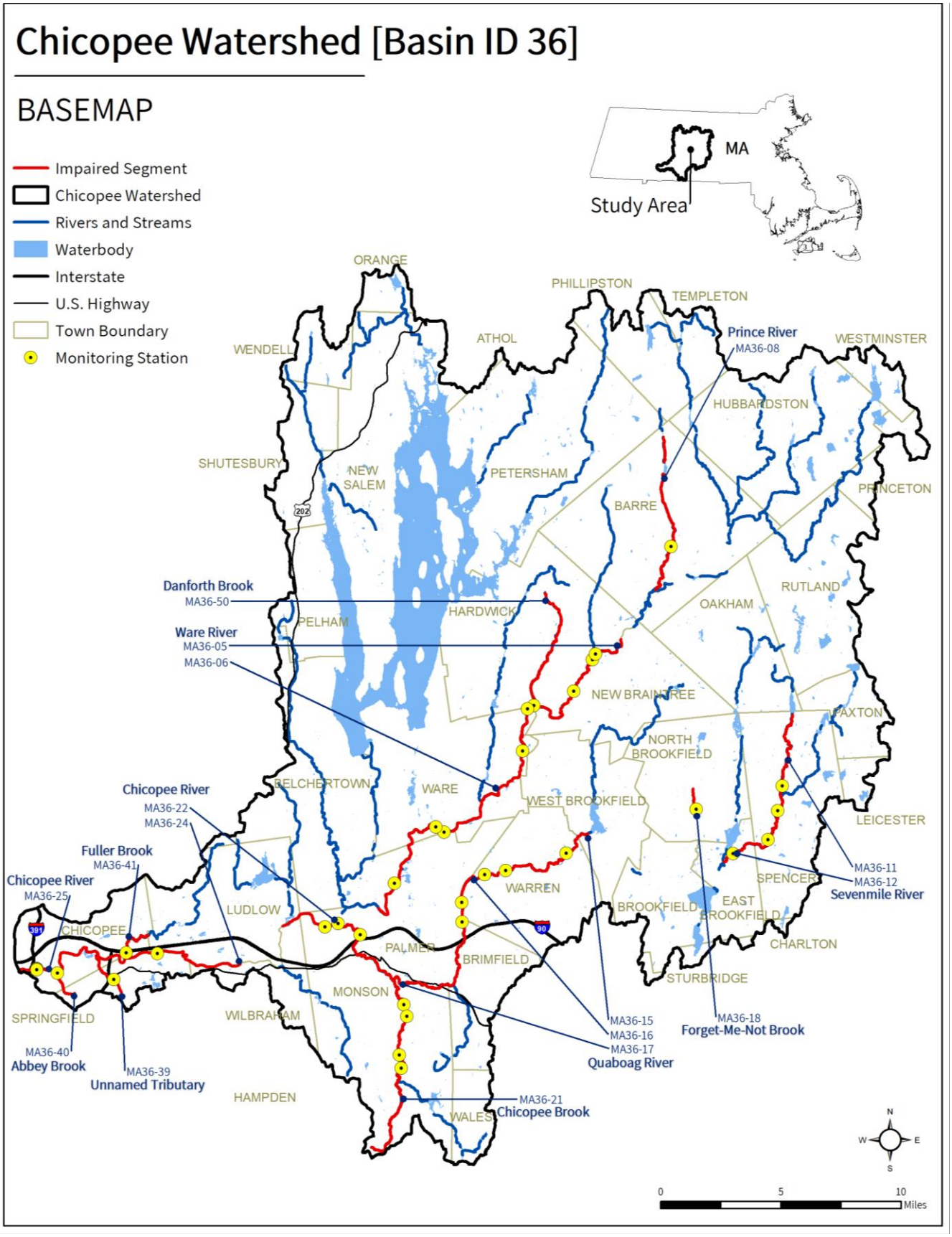
Beyond these activities, the Massachusetts Statewide Municipal Stormwater Coalition (MSMSC), composed of about 10 stormwater groups around the state, further coordinates with and assists municipalities on pathogen pollutant concerns in the “Think Blue” campaign (Think Blue Massachusetts, 2019).

Additional watershed scale initiatives are carried out by the Chicopee 4Rivers Watershed Council (C4RC). C4RC promotes stewardship, local conservation, and restoration of the rivers and habitats within the Chicopee River watershed. They also work towards maintaining balanced community views of economics, community development, and sustainability, as a member of the Massachusetts River Alliance (C4RWC n.d.).

The following actions will help reduce pathogen loads to the impaired 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.

- **CSO Removal:** Removal of the eight CSOs in the watershed is a top priority.
- **Municipalities:** Continue to implement requirements of the MS4 General 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, 2020A).
- **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:
        - MAPC created a Stormwater Utility/Funding Starting Kit (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 (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.


Chicopee Watershed [Basin ID 36]
BASEMAP
Impaired Segment
Chicopee Watershed
Rivers and Streams
Waterbody
Interstate
U.S. Highway
Town Boundary
Monitoring Station
MA
Study Area
ORANGE
PHILLIPSTON
TEMPLETON
WESTMINSTER
ATHOL
WENDELL
Prince River
MA36-08
HUBBARDSTON
SHUTESBURY
NEW SALEM
PETERSHAM
BARRE
PRINCETON
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MA36-18
Forget-Me-Not Brook
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Abbey Brook
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Unnamed Tributary
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Figure 2-1: Map of all pathogen-impaired river segments, water quality monitoring stations, municipal borders, waterbodies, and roads in the Chicopee River watershed.

3. MA36-05 Ware River

3.1. Waterbody Overview

Reduction from Highest Calculated Geomean: 86%

Watershed Area (Acres): 106,111

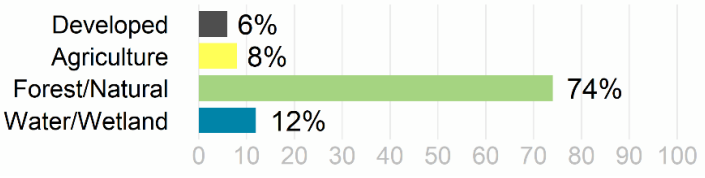
Segment Length (miles): 11.5

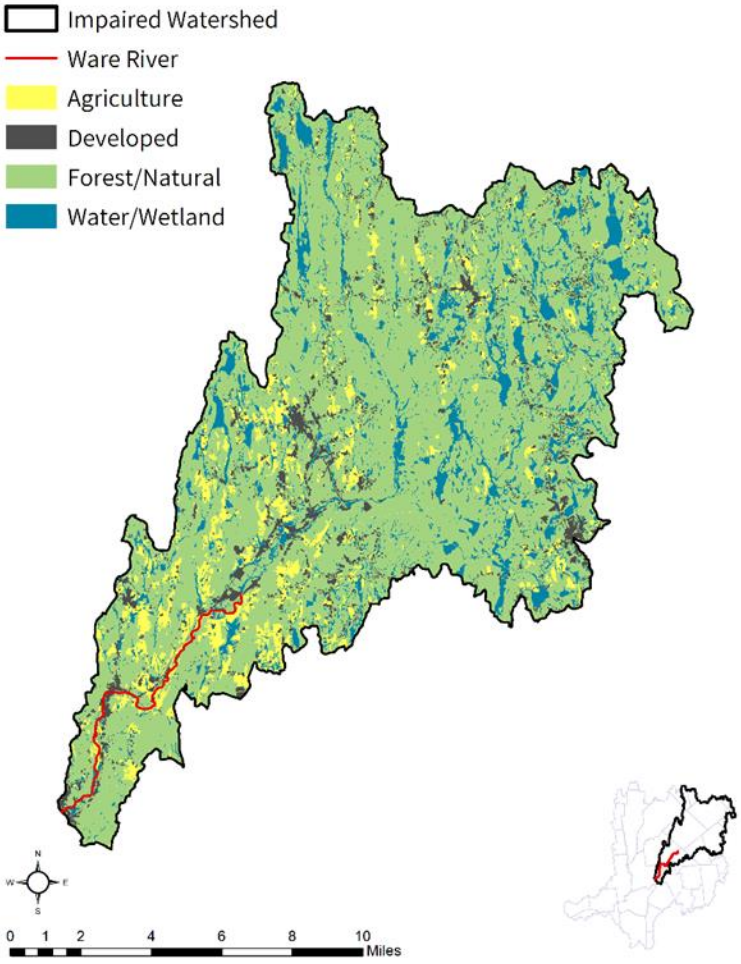
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifiers): B (Warm Water)

Impervious Area (Acres, %): 3,213 (3%)

DCIA Area (Acres, %): 854 (1%)





The Ware River segment MA36-05 is 11.5 miles long, beginning at the outlet of the Wheelwright Pond Dam (NATID: MA00616) at the border of New Braintree and Hardwick, MA. Segment MA36-05 flows southwest, serving as the boundary between New Braintree and Hardwick, then flows south through Ware, MA. Segment MA36-05 is bound at its downstream end by the Ware Impoundment Dam (NATID: MA00594) in Ware, MA.

Tributaries to Ware River segment MA36-05 include Broad Meadow Brook, Winimusset Brook, and Fish Brook, as well as the pathogen-impaired Prince River (MA36-08) and Danforth Brook (MA36-50).

Key landmarks in the watershed include the town centers of Ware, Barre, Hubbardston, Rutland, and the village of South Barre. Portions of downtown Ware, plus the villages of Wheelwright and Gilbertville, are along the impaired segment. The Wachusett Mountain State Reservation and Hubbardston State Forest lie near the headwaters of the segment, and the Dunroamin Country Club/golf course sits along the impaired segment. The Quabbin Aqueduct cuts from east to west through the watershed but does not contribute to or diminish the flow of the Ware River. Five roadways cross the river, including Hardwick Road (New Braintree), Main Street/MA-32 (Hardwick), and East Main Street/MA-32 (Ware). The Mass Central Rail Trail runs along a portion of the segment south of the village of Wheelwright.

The Ware River (MA36-05) drains an area of 166 square miles, of which 5 mi^2 (3%) is covered with impervious surfaces, and 1 mi^2 (1%) is identified as directly connected impervious area (DCIA). The

watershed is served partially[1] by public sewer and 2% is subject to stormwater regulations under the National Pollutant Discharge Elimination System (NPDES) General MS4 Stormwater Permit (USEPA, 2020A). There are three NPDES permits on file governing point source discharges of pollutants to surface waters (Table 3-1), as well as 11 landfills. There are no MassDEP permits for discharges to groundwater for on-site wastewater discharge within this watershed, no combined sewer overflows, and no known unpermitted land disposal dumping grounds within the segment watershed.

Table 3-1. 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
MA0100102	HARDWICK WPC - GILBERTVILLE	HARDWICK	MUN
MA0102431	HARDWICK WPC - WHEELWRIGHT	HARDWICK	MUN
MA0103152	BARRE WWTP	BARRE	MUN

The contributing watershed hosts a variety of land uses, including forested and natural areas, agriculture, and mixed commercial and residential development. Most of the agricultural land is located in the southwestern part of the watershed near the impaired segment, where row crops and hay fields are most common, along with a few farms with livestock.

In the watershed of the Ware River (MA36-05), under the Natural Heritage and Endangered Species Program (NHESP), there are 7,194 acres (7%) identified as Priority Habitats of Rare Species and 655 acres (1%) as Priority Natural Vegetation Communities. There are 61,793 acres (58%) under Public Water Supply protection, but no Areas of Critical Environmental Concern or Outstanding Resource Waters identified in this watershed. Over 7,168 acres (7%) of land are protected in perpetuity[2] within the segment watershed, which is part of a total of 43,246 acres (41%) of Protected and Recreational Open Space[3]. 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, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[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 the State of Massachusetts).

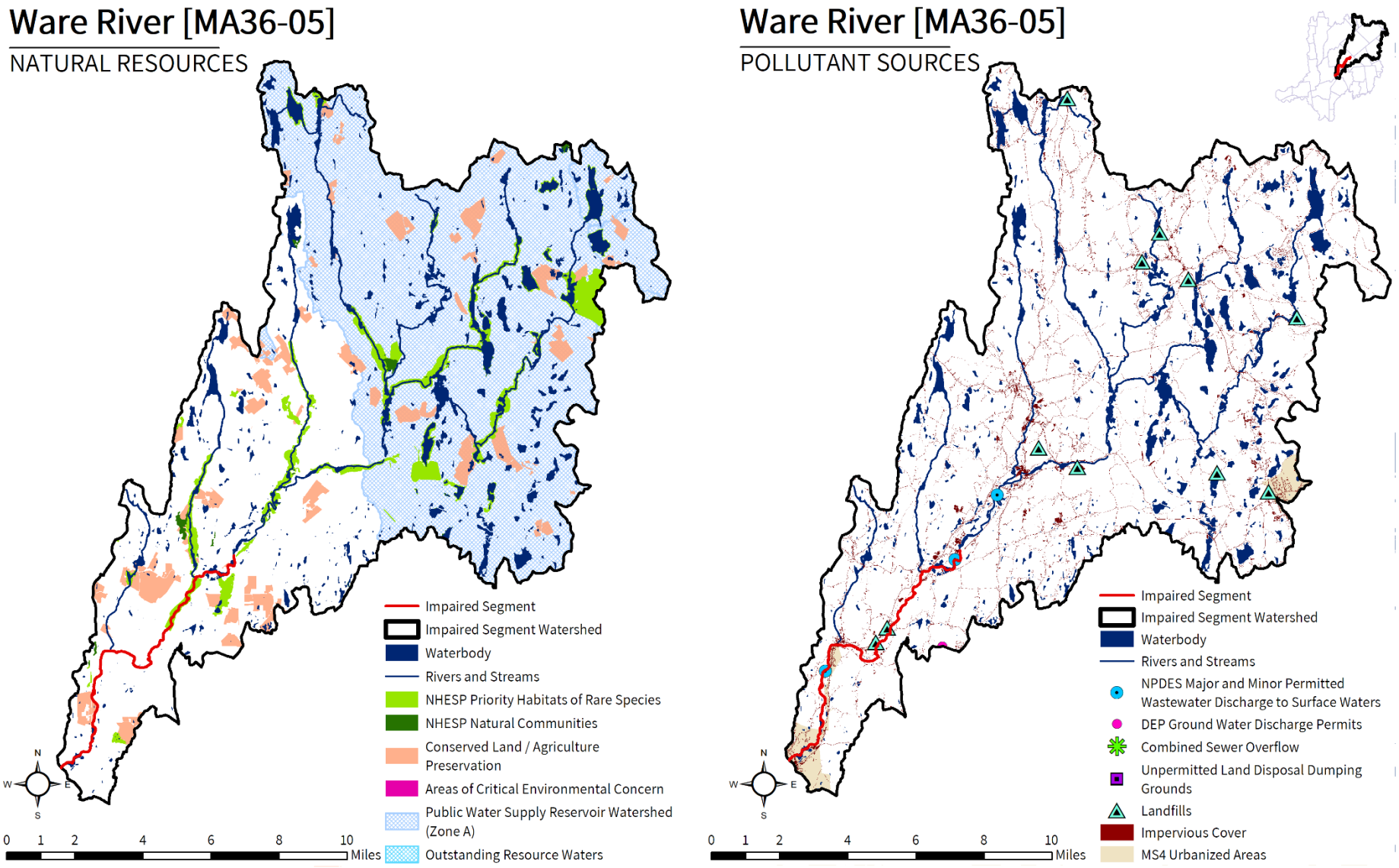


Figure 3-1. Natural resources and potential pollution sources draining to the Ware River segment MA36-05. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

3.2. Waterbody Impairment Characterization

The Ware River (MA36-05) is a Class B, Warm Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS at the stations listed below (refer to Tables 3-2, 3-3; 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, 30-day rolling basis.

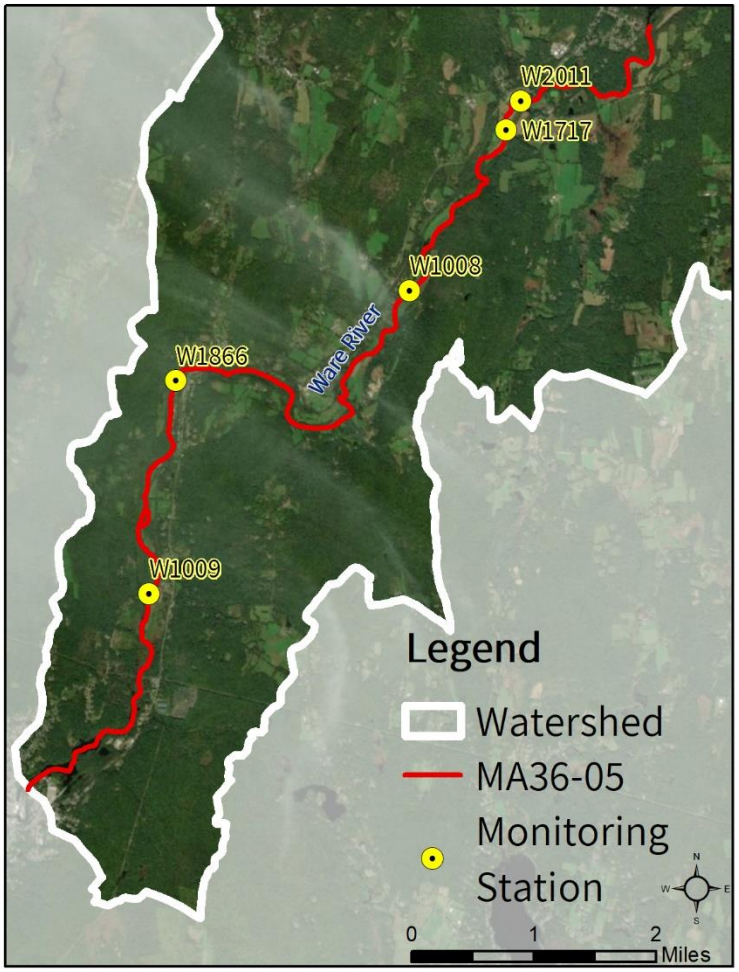


Figure 3-2. Location of monitoring station(s) along the impaired Ware River segment

- In 2008, six samples were collected at W1008, 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 Statistical Threshold Value (STV) criterion was applied to single sample results. Out of six samples, one exceeded the STV criterion during wet weather only.
- In 2008, six samples were collected at W1009, 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 six samples, two exceeded the STV criterion during both wet and dry weather.
- In 2014, five samples were collected at W1717, 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 2008, six samples were collected at W1866, 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 six samples, none exceeded the STV criterion.
- In 2008, one sample was collected at W2011, resulting in no 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 one sample, none exceeded the STV criterion.

Table 3-2. Summary of indicator bacteria sampling results by station for the Ware River (MA36-05). 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
W1008	5/20/2008	9/23/2008	6	219	1	1
W1009	5/20/2008	9/23/2008	6	900	3	2
W1717	5/8/2014	8/27/2014	5	145	1	0
W1866	5/20/2008	9/23/2008	6	193	2	0
W2011	9/23/2008	9/23/2008	1	20	0	0

Table 3-3. Indicator bacteria data by station, indicator, and date for the Ware River (MA36-05). Each sample date was designated as representing wet or dry weather conditions with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text 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 (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
W1008	*E. coli*	5/20/2008	DRY	34	34	
W1008	*E. coli*	6/17/2008	WET	270	96	
W1008	*E. coli*	7/9/2008	DRY	30	90	
W1008	*E. coli*	7/22/2008	WET	60	42	
W1008	*E. coli*	8/19/2008	WET	800	219	
W1008	*E. coli*	9/23/2008	DRY	40	40	
W1009	*E. coli*	5/20/2008	DRY	40	40	
W1009	*E. coli*	6/17/2008	WET	380	123	
W1009	*E. coli*	7/9/2008	DRY	90	185	
W1009	*E. coli*	7/22/2008	WET	90	90	
W1009	*E. coli*	8/19/2008	WET	800	268	
W1009	*E. coli*	9/23/2008	DRY	900	900	
W1717	*E. coli*	5/8/2014	DRY	33	33	
W1717	*E. coli*	6/4/2014	DRY	58	44	
W1717	*E. coli*	7/7/2014	WET	68	68	
W1717	*E. coli*	7/31/2014	DRY	126	93	
W1717	*E. coli*	8/27/2014	DRY	166	145	
W1866	*E. coli*	5/20/2008	DRY	22	22	
W1866	*E. coli*	6/17/2008	WET	330	85	
W1866	*E. coli*	7/9/2008	DRY	100	182	
W1866	*E. coli*	7/22/2008	WET	120	110	
W1866	*E. coli*	8/19/2008	WET	310	193	
W1866	*E. coli*	9/23/2008	DRY	40	40	
W2011	*E. coli*	9/23/2008	DRY	20	20	

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 which 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 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).

The indicator bacteria data for the Ware River (MA36-05) were elevated during both wet and dry weather. Elevated indicator bacteria during wet weather 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. Elevated indicator bacteria counts during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens.

Each potential pathogen source relevant to this segment is described in further detail below.

Urban Stormwater: Portions of the Ware River (MA36-05) watershed are moderately developed, with 2% of the watershed as designated MS4 area and 1% as DCIA. Development is concentrated along the river corridor in town and village centers. Stormwater runoff from urban areas is likely a contributing source of pathogens.

Illicit Sewage Discharges: With some (2%) of the watershed designated as MS4 area and some of the watershed served by sewer, illicit storm drain connections and/or discharges from failing infrastructure, such as leaky sewer lines or SSOs, are possible sources of pathogens. Portions of Barre, Hardwick, and Ware are sewered, thus leaking sewer lines or illicit connections to sewer lines may be possible sources of pathogens to the segment.

On-Site Wastewater Disposal Systems: Residential and commercial areas in the watershed also use on-site septic systems for wastewater treatment; it is likely that some on-site septic systems are not properly maintained and are discharging untreated effluent to groundwater.

Agriculture: There are substantial agricultural activities in the watershed, accounting for 8% of the total land use (exceeding the 6% of the watershed that is developed). Agricultural activities visible on recent aerial photos include open fields, row crops, and pastureland. Some actively farmed lands are adjacent to the river. Agricultural activities related to manure storage and spreading, if not well managed, are possible sources of pathogens to waterbodies. Stormwater runoff from agricultural lands are likely a large contributing source of pathogens to the impaired segment.

Pet Waste: There are many recreational areas throughout the watershed, including Greenville Park and the Mass Central Rail Trail, both adjacent to 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: There are large conservation lands, open lands, and wetlands in the downstream portion of the river. Large open mowed areas with a clear sightline to a waterbody adjacent to the impaired segment, may attract excessive waterfowl and elevate indicator bacteria 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 Barre

Barre is not within the designated MS4 area for the Chicopee Watershed.

Barre has the following ordinances and bylaws relevant to preventing, reducing or eliminating pathogenic pollution:

- Sewer Use Rules and Regulations, Chapter 403: https://ecode360.com/BA1830/search?query=sewer&scope=all&sortOrder=relevance (Town of Barre n.d., a)
- Pet waste bylaws: Section 9-31: Defecation of Dogs and Section 11-3a: Removal of nuisances https://ecode360.com/9218732?highlight=dogs&searchId=5705266456466278#9218732 (Town of Barre n.d., b)

Barre's Open Space and Recreation Plan:

http://www.cmrpc.org/sites/default/files/Documents/CDAP/Doc_resources/Barre%20Open%20Space%20and%20Recreation%20Plan%20final.pdf (Town of Barre and CMRPC, 2010).

Town of Hardwick

A small portion of the town of Hardwick is designated as MS4 area; however, the town is not listed by EPA among Regulated MS4 Communities in Massachusetts. See: https://www.epa.gov/npdes-permits/regulated-ms4-massachusetts-communities (US EPA, 2020)

Hardwick has the following ordinances and bylaws relevant to preventing, reducing or eliminating pathogenic pollution:

- Hardwick does not have supplementary regulations beyond the MassDEP regulations for stormwater management and wetland protection.
- Title 5 Supplementary Regulations: No
- Stormwater Utility: No
- Pet Waste Ordinance: No

The Town of Hardwick has a strategic Community Development Plan was prepared in 1996, and updated in 2014 for FY2015 (PVPC, 2014). The Open Space and Recreation Plan has a water resources section; stormwater is mentioned as a threat to Hardwick Pond (Town of Hardwick Planning Department, 2013). The Open Space and Recreation Plan also has a sewer infrastructure section that notes most of the town is "dependent on soil suitability for on-site septic systems" and the town has limited public sewerage.

Town website: https://www.townofhardwick.com/ (Town of Hardwick, 2020)

Open Space and Recreation Plan: (Town of Hardwick Planning Department, 2013)

Town of Hubbardston

Hubbardston is not within the designated MS4 area of the Chicopee Watershed.

Hubbardston has regulations and bylaws addressing erosion and sedimentation: https://www.hubbardstonma.us/planning-board/files/earth-removal-general-bylaw-ch-xxi-2018 (Town of Hubbardston, 2018) and

https://www.hubbardstonma.us/planning-board/files/earth-removal-rules-regs-2010 (Town of Hubbardston, 2010).

Hubbardston is in the process of updating its 1988 Master Plan as of 2020: https://www.hubbardstonma.us/planning-board/pages/master-plan-update-2020 (Town of Hubbardston, 2020)

Town of New Braintree

New Braintree does not have any designated MS4 areas. No municipal ordinances, bylaws, or activities concerning stormwater or pathogen pollutants were found.

Town of Rutland

Eight percent of Rutland is in MS4 area and has an EPA approved Notice of Intent (NOI, MS4 Permit ID #MAR041154). Rutland has a Stormwater Management Plan and has mapped all of its MS4 stormwater systems. According to the NOI, the illicit discharge detection and elimination (IDDE), erosion and sediment control (ESC), and post-construction stormwater regulations were adopted by November 2018, and the Stormwater Management bylaw appears to cover IDDE. There are no reported stormwater outfalls resulting in impairments.

Rutland has the following ordinances and bylaws relevant to preventing, reducing or eliminating pathogenic pollution:

- Stormwater Management bylaw: https://www.townofrutland.org/home/pages/stormwater-management (Town of Rutland, 2019a)
- Stormwater Management Plan: https://www.townofrutland.org/sites/g/files/vyhlif1156/f/uploads/storm_water_management_plan.pdf (Town of Rutland, 2019b)
- Animal control bylaw: Section G public nuisance: https://www.townofrutland.org/home/pages/animal-control-bylaw (Town of Rutland, 2015).

The first Master Plan for the Town of Rutland was approved at town meeting in May 2000 (Town of Rutland, 2000).

The Town of Rutland Open Space and Recreation Plan was reviewed by the Open Space Committee on January 3, 2017 (Town of Rutland, 2017).

Town of Ware

The waiver for the Town of Ware MS4 General Permit was approved on August 19, 2015, as documented at https://www3.epa.gov/region1/npdes/stormwater/ma/waivers/ware-epa-waiver-response.pdf (Moraff, 2015).

No stormwater or pathogen pollutant ordinances or bylaws were found online for the Town of Ware.

The Town of Ware Master Plan can be found at: http://cms.revize.com/revize/ware/document_center/Planning/Master%20Plan/2016%20Master%20Plan-Ware%20MA.pdf (Town of Ware, 2016a).

The Town of Ware Open Space and Recreation Plan can be found at: http://www.townofware.com/document_center/Planning/OS&RPlan/2016%20osrp%20March%203,%202016%20-%20web.pdf (Town of Ware, 2016b).

4. MA36-06 Ware River

4.1. Waterbody Overview

The lower Ware River segment MA36-06 is 10.1 miles in length and begins at the outlet of the Ware Impoundment Dam (NATID: MA00594) in Ware. Segment MA36-06 flows southwest into Palmer, where it is bound at its downstream end by the Thorndike Dam (NATID: MA00563).

Tributaries to Ware River segment MA36-06 include Muddy Brook, Flat Brook, Penny Brook (and its tributary Beaver Brook), and smaller unnamed streams. Impaired segment tributaries to the Ware River segment (MA36-06) include Prince River (MA36-08), Danforth Brook (MA36-50), and Ware River (MA36-05). Lakes and ponds include Snow Pond, Martowski Pond, Penny Brook Pond, Railroad Pond, Pattaquattic Pond, Bennet Street Pond, Forest Lake, Beaver Lake, and several others.

Key landmarks in the watershed include downtown Ware, the Baystate Mary Lane Hospital, as well as those mentioned for the upstream segment (MA36-05). Road crossings include East Main St, South St, and Palmer Rd in Ware; and State St and Church St in Palmer.

The Ware River (MA36-06) drains an area of 215 square miles, of which 7 mi^2 (3%) is covered with impervious surfaces and 2 mi^2 (1%) is identified as directly connected impervious area (DCIA).

Reduction from Highest Calculated Geomean: 88%

Watershed Area (Acres): 137,373

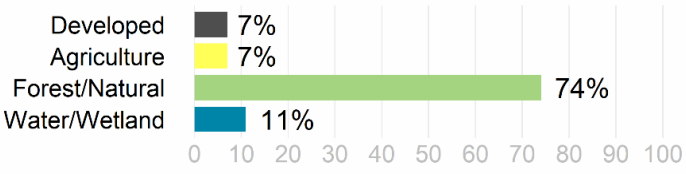
Segment Length (miles): 10.1

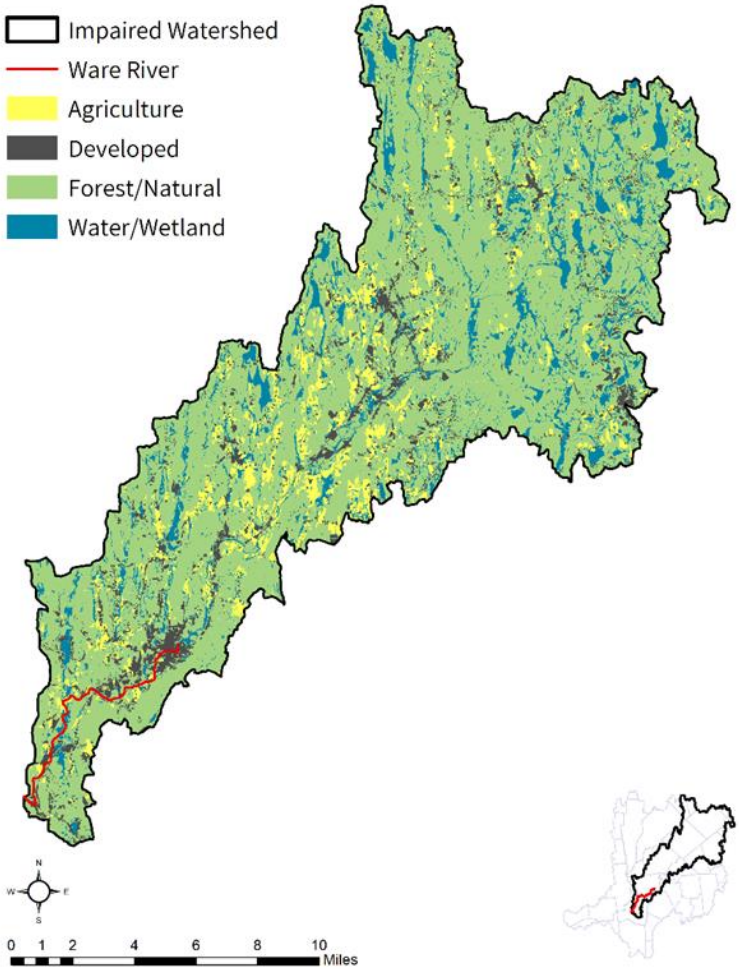
Impairment(s): *E. coli,* fecal coliform (Primary Contact Recreation)

Class (Qualifiers): B (Warm Water)

Impervious Area (Acres, %): 4,737 (3%)

DCIA Area (Acres, %): 1,445 (1%)





The watershed is served partially[4] by public sewer, and 4% is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020A), with the MS4 area concentrated around the impaired segment. There are four NPDES permits on file governing point source discharges of pollutants to surface waters within the full segment watershed, one of which is in the immediate drainage area (Table 4-1). There is one industrial discharge permit in the segment watershed (Table 4-2). There are no MassDEP discharges to groundwater permits for on-site wastewater discharges, no combined sewer overflows, 18 landfills, and 2 unpermitted land disposal dumping grounds within the segment watershed.

Table 4-1. NPDES permits for Wastewater Treatment Facilities (WWTF) in the segment watershed (MA36-06). 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
MA0100889	WARE WWTP	WARE	MUN

Table 4-2. NPDES permits for Industrial Discharge in the segment watershed (MA36-06). Only permits unique to this segment watershed are shown.

NPDES ID	NAME	TOWN
MA0030571	QUABBIN WIRE & CABLE CO., INC.	WARE

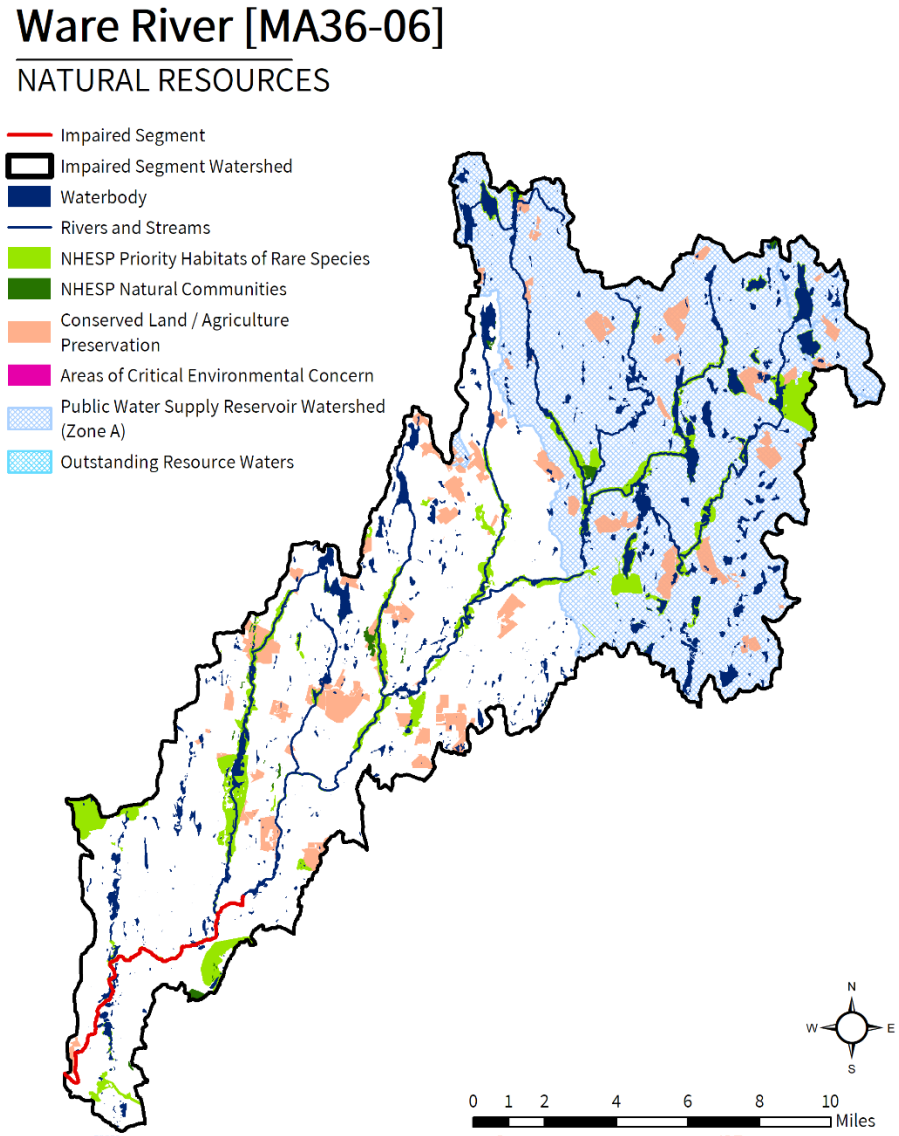
The segment flows through land uses ranging from least disturbed (forested and natural areas) to most disturbed (agricultural and developed commercial and residential areas). Although most of the watershed is forested (74%), the mixed residential and commercial developed areas of Ware are concentrated around this segment. Most of the agricultural lands are in the central part of the watershed upstream from this segment of the Ware River.

In the watershed of this segment of the Ware River (MA36-06), under the NHESP, there are 10,887 acres (8%) identified as Priority Habitats of Rare Species and 1,029 acres (1%) of Priority Natural Vegetation Communities. There are 61,795 acres (45%) under Public Water Supply protection but no Areas of Critical Environmental Concern or Outstanding Resource Waters. Over 8,439 acres (6%) of land are protected in perpetuity[5] within the segment watershed, which is part of a total of 50,206 acres (37%) of Protected and Recreational Open Space[6]. See Figure 4-1.

[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.

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

[6] 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 the State of Massachusetts).



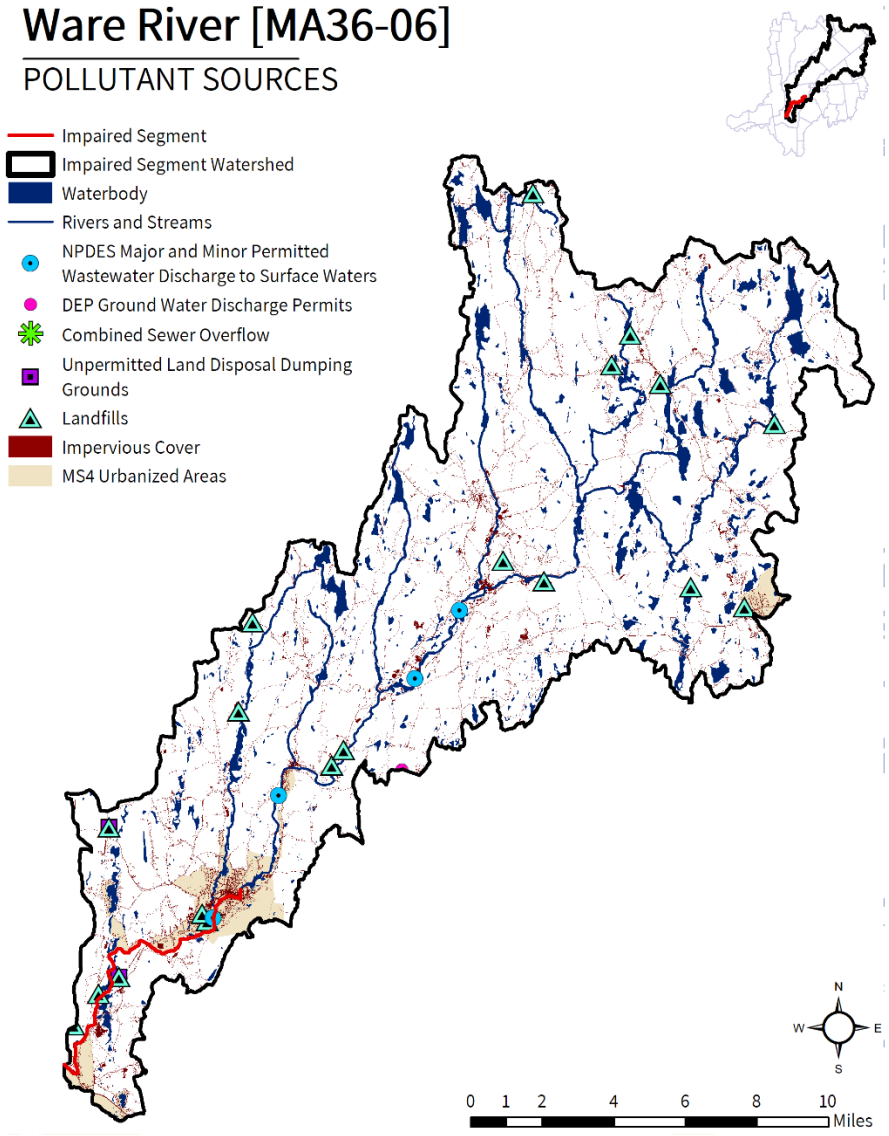


Figure 4-1. Natural resources and potential pollution sources draining to the Ware River segment MA36-06. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

4.2. Waterbody Impairment Characterization

The Ware River (segment MA36-06) is a Class B, Warm Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS at the stations identified below (refer to Tables 4-3, 4-4; Figure 4-2), using the indicator bacteria *E. coli*. Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 30-day rolling basis.

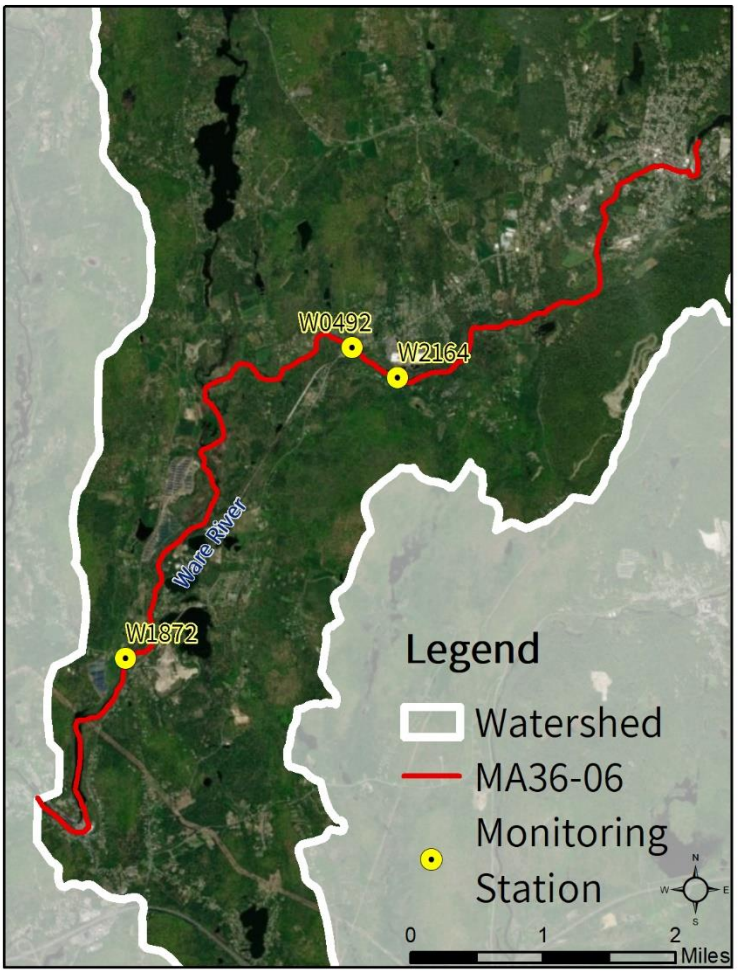


Figure 4-2. Location of monitoring station(s) along the impaired Ware River segment.

- From 2007-2013, 29 samples were collected at W0492, resulting in 13 days when the 30-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 29 samples, four exceeded the STV criterion during both wet and dry weather.
- In 2008, six samples were collected at W1872, 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 six samples, two exceeded the STV criterion during wet weather only.
- In 2014, five samples were collected at W2164, with no 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.

Table 4-3. Summary of indicator bacteria sampling results by station for the Ware River (MA36-06). 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 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
W0492	8/28/2007	4/23/2013	29	1050	13	4
W1872	5/20/2008	9/23/2008	6	182	4	2
W2164	5/8/2014	8/27/2014	5	72	0	0

Table 4-4. Indicator bacteria data by station, indicator, and date for the Ware River (segment MA36-06). 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 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 (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
W0492	*E. coli*	8/28/2007	DRY	118	118	
W0492	*E. coli*	10/16/2007	DRY	86	86	
W0492	*E. coli*	1/23/2008	DRY	74	74	
W0492	*E. coli*	3/25/2008	DRY	1050	1050	
W0492	*E. coli*	6/16/2008	DRY	387	387	
W0492	*E. coli*	7/22/2008	WET	118	118	
W0492	*E. coli*	8/18/2008	WET	78	96	
W0492	*E. coli*	9/23/2008	DRY	219	219	
W0492	*E. coli*	11/18/2008	WET	236	236	
W0492	*E. coli*	2/23/2009	DRY	144	144	
W0492	*E. coli*	4/28/2009	DRY	84	84	
W0492	*E. coli*	6/23/2009	DRY	105	105	
W0492	*E. coli*	8/25/2009	WET	150	150	
W0492	*E. coli*	10/27/2009	WET	156	156	
W0492	*E. coli*	2/9/2010	DRY	78	78	
W0492	*E. coli*	7/20/2010	WET	140	140	
W0492	*E. coli*	10/5/2010	DRY	104	104	
W0492	*E. coli*	11/16/2010	DRY	411	411	
W0492	*E. coli*	3/22/2011	DRY	50	50	
W0492	*E. coli*	4/26/2011	WET	22	22	
W0492	*E. coli*	6/21/2011	DRY	84	84	
W0492	*E. coli*	8/30/2011	WET	488	488	
W0492	*E. coli*	10/25/2011	DRY	86	86	
W0492	*E. coli*	1/24/2012	DRY	71	71	
W0492	*E. coli*	3/27/2012	DRY	56	56	
W0492	*E. coli*	5/23/2012	DRY	49	49	
W0492	*E. coli*	7/24/2012	DRY	517	517	
W0492	*E. coli*	9/25/2012	DRY	62	62	
W0492	*E. coli*	11/13/2012	DRY	249	249	
W0492	*E. coli*	2/26/2013	DRY	249	249	
W0492	*E. coli*	4/23/2013	DRY	40	40	
W1872	*E. coli*	5/20/2008	DRY	64	64	
W1872	*E. coli*	6/17/2008	WET	510	181	
W1872	*E. coli*	7/9/2008	DRY	40	143	
W1872	*E. coli*	7/22/2008	WET	60	49	
W1872	*E. coli*	8/19/2008	WET	550	182	
W1872	*E. coli*	9/23/2008	DRY	140	140	
W2164	*E. coli*	5/8/2014	DRY	19	19	
W2164	*E. coli*	6/4/2014	DRY	45	29	
W2164	*E. coli*	7/7/2014	WET	63	63	
W2164	*E. coli*	7/31/2014	DRY	51	57	
W2164	*E. coli*	8/27/2014	DRY	102	72	

4.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which 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 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).

The indicator bacteria data for this Ware River segment (MA36-06) were elevated during both wet and dry weather. Elevated indicator bacteria during wet weather 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. Elevated indicator bacteria during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources.

Each potential pathogen source relevant to this segment is described in further detail below.

Urban Stormwater: Portions of this Ware River segment (MA36-06) watershed are highly developed, with 4% of the land area identified as within MS4 and 1% as DCIA. Much of the MS4 area is concentrated around the impaired segment. The upstream part of the segment is surrounded by mixed commercial and residential land uses within Ware town center, and the rest of the watershed largely consists of scattered rural residential land uses. Stormwater runoff from urban areas is likely a significant source of pathogens.

Illicit Sewage Discharges: Most of the area adjacent to the segment is supported by the municipal sewerage system, and illicit discharges are possible. 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 typically a significant source of pathogens.

On-Site Wastewater Disposal Systems: Given the large portion of the watershed not covered by municipal sewer service, malfunctioning septic systems are also a possible source. It is likely that a portion of septic systems are not properly maintained and are discharging untreated effluent to groundwater.

Agriculture: There are significant agriculture activities in the watershed, accounting for 7% of the total land use. Agricultural land uses visible on recent aerial photos include open fields, row crops, and pastureland. Agricultural activities related to manure storage and spreading, if not well managed, are possible sources of pathogens to waterbodies. Stormwater runoff from agricultural lands is likely a contributing source of pathogens to the impaired segment.

Pet Waste: Conservation lands, parks, ballfields, and residential neighborhoods 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, mowed areas and open fields with a clear sightline to a waterbody, along with open meadow wetlands, may attract large waterfowl populations which lead to elevated 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 Barre. See Section 3.4

Town of Hardwick. See Section 3.4

Town of Hubbardston. See Section 3.4

Town of Palmer

Less than half of Palmer is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit, and their approved Notice of Intent (NOI) is covered under Permit ID #MAR041017.The town has completed a Stormwater Management Plan (Town of Palmer, 2019). The town has mapped 90% of its stormwater outfall system (available online) and planned to complete the map in 2019. The town adopted illicit discharge detection and elimination (IDDE), erosion and sediment control (ESC), and post-construction stormwater regulations in 2008. According to the NOI, there are many stormwater outfalls into pathogen-impaired river segments in the Chicopee Watershed, including six to the Ware River (MA36-06), 23 to the Quaboag River (MA36-17), and four to the Chicopee River (MA36-22).

Palmer has the following ordinances and bylaws relevant to preventing, reducing or eliminating pathogenic pollution:

- Stormwater Ordinance: https://www.townofpalmer.com/planning (Town of Palmer, 2008)
- Wetland Protection Bylaw: https://www.townofpalmer.com/vertical/sites/%7B034F9CAE-5196-4551-90C2-FBFD76374BDB%7D/uploads/2015_Palmer_Wetlands_Regulation_(2016_Amendments)(1).pdf (Town of Palmer, 2015)
- Title 5 Supplementary Regulations: Nothing beyond State of Massachusetts Title 5 Regulations.
- Stormwater Utility: No
- Pet Waste: No

The Town of Palmer's Community Plan has a chapter on resource protection (PVPC, 2003). Nonpoint source pollution, particularly via stormwater runoff, is identified as an environmental problem, noting that NPS pollutants negatively impact the town's rivers and ponds. The plan recommends developing stricter standards for development to protect water quality. The town sewer system serves central Palmer, and the plan recommends upgrading and potentially extending service to industrial/commercial sites. Approximately 1,000 of Palmer's housing units have on-site septic systems.

Stormwater Management Plan: https://www.townofpalmer.com/vertical/sites/%7B034F9CAE-5196-4551-90C2-FBFD76374BDB%7D/uploads/2019_Stormwater_Management_Program_with_appendixes.pdf (Town of Palmer, 2019)

Community Plan: https://www.townofpalmer.com/vertical/sites/%7B034F9CAE-5196-4551-90C2-FBFD76374BDB%7D/uploads/Palmer_final_cdplan.pdf (PVPC, 2003)

Open Space and Recreation Plan: https://www.townofpalmer.com/index.asp?SEC=BAD42420-FF52-4A88-9825-B81A68AFFE43&DE=3E5BDF39-2909-491F-8705-B8BB792B6219&Type=B_BASIC (Town of Palmer, 2014).

Town of Rutland. See Section 3.4

Town of Ware. See Section 3.4

5. MA36-08 Prince River

5.1. Waterbody Overview

The Prince River segment MA36-08 is 7.1 miles long and begins at the outlet of Hemingway Pond in Barre, MA. Segment MA36-08 flows south through the Old Reservoir the 0.6-mile reach within Old Reservoir (MA36114) is not included in impaired segment MA36-08). The Prince River ends at its confluence with Ware River, Barre.

Tributaries to the Prince River include Pleasant Brook from the east, and Galloway and Smith Brooks from the west, in addition to about 8.5 miles of unnamed streams within the watershed. Barre Town Reservoir and Hemingway Pond are within the watershed.

Key landmarks in the watershed include the town center of Barre and the Felton athletic fields. Segment MA36-08 crosses Mechanic Street/MA-62, Worcester Road/MA-122, South Barre Road/MA-32, and others, all within the town of Barre.

The Prince River (MA36-08) drains an area of 14 square miles, of which 0.6 mi^2 (4%) is covered with impervious surfaces, and 0.2 mi^2 (2%) is identified as directly connected impervious area (DCIA). In

Reduction from Highest Calculated Geomean: 61%

Watershed Area (Acres): 8,971

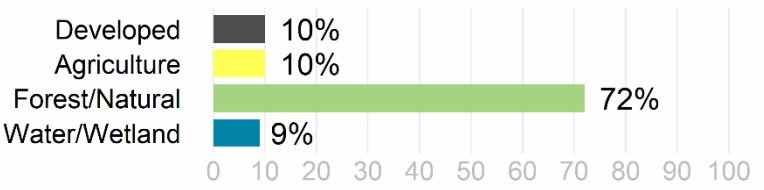
Segment Length (miles): 7.1

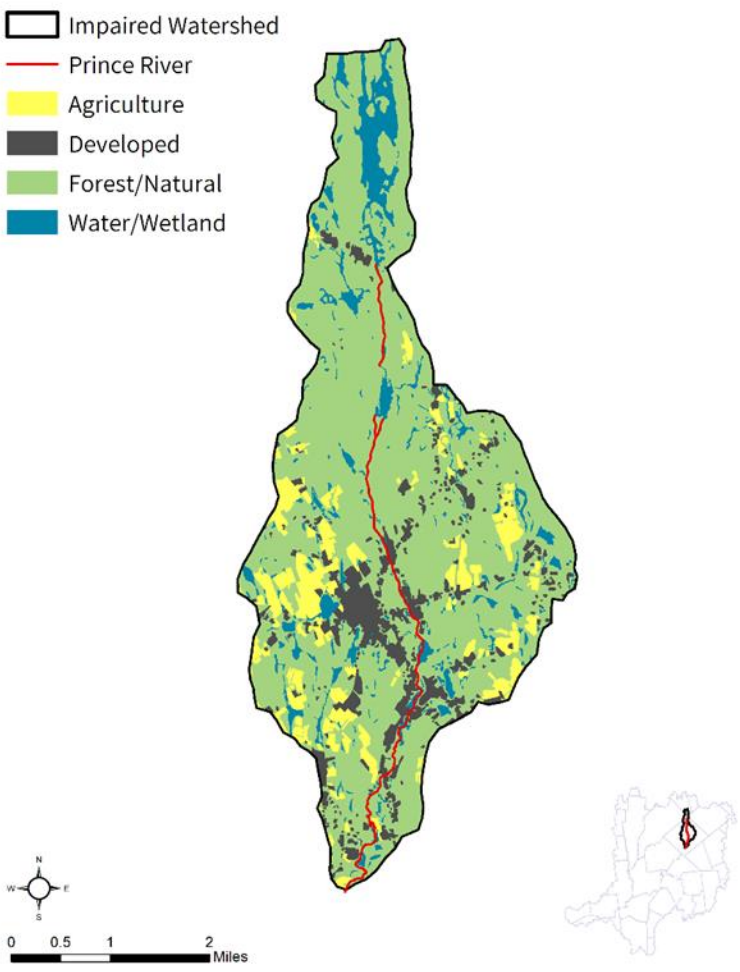
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifiers): B (Cold Water, High Quality Water)

Impervious Area (Acres, %): 362 (4%)

DCIA Area (Acres, %): 134 (2%)





terms of land area, the watershed is likely partially[7] served by public sewer but none of the watershed is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (USEPA, 2020A). There are no NPDES permits on file governing point source discharges of pollutants to surface waters within the segment watershed, no MassDEP discharge to groundwater permits for on-site wastewater discharge, no combined sewer overflows, no landfills, and no unpermitted land disposal dumping grounds within the watershed.

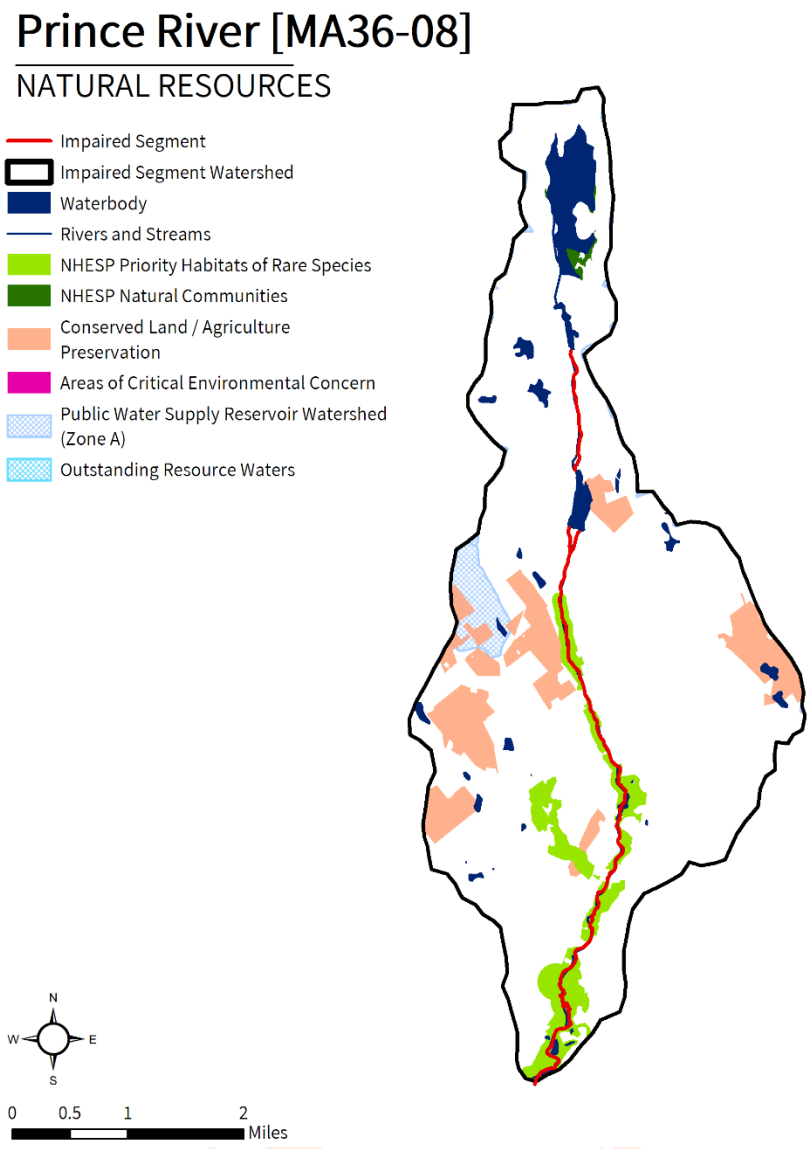
The segment flows through a mix of forest and low to medium density mixed residential and commercial land uses. Most agricultural lands are west of the impaired segment along South Street and Wauwinet Road, and to the east along Walnut Hill and Adams Roads. Development density is greatest in the watershed to the west of the segment in downtown Barre.

In the watershed of the Prince River (MA36-08), under the NHESP, there are 520 acres (6%) identified as Priority Habitats of Rare Species and 146 acres (2%) of Priority Natural Vegetation Communities. There are 248 acres (3%) under Public Water Supply protection, but no Areas of Critical Environmental Concern or Outstanding Resource Waters identified in this watershed. Over 837 acres (9%) of land are protected in perpetuity[8] within the segment watershed, which is part of a total of 2,866 acres (32%) of Protected and Recreational Open Space[9]. 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, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[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 the State of Massachusetts).



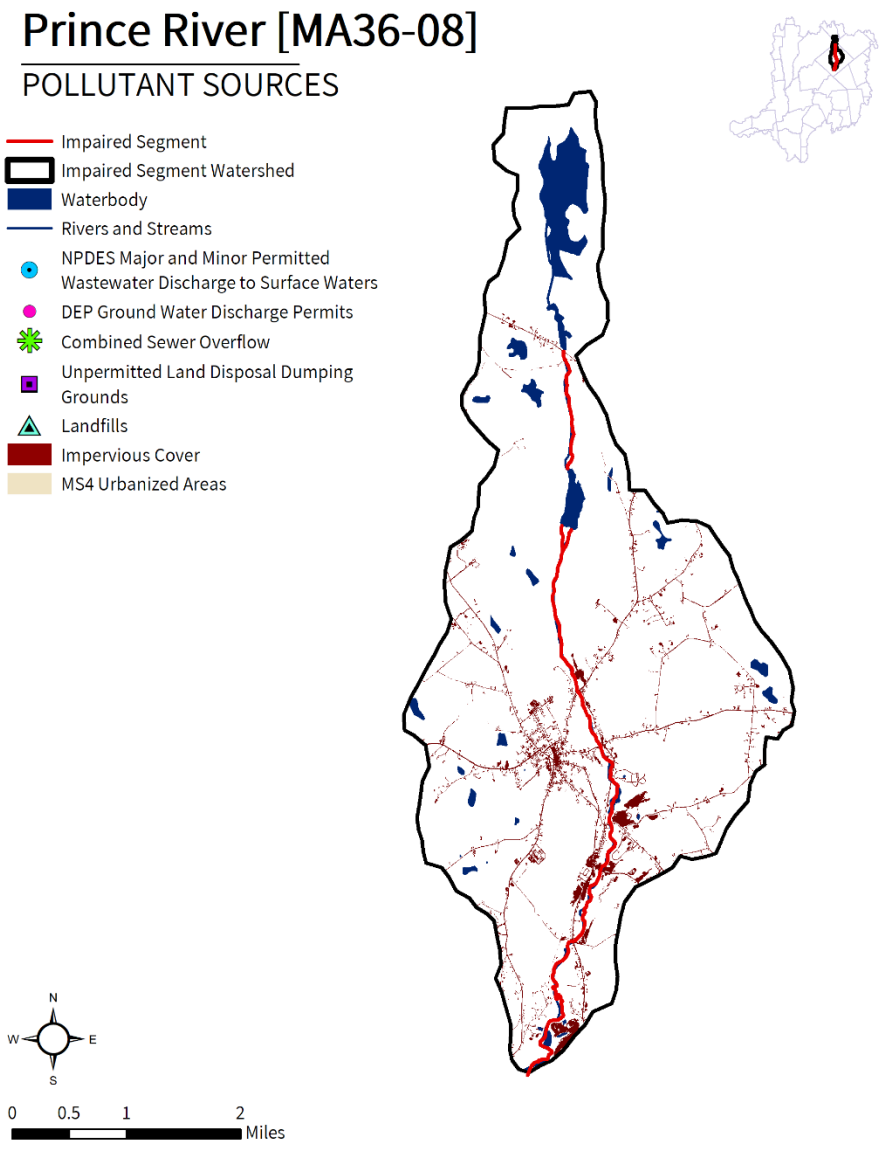


Figure 5-1. Natural resources and potential pollution sources draining to the Prince River segment MA36-08. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

5.2. Waterbody Impairment Characterization

The Prince River segment (MA36-08) is a Class B, Cold Water and High Quality Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS at the station identified below (refer to Tables 5-1, 5-2; Figure 5-2), using the indicator bacteria *E. coli*. Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 90-day rolling basis.

- In 2008, six samples were collected at W1850, 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 Statistical Threshold Value (STV) criterion was applied to single sample results. Out of six samples, two exceeded the STV criterion during both wet and dry weather.

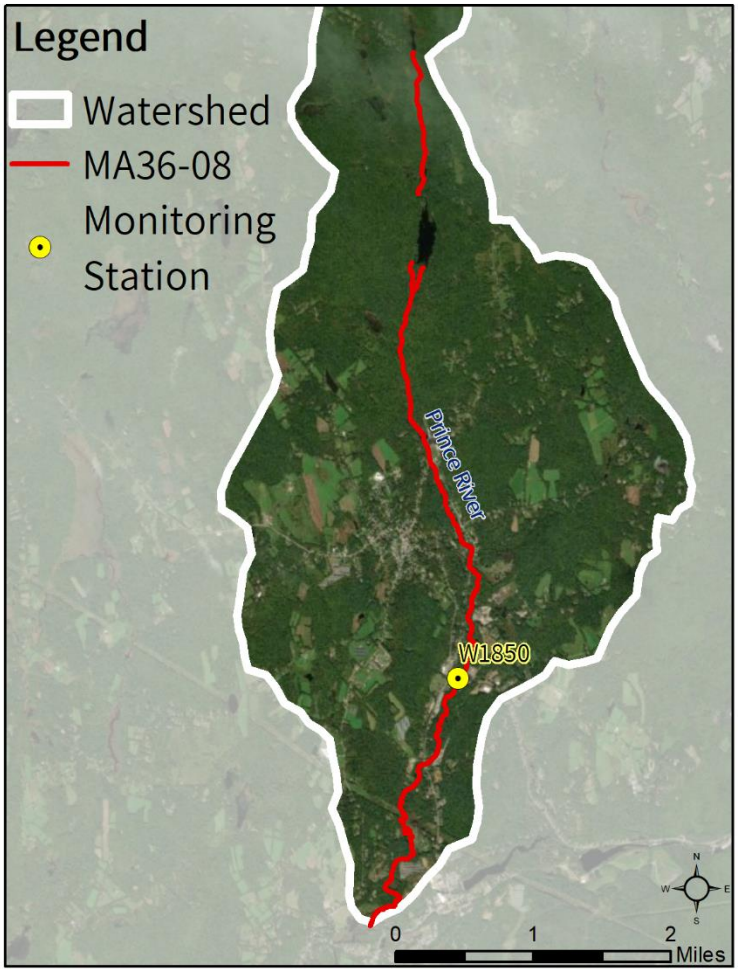


Figure 5-2. Location of monitoring station(s) along the impaired Prince River segment.

Table 5-1. Summary of indicator bacteria sampling results by station for the Prince River (segment MA36-08). The maximum 90-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the 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
W1850	5/20/2008	9/23/2008	6	320	5	2

Table 5-2. Indicator bacteria data by station, indicator, and date for the Prince River (segment MA36-08). Each sample date was designated as representing wet or dry weather conditions with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text 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 (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W1850	*E. coli*	5/20/2008	DRY	50	50	
W1850	*E. coli*	6/17/2008	WET	470	153	
W1850	*E. coli*	7/9/2008	WET	100	133	
W1850	*E. coli*	7/22/2008	WET	280	160	
W1850	*E. coli*	8/19/2008	DRY	800	320	
W1850	*E. coli*	9/23/2008	DRY	50	183	

5.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which 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 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).

The indicator bacteria data for the Prince River segment (MA36-08) were elevated during both wet and dry weather. Elevated results during wet weather are consistent with urban stormwater, pet waste, and wildlife pathogen sources. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated wet weather indicator bacteria levels. Elevated results during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens.

Each potential pathogen source relevant to this segment is described in further detail below.

Urban Stormwater: Portions of the Prince River (segment MA36-08) watershed are moderately developed, though none of the land area is identified as within MS4 and only 2% is DCIA. Low density residential development is predominant in the downstream reaches of the segment (south of MA-62), and there are some areas where commercial land uses are adjacent to the river. Nonetheless, stormwater runoff from developed areas is likely a significant source of pathogens.

Illicit Sewage Discharges: With a portion of the watershed served by a municipal sewer system, illicit discharges are a possible source of pathogens. Sewer-related issues 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: Given the large portion of the watershed not covered by a municipal sewer service, malfunctioning on=site septic systems are also a possible source. It is likely that a portion of septic systems are not properly maintained and are discharging untreated effluent to groundwater.

Agriculture: There are significant agriculture activities in the watershed, accounting for 10% of the total land use. Agricultural activities visible on recent aerial photos include open fields, row crops, and pastureland. Agricultural activities related to manure storage and spreading, if not well managed, are possible sources of pathogens to waterbodies. Stormwater runoff from agricultural lands is likely a large source of pathogens to this segment.

Pet Waste: There are parks, conservation lands, and wetlands along much of the river segment. Conservation lands, parks, ballfields, and residential neighborhoods 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 or open fields having large open mowed areas with a clear sightline to a waterbody may attract excessive waterfowl and elevate 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. The Prince River watershed draining directly to this segment is entirely within the Town of Barre.

Town of Barre. See Section 3.4

6. MA36-11 Sevenmile River

6.1. Waterbody Overview

The Sevenmile River segment MA36-11 is 7.3 miles long and begins at the outlet of Browning Pond in Spencer, MA. Segment MA36-11 flows entirely within the town of Spencer, in a southward direction to its confluence with the Cranberry River.

Tributaries to this Sevenmile River segment include Turkey Hill Brook, which meets the Sevenmile River about 0.15 miles north of the MA-31/Sevenmile River Road crossing, plus many smaller unnamed tributaries. Lakes and ponds in the watershed include Sugden Reservoir, Thompsons Pond, Buckhill Pond, and Spring Street Pond.

Key landmarks in the watershed include the town centers of Paxton and Spencer, the Spencer Fair grounds, Spencer Airport, and the Kettle Brook Golf Club. This segment is crossed by North Spencer Road/MA-31, Pleasant Street/MA-31, West Main Street/MA-9, and others, all within the town of Spencer.

The Sevenmile River (segment MA36-11) drains an area of 32 square miles, of which 2 mi^2 (6%) is covered with impervious surfaces and 1 mi^2 (3%) is identified as directly connected impervious area (DCIA). In terms of land area, the watershed is

Reduction from Highest Calculated Geomean: 75%

Watershed Area (Acres): 20,184

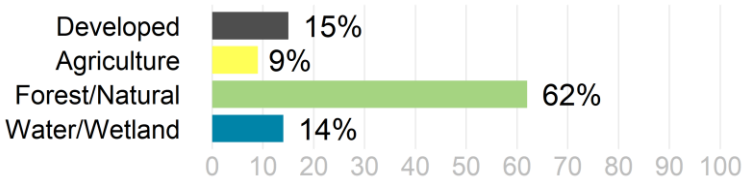
Segment Length (miles): 7.3

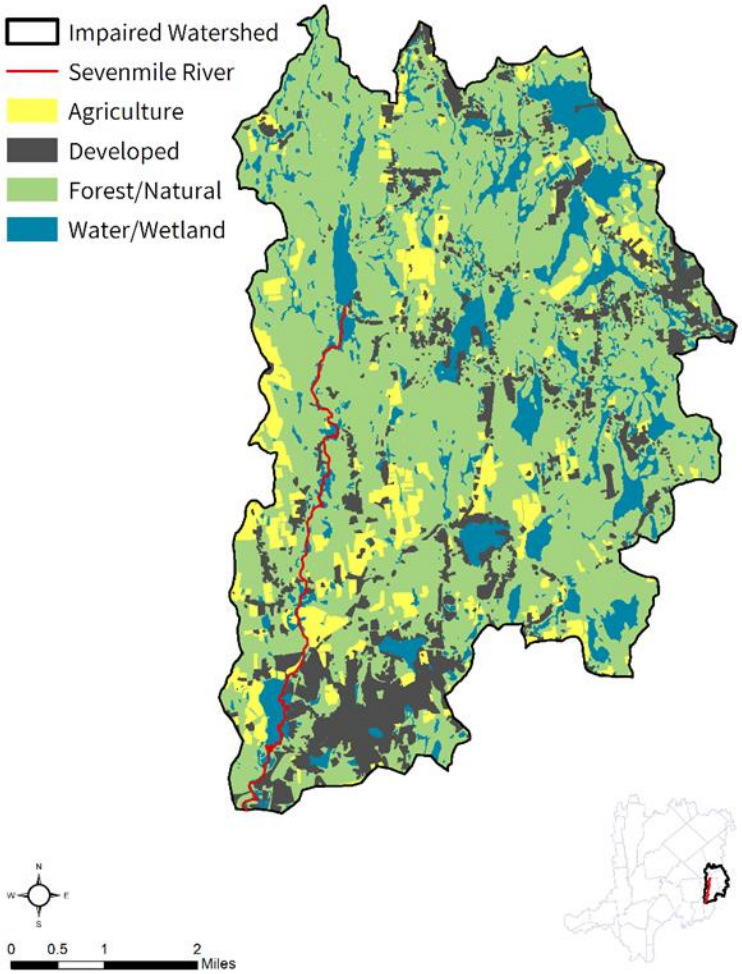
Impairment(s): *E. coli* (Primary Contact Recreation)

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

Impervious Area (Acres, %): 1,163 (6%)

DCIA Area (Acres, %): 503 (3%)





partially[10] served by public sewer, and 15% is subject to stormwater regulations under the National Pollutant Discharge Elimination System (NPDES) General MS4 Stormwater Permit (USEPA, 2020A). There are no NPDES permits on file governing point source discharges of pollutants to surface waters, no MassDEP discharge to groundwater permits for on-site wastewater discharges, no combined sewer overflows, two landfills, and no unpermitted land disposal dumping grounds in the watershed.

The segment flows through varying land uses, primarily forest in the upper watershed, and mixed residential and commercial developed areas in the lower. There are also relatively large agricultural lands, including areas of row crops, adjacent to the segment.

In the watershed of the Sevenmile River (segment MA36-11), under the Natural Heritage and Endangered Species Program, there are 437 acres (2%) identified as Priority Habitats of Rare Species and 57 acres (<1%) of Priority Natural Vegetation Communities. There are 339 acres (2%) under Public Water Supply protection, but no Areas of Critical Environmental Concern or Outstanding Resource Waters identified in this watershed. Over 422 acres (2%) of land are protected in perpetuity[11] within the segment watershed, which is part of a total of 5,987 acres (30%) of Protected and Recreational Open Space[12]. See Figure 6-1.

[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.

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

[12] 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 the State of Massachusetts).

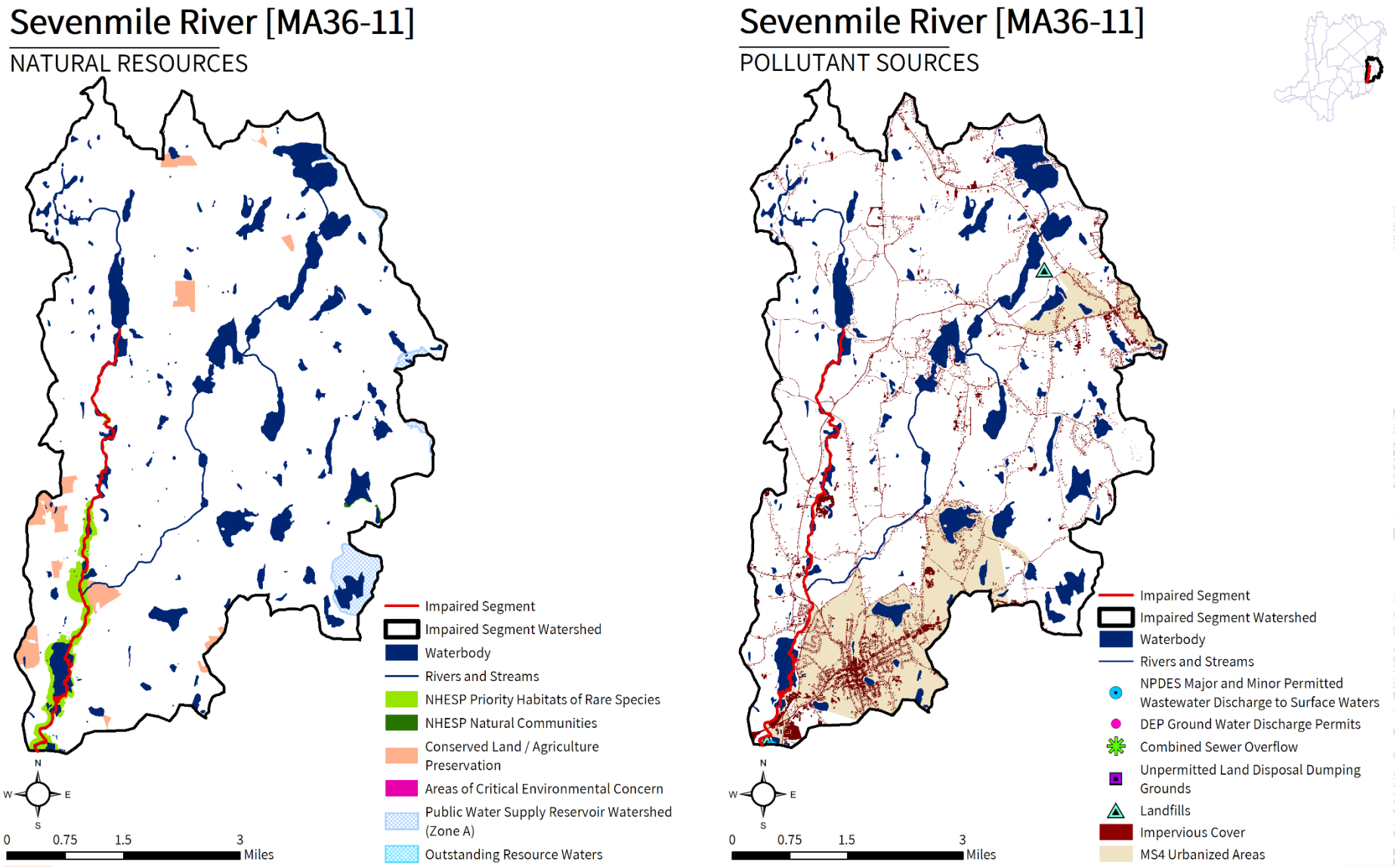


Figure 6-1. Natural resources and potential pollution sources draining to the Sevenmile River segment MA36-11. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

6.2. Waterbody Impairment Characterization

The Sevenmile River segment (MA36-11) is a Class B, Warm Water and High Quality Water (MassDEP, 2021).

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

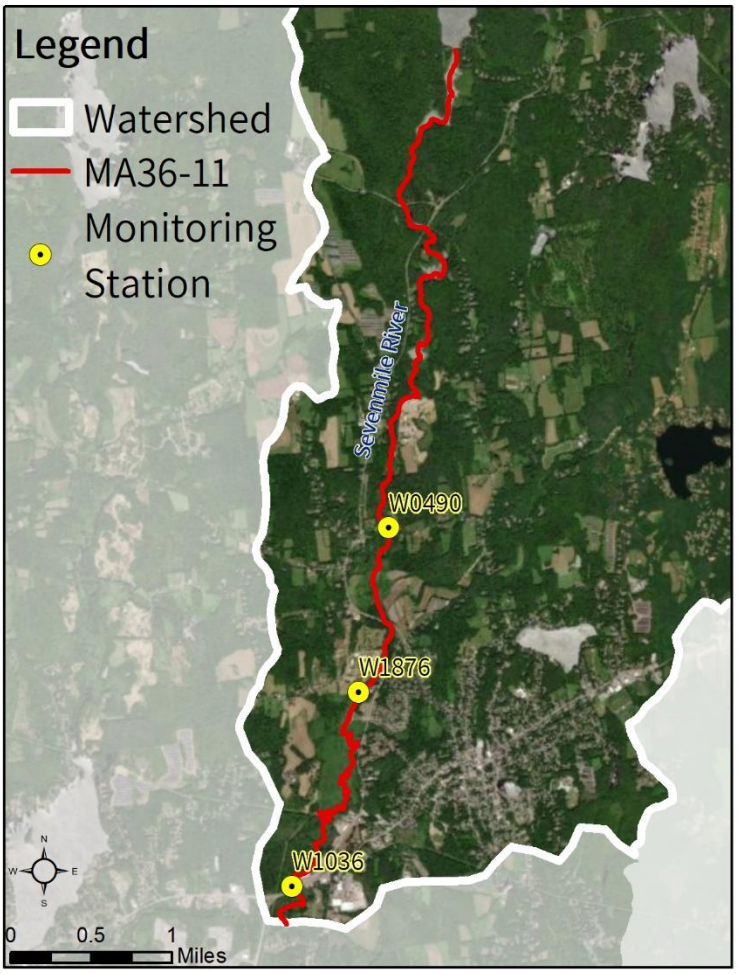


Figure 6-2. Location of monitoring station(s) along the impaired upper Sevenmile River segment.

- From 2007-2013, 30 samples were collected at W0490, 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 Statistical Threshold Value (STV) criterion was applied to single sample results. Out of 30 samples, two exceeded the STV criterion in 2008 and 2012 during both wet and dry weather.
- In 2008, six samples were collected at W1036, 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, three exceeded the STV criterion during both wet and dry weather.
- In 2008, six samples were collected at W1876, 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, two exceeded the STV criterion during wet weather only.

Table 6-1. Summary of indicator bacteria sampling results by station for the Sevenmile River (segment MA36-11). 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
W0490	8/28/2007	4/23/2013	30	304	4	2
W1036	5/20/2008	9/23/2008	6	495	5	3

W1876	5/20/2008	9/23/2008	6	376	5	2

Table 6-2. Indicator bacteria data by station, indicator, and date for the Sevenmile River (segment MA36-11). 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 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 (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W0490	*E. coli*	8/28/2007	DRY	32	32	
W0490	*E. coli*	10/16/2007	DRY	39	35	
W0490	*E. coli*	1/23/2008	DRY	25	25	
W0490	*E. coli*	3/25/2008	DRY	4	10	
W0490	*E. coli*	6/16/2008	WET	120	22	
W0490	*E. coli*	7/22/2008	WET	770	304	
W0490	*E. coli*	8/18/2008	DRY	26	134	
W0490	*E. coli*	9/23/2008	DRY	42	94	
W0490	*E. coli*	11/18/2008	DRY	15	25	
W0490	*E. coli*	2/23/2009	WET	18	18	
W0490	*E. coli*	4/28/2009	DRY	24	21	
W0490	*E. coli*	6/23/2009	DRY	46	33	
W0490	*E. coli*	8/25/2009	DRY	88	64	
W0490	*E. coli*	10/27/2009	DRY	49	66	
W0490	*E. coli*	7/20/2010	DRY	62	62	
W0490	*E. coli*	10/5/2010	DRY	50	56	
W0490	*E. coli*	11/16/2010	DRY	7	19	
W0490	*E. coli*	3/22/2011	DRY	5	5	
W0490	*E. coli*	4/26/2011	DRY	6	5	
W0490	*E. coli*	6/21/2011	DRY	71	21	
W0490	*E. coli*	8/30/2011	WET	88	79	
W0490	*E. coli*	10/25/2011	DRY	26	48	
W0490	*E. coli*	1/24/2012	DRY	5	5	
W0490	*E. coli*	3/27/2012	DRY	79	20	
W0490	*E. coli*	5/23/2012	WET	81	80	
W0490	*E. coli*	7/24/2012	DRY	770	250	
W0490	*E. coli*	9/25/2012	DRY	25	139	
W0490	*E. coli*	11/13/2012	DRY	10	16	
W0490	*E. coli*	2/26/2013	WET	10	10	
W0490	*E. coli*	4/23/2013	DRY	24	15	
W1036	*E. coli*	5/20/2008	DRY	52	52	
W1036	*E. coli*	6/17/2008	WET	1360	266	
W1036	*E. coli*	7/9/2008	WET	200	242	
W1036	*E. coli*	7/22/2008	WET	460	284	
W1036	*E. coli*	8/19/2008	DRY	480	495	
W1036	*E. coli*	9/23/2008	DRY	100	258	
W1876	*E. coli*	5/20/2008	DRY	102	102	
W1876	*E. coli*	6/17/2008	WET	840	293	
W1876	*E. coli*	7/9/2008	WET	90	198	
W1876	*E. coli*	7/22/2008	WET	940	292	
W1876	*E. coli*	8/19/2008	DRY	280	376	
W1876	*E. coli*	9/23/2008	DRY	140	240	

6.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which 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 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 the Sevenmile River (MA36-11) were elevated during both wet and dry weather. Elevated results during wet weather 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. Elevated results during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens.

Each potential pathogen source relevant to this segment is described in further detail below.

Urban Stormwater: The areas around the Sevenmile River (segment MA36-11) are moderately developed, consisting of medium and low density residential, industrial, and commercial areas. The watershed has 15% of its area identified as within MS4 and 3% as DCIA. These factors indicate that stormwater runoff is likely a source of pathogens.

Illicit Sewage Discharges: Municipal sewer service is likely in place along the lower portion of the impaired segment, where most of the MS4 area is located. Sewer system-related issues 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: Much of the watershed is served by on-site septic systems for wastewater disposal, so malfunctioning systems are also a possible source. It is likely that a portion of these are not properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Agricultural activities in the watershed account for 9% of the total land use area. Agricultural activities visible on recent aerial photos include open fields, row crops, and pastureland. Large actively farmed fields are adjacent to the impaired segment. Agricultural activities related to manure storage and spreading, if not well managed, are possible sources of pathogens to waterbodies. Stormwater runoff from agricultural lands is likely a source of pathogens to the segment.

Pet Waste: There are residential areas and small parks along the Sevenmile River, and 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, mowed areas with a clear sightline to a waterbody, in addition to the large wetlands adjacent to the impaired segment, may attract large congregations of 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.

Town of Paxton

Less than half of the Town of Paxton is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Paxton (Permit ID #MAR041148) has an EPA-approved Notice of Intent (NOI). The town also has a Stormwater Management Plan, available for viewing at Town Hall at 697 Pleasant Street, Paxton MA, 01612. Paxton has mapped all of its MS4 stormwater system, which is available online (Town of Paxton n.d., a). The town adopted illicit discharge detection and elimination (IDDE) and erosion and sediment control (ESC) regulations in 2017, as well as post-construction stormwater regulations in 2006. According to the NOI, there are no stormwater outfalls into impaired segments in the Chicopee River watershed.

Paxton has the following ordinances and bylaws relevant to preventing, reducing or eliminating pathogenic pollution:

- Stormwater Ordinance and/or Bylaws: https://www.townofpaxton.net/vertical/sites/%7B4877D6D1-B638-4BAD-B942-A67C40C2215D%7D/uploads/Paxton_Storm_Water_RulesRegs.pdf (Town of Paxton, 2012)
- Stormwater Utility: no
- Title 5 Supplementary Regulation: Nothing beyond State of Massachusetts Title 5 Regulations.
- Wetland Protection Bylaw: https://www.townofpaxton.net/vertical/sites/%7B4877D6D1-B638-4BAD-B942-A67C40C2215D%7D/uploads/PaxtonWetlandsBylaw.pdf (Town of Paxton, 2018)
- Pet Waste Ordinance: Although there is no pet waste ordinance, the town website provides information on the importance of removing pet waste: https://www.townofpaxton.net/index.asp?SEC=B2B13341-86D3-4C6B-8C56-E69B6E3185D9&Type=B_BASIC (Town of Paxton n.d., b)
- Contact Recreation Ordinance: No

The Paxton Master Plan has a water resources section in the Open Space and Recreation chapter which includes detailed information on reservoirs, the town water supply, waterbodies, wetlands, and temporary and permanent streams (Town of Paxton n.d., c). Paxton does list impaired streams within the town but the master plan does not mention stormwater, MS4, or bacteria. The town of Paxton does not have a sewer system.

Paxton Town Website: https://www.townofpaxton.net/ (Town of Paxton, 2020)

Master Plan: https://www.townofpaxton.net/index.asp?SEC=04CA294F-9838-41FB-B9C3-8264DF405826&DE=C22A1923-B5C5-4D92-9019-6807FFE59EC0&Type=B_BASIC (Town of Paxton n.d., c)

Stormwater Web Page: https://www.townofpaxton.net/?SEC=B3706735-7F7E-4632-8E1C-8E8B1E765ED6 (Town of Paxton n.d., d)

Open Space and Recreation Plan: https://www.townofpaxton.net/vertical/sites/%7B4877D6D1-B638-4BAD-B942-A67C40C2215D%7D/uploads/PaxtonOpenSpacePlan2003.pdf (Town of Paxton, 2003)

Town of Rutland. See Section 3.4

Town of Spencer

About half of the Town of Spencer is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Spencer (Permit ID #MAR041162) has an EPA approved Notice of Intent (NOI). Spencer also has a Stormwater Management Plan, available at https://www.spencerma.gov/sites/g/files/vyhlif1246/f/uploads/2003spencerstormwatermanagementprogram.pdf (Prism, 2003). The town has mapped all of its MS4 stormwater system, which is available online. It adopted illicit discharge detection and elimination (IDDE) and erosion and sediment control (ESC), and post-construction stormwater regulations in 2015. According to the NOI, there are no stormwater outfalls from the Town of Spencer into impaired segments in the Chicopee River watershed.

Spencer has the following ordinances and bylaws relevant to preventing, reducing or eliminating pathogenic pollution:

- Stormwater Ordinance and/or Bylaws: https://www.spencerma.gov/sites/g/files/vyhlif1246/f/uploads/stormwater_regulations.pdf (Town of Spencer, 2016)
- Stormwater Utility: No
- Title 5 Supplementary Regulation: Nothing beyond State of Massachusetts Title 5 Regulations.
- Wetland Protection Bylaw: https://www.spencerma.gov/sites/g/files/vyhlif1246/f/uploads/conservation_regulations.pdf (Town of Spencer, 2011).
- Pet Waste Ordinance: No
- Contact Recreation Ordinance: No

The Spencer Master Plan provides information on water resources within the town. Spencer does not have any impaired waterways within its border (Town of Spencer, 2003). The Master Plan notes that the town's wastewater treatment plant has a NPDES permit. The town is partially served by a sewer system, although the plan notes that the sewer system's pipes are old and have infiltration problems, and heavy storm events cause overflow issues.

Spencer Town Website: https://www.spencerma.gov/ (Town of Spencer, 2020)

Master Plan:https://www.spencerma.gov/sites/g/files/vyhlif1246/f/uploads/master_plan.pdf (Town of Spencer, 2003)

Stormwater Web Page: https://www.spencerma.gov/conservation-commission/pages/stormwater-information (Town of Spencer, n.d.)

Open Space and Recreation Plan
https://www.spencerma.gov/sites/g/files/vyhlif1246/f/uploads/open_space_plan.pdf (Town of Spencer, 2012)

7. MA36-12 Sevenmile River

7.1. Waterbody Overview

The Sevenmile River segment MA36-12 is 2.5 miles long and begins at the confluence of Sevenmile River with Cranberry River in Spencer, MA. Segment MA36-12 flows southwest into East Brookfield to end at its confluence with the East Brookfield River in East Brookfield.

Tributaries to the lower Sevenmile River segment include the Cranberry River. The pathogen-impaired upper Sevenmile River segment MA36-11 is immediately upstream. Lakes and ponds in the watershed include Penn Central Pond, and those listed for upstream segment MA36-11.

Key landmarks in the watershed include the Spencer State Forest, downtown East Brookfield, East Brookfield District Court, and the East Brookfield Elementary School. Key transportation crossings of the lower Sevenmile River include the Podunk Pike/MA-49 (Spencer); and Cove St, Bridge St, and the Boston Subdivision railroad (East Brookfield).

The Sevenmile River (MA36-12) drains an area of 41 square miles (mi^2), of which 2.5 mi^2 (6%) is covered with impervious surfaces and 1 mi^2 (3%) is identified as directly connected impervious area (DCIA). In terms of land area, the watershed

Reduction from Highest Calculated Geomean: 72%

Watershed Area (Acres): 26,378

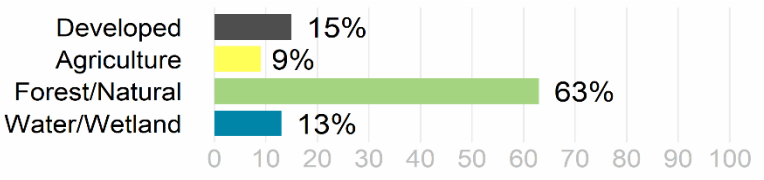
Segment Length (miles): 2.5

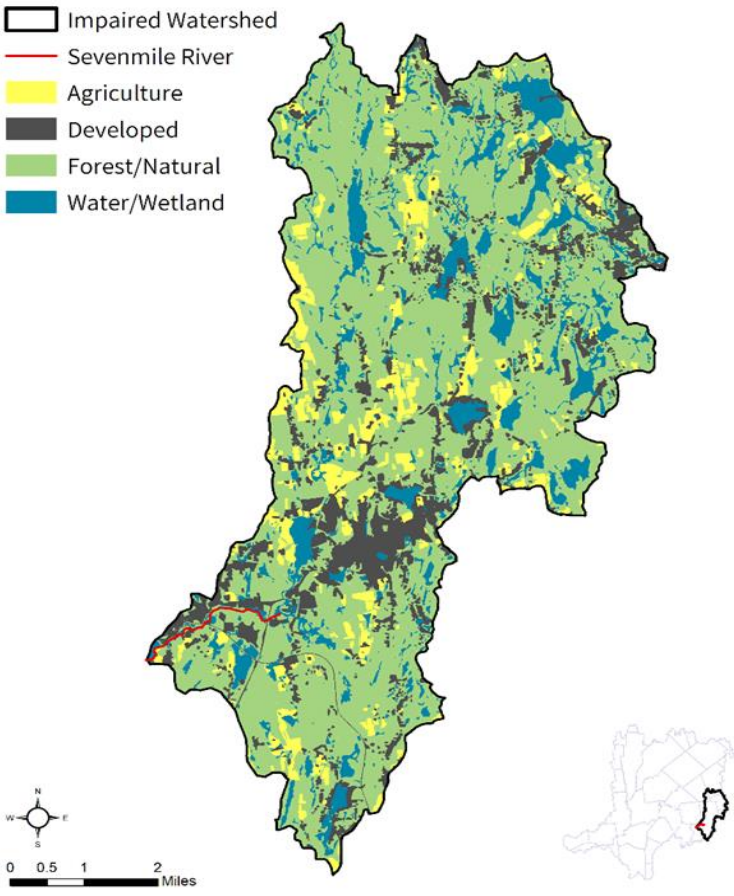
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifiers): B (Warm Water)

Impervious Area (Acres, %): 1,593 (6%)

DCIA Area (Acres, %): 701 (3%)





is partially[13] served by public sewer, and 15% is subject to stormwater regulations under the National Pollutant Discharge Elimination System (NPDES) General MS4 Stormwater Permit (USEPA, 2020A). There is one NPDES permit for a point source discharge of pollutants to a surface water within the immediate drainage area of this segment, the Spencer WWTP (Table 7-1). There are no MassDEP discharge to groundwater permits for on-site wastewater discharge, no combined sewer overflows, three landfills, and no unpermitted land disposal dumping grounds within the segment watershed.

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

Table 7-1. NPDES permits for Wastewater Treatment Facilities (WWTF) in the segment watershed (MA36-12). 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
MA0100919	SPENCER WWTP	SPENCER	MUN

The lower Sevenmile River segment flows through a mix of forested and developed land uses. Developed lands are concentrated on the right bank of the river near downtown East Brookfield, although there is a wide vegetated buffer along the river itself. There is a large intermodal (railroad) transportation facility with expansive parking lots on the left bank, again with a substantial vegetated buffer to the river. Agricultural land uses are less extensive around this segment of the Sevenmile River, though they comprise a significant portion of the overall watershed (9%).

In the watershed of the Sevenmile River (MA36-12), under the Natural Heritage and Endangered Species Program, there are 777 acres (3%) identified as Priority Habitats of Rare Species and 68 acres (<1%) of Priority Natural Vegetation Communities. There are 339 acres (1%) under Public Water Supply protection but no Areas of Critical Environmental Concern or Outstanding Resource Waters identified in this watershed. Over 710 acres (3%) of land are protected in perpetuity[14] within the segment watershed, which is part of a total of 7,094 acres (27%) of Protected and Recreational Open Space[15]. See Figure 7-1.

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

[15] 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 the State of Massachusetts).

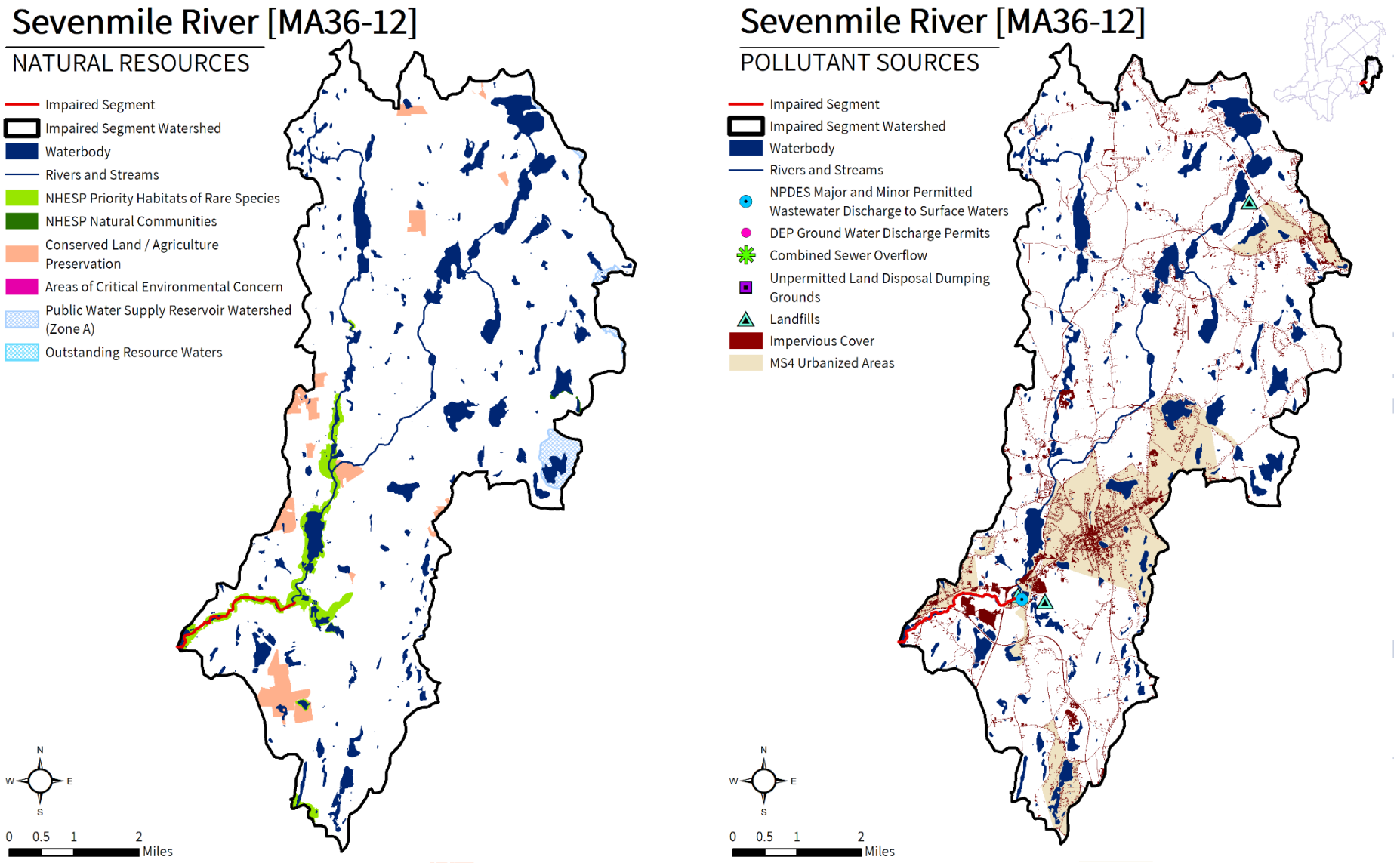


Figure 7-1. Natural resources and potential pollution sources draining to the Sevenmile River segment MA36-12. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

7.2. Waterbody Impairment Characterization

The Sevenmile River (segment MA36-12) is a Class B, Warm Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS at the station listed below (refer to Tables 7-2, 7-3; Figure 7-2), using the indicator bacteria *E. coli*. Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 30-day rolling basis.

- In 2008, six samples were collected at W1870, 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 Statistical Threshold Value (STV) criterion was applied to single sample results. Out of six samples, two exceeded the STV criterion during both wet and dry weather.

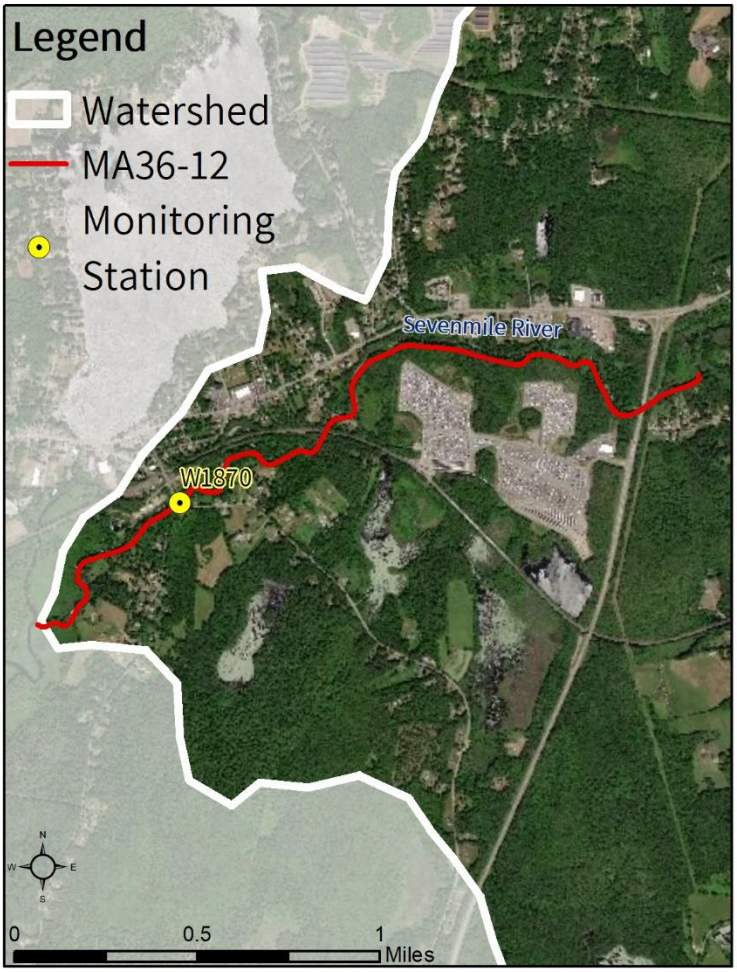


Figure 7-2. Location of monitoring station(s) along the impaired lower Sevenmile River river segment.

Table 7-2. Summary of indicator bacteria sampling results by station for the Sevenmile River (segment MA36-12). 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
W1870	5/20/2008	9/23/2008	6	449	4	2

Table 7-3. Indicator bacteria data by station, indicator, and date for the Sevenmile River (segment MA36-12). Each sample date was designated as representing wet or dry weather conditions with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text 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 (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
W1870	*E. coli*	5/20/2008	DRY	40	40	
W1870	*E. coli*	6/17/2008	WET	1440	240	
W1870	*E. coli*	7/9/2008	WET	140	449	
W1870	*E. coli*	7/22/2008	WET	240	183	
W1870	*E. coli*	8/19/2008	DRY	800	438	
W1870	*E. coli*	9/23/2008	DRY	50	50	

7.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which 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 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 the Sevenmile River (segment MA36-12) were elevated during both wet and dry weather. Elevated results during wet weather 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. Elevated results during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens.

Each potential pathogen source relevant to this segment is described in further detail below.

Urban Stormwater: The Sevenmile River (segment MA36-12) watershed is moderately developed with 15% of the land area identified as within MS4 and 3% as DCIA. The area of East Brookfield in which the segment flows is medium density mixed residential and commercial development, including large parking lots associated with an intermodal transportation facility. These factors indicate that stormwater runoff is likely a source of pathogens.

Illicit Sewage Discharges: The direct drainage area immediately surrounding the segment in East Brookfield appears to contain little, if any, municipal sewer service, but some of the watershed (15%) is designated as MS4 area, including along the river in North Brookfield, where public sewers are located. The town of North Brookfield, as of February 2020, is considering expanding sewer service to East Brookfield, which would affect properties adjacent to the impaired segment. 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: Given that most of the watershed is not sewered, malfunctioning on-site septic systems are a possible source of pathogens to the river. It is likely that a portion of such systems are not properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Agricultural activities in the watershed account for 9% of the total land area, although most are not directly adjacent to the segment. Agricultural activities visible on recent aerial photos include open fields, row crops, and pastureland. Agricultural activities related to manure storage and spreading, if not well managed, are possible sources of pathogens to waterbodies. Stormwater runoff from agricultural lands is likely a contributing source of pathogens to the segment.

Pet Waste: This segment of the Sevenmile River appears to have a substantial forested buffer between the developed areas in East Brookfield and the river itself; however, there are many conservation and recreational lands in the watershed. Trails and parks popular for dog walking adjacent to the river or tributary streams may carry pathogens to the segment.

Wildlife Waste: Conservation and recreational lands with large open mowed areas or fields with a clear sightline to a waterbody, as well as the large open meadow wetland in the downstream portion of the segment, may attract large congregations of 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 East Brookfield

Approximately 12% of the Town of East Brookfield is identified as within an MS4 area; however, the town is not listed by EPA among Regulated MS4 Communities in Massachusetts. See: https://www.epa.gov/npdes-permits/regulated-ms4-massachusetts-communities (USEPA, 2020b).

East Brookfield has the following ordinances and bylaws relevant to preventing, reducing or eliminating pathogenic pollution:

- East Brookfield does not have supplementary regulations beyond the MassDEP regulations for stormwater management and wetland protection.
- Title 5 Supplementary Regulations: Nothing beyond State of Massachusetts Title 5 Regulations
- Pet Waste: No
- Stormwater Utility (or similar): No
- Contact Recreation Regulations or Bylaws: No

East Brookfield's Master Plan has a Water Resources section in the Environmental Inventory and Analysis chapter (page 13)(Town of East Brookfield 2008, p. 13). The plan mentions the town should consider adopting a stormwater management bylaw and notes that the Lake Lashaway Association has monitored water quality, including coliform bacteria. The Open Space and Recreation chapter has a section on Surface Water Pollution, and also mentions stormwater controls. The East Brookfield Master Plan is available at https://www.eastbrookfieldma.us/planning-board/pages/east-brookfield-master-plan.

East Brookfield's Open Space and Recreation Plan:
https://www.eastbrookfieldma.us/sites/g/files/vyhlif541/f/file/file/2006_open_space_and_recreation_plan.pdf
(Town of East Brookfield, 2006)

Town of Spencer. See Section 6.4

A watershed-based plan has been created for this watershed by the Town of Spencer and Geosyntec Consultants, Inc. (Geosyntec, 2020).

Town of Paxton. See Section 6.4

8. MA36-15 Quaboag River

8.1. Waterbody Overview

The Quaboag River segment, MA36-15, is 6.2 miles long and begins at the MA-67/Quaboag Street bridge in West Brookfield, MA. Segment MA36-15 flows westward into Warren, MA. The segment ends at the Warren Wastewater Treatment Plant discharge (NPDES: MA0101567) in Warren, MA.

Tributaries to this Quaboag River segment include Naultaug Brook, Sullivan Brook, Cheney Brook, O'Neil Brook, School Street Brook, and many unnamed streams. Major lakes and ponds include Quaboag Pond and Wickaboag Lake. Impaired segment tributaries to MA36-15 include Sevenmile River segments MA36-11 and MA36-12, and Forget-Me-Not Brook segment MA36-18.

Key landmarks in the watershed include those mentioned for the lower Sevenmile River (segment MA36-12), as well as the town centers of Spencer, North Brookfield, West Brookfield, Brookfield, Warren, Oakham, and New Braintree; Spencer State Forest; and the Bay Path Golf Course. This segment flows in a western direction along state roads MA-19 and MA-67, with seven road crossings, including Main Street/MA-67, all within the town of Warren.

This reach of the Quaboag River drains an area of 147 square miles, of which 7 mi^2 (5%) is considered to be impervious surface, and 3 mi^2 (2%) is identified as directly connected impervious area (DCIA). In terms of land area, the

Reduction from Highest Calculated Geomean: 95%

Watershed Area (Acres): 93,842

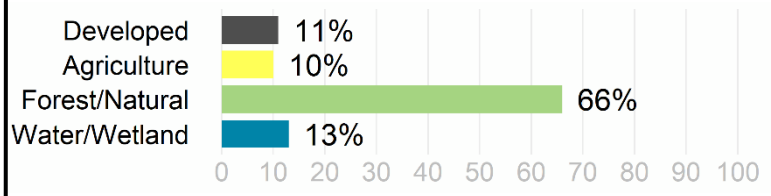
Segment Length (miles): 6.2

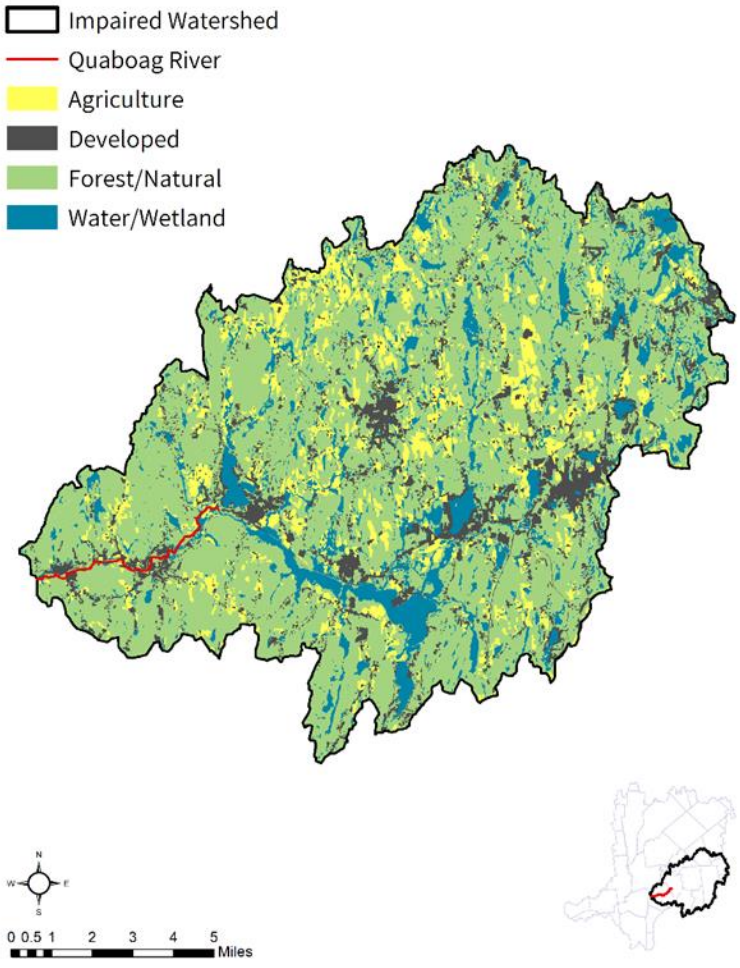
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifiers): B (Warm Water)

Impervious Area (Acres, %): 4,293 (5%)

DCIA Area (Acres, %): 1,617 (2%)





watershed is partially[16] served by public sewer and 11% is subject to stormwater regulations under the National Pollutant Discharge Elimination System (NPDES) General MS4 Stormwater Permit (USEPA, 2020A). There are three NPDES permits on file governing point source discharges of pollutants to surface waters within the full segment watershed, including one within the immediate drainage area (Table 8-1), as well as two MassDEP discharge to groundwater permits for on-site wastewater discharge within the immediate drainage area (Table 8-2). There are no combined sewer overflows, 11 landfills, and no unpermitted land disposal dumping grounds within the segment watershed. See Figure 8-1.

Table 8-1. 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
MA0101567	WARREN WWTF	WARREN	MUN

Table 8-2. 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
502-3	DOC TRAINING FACILITY	NEW BRAINTREE	Sanitary Discharge	114,000
808-1	QUABOAG ON THE COMMON	WEST BROOKFIELD	Sanitary Discharge	18,310

The segment MA36-15 flows through varied land uses ranging from forested and natural areas to agriculture and densely developed commercial and residential development. Much of river immediately upstream of the impaired segment is flanked by open meadow wetlands. The developed lands are concentrated in the watershed along the river corridor, including the developed areas of Spencer, North Brookfield, and West Brookfield.

In the watershed of the this reach of the Quaboag River (segment MA36-15), under the Natural Heritage and Endangered Species Program, there are 6,013 acres (6%) identified as Priority Habitats of Rare Species and 1,051 acres (1%) of Priority Natural Vegetation Communities. There are 1,709 acres (2%) under Public Water Supply protection, but no Areas of Critical Environmental Concern or Outstanding Resource Waters identified in this watershed. Over 5,397 acres (6%) of land are protected in perpetuity[17] within the segment watershed, which is part of a total of 21,011 acres (22%) of Protected and Recreational Open Space[18]. See Figure 8-1.

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

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

[18] 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 the State of Massachusetts).

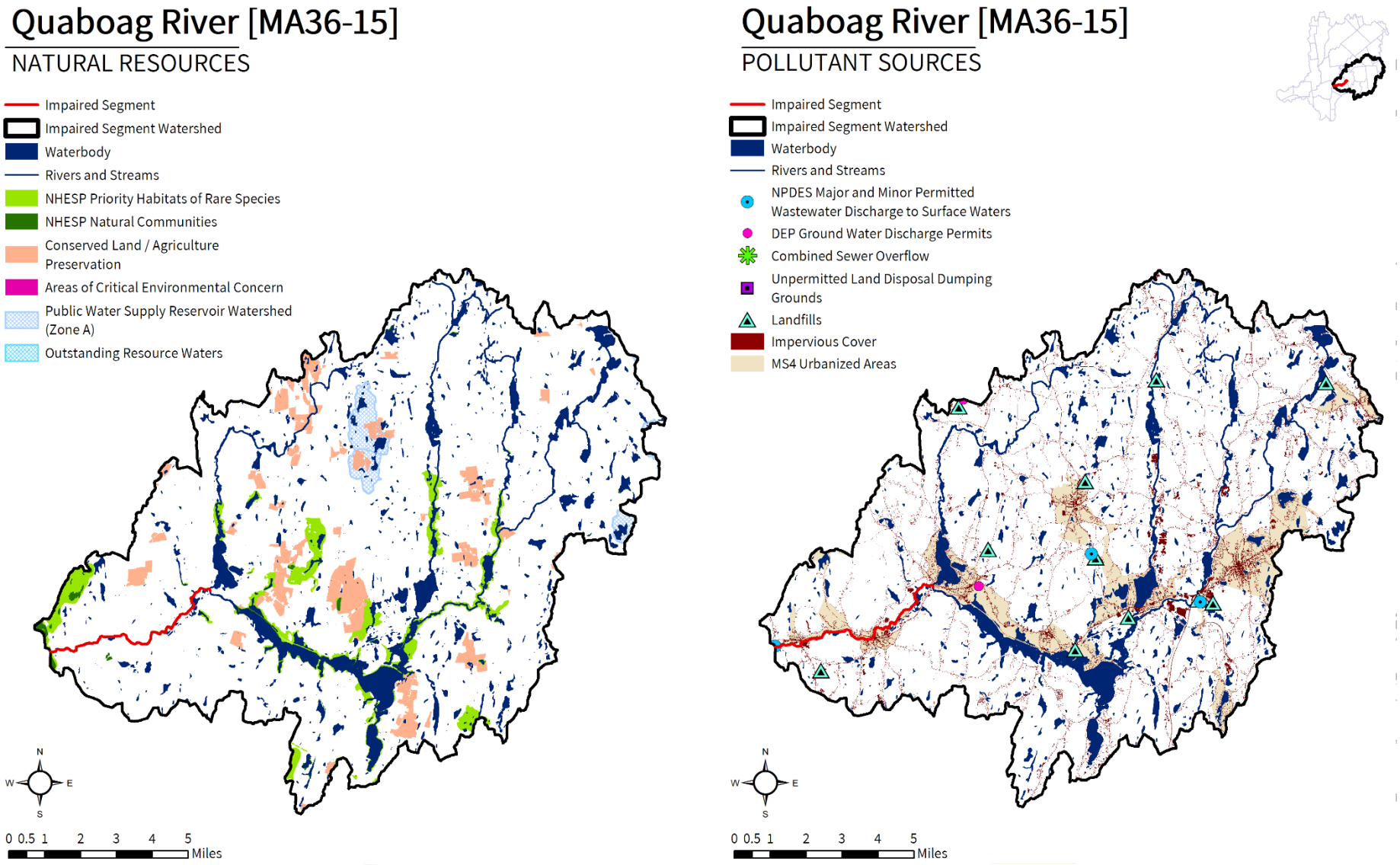


Figure 8-1. Natural resources and potential pollution sources draining to the Quaboag River segment MA36-15. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

8.2. Waterbody Impairment Characterization

The Quaboag River (MA36-15) is a Class B, Warm Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS at the stations listed below (refer to Tables 8-3, 8-4; Figure 8-2), using the indicator bacteria *E. coli*. Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 30-day rolling basis.

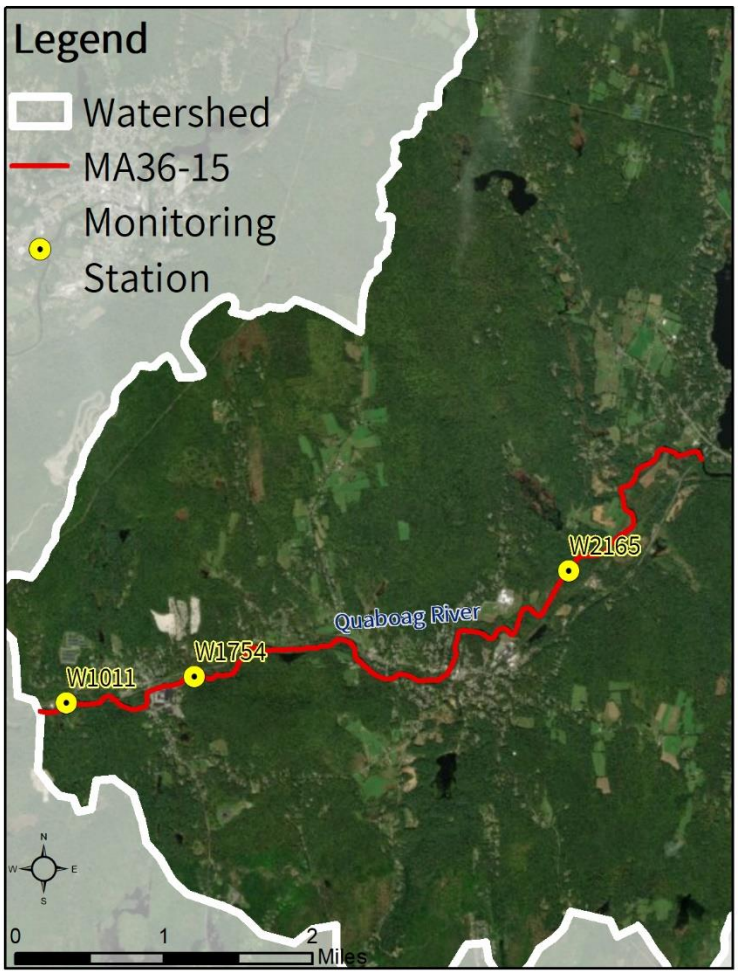


Figure 8-2. Location of monitoring station(s) along the impaired river segment.

- In 2008, six samples were collected at W1011, 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 Statistical Threshold Value (STV) criterion was applied to single sample results. Out of six samples, three exceeded the STV criterion during wet weather.
- In 2014, five samples were collected at W1754, 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, two exceeded the STV criterion during dry weather only.
- In 2014, five samples were collected at W2165, resulting in no 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.

Table 8-3. Summary of indicator bacteria sampling results by station for the Quaboag River (segment MA36-15). 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
W1011	5/20/2008	9/23/2008	6	782	4	3
W1754	5/13/2014	8/28/2014	5	2420	3	2
W2165	5/13/2014	8/28/2014	5	118	0	0

Table 8-4. Indicator bacteria data by station, indicator, and date for the Quaboag River (segment MA36-15). 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 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 (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
W1011	*E. coli*	5/20/2008	DRY	22	22	
W1011	*E. coli*	6/17/2008	WET	720	126	
W1011	*E. coli*	7/9/2008	DRY	850	782	
W1011	*E. coli*	7/22/2008	WET	160	369	
W1011	*E. coli*	8/19/2008	WET	800	358	
W1011	*E. coli*	9/23/2008	DRY	140	140	
W1754	*E. coli*	5/13/2014	WET	30	30	
W1754	*E. coli*	6/5/2014	DRY	517	125	
W1754	*E. coli*	7/8/2014	DRY	2420	2420	
W1754	*E. coli*	8/4/2014	DRY	122	543	
W1754	*E. coli*	8/28/2014	WET	172	145	
W2165	*E. coli*	5/13/2014	WET	25	25	
W2165	*E. coli*	6/5/2014	DRY	285	84	
W2165	*E. coli*	7/8/2014	DRY	28	28	
W2165	*E. coli*	8/4/2014	DRY	54	39	
W2165	*E. coli*	8/28/2014	WET	260	118	

8.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which 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 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).

The indicator bacteria data for the Quaboag River (segment MA36-15) were elevated during both wet and dry weather. Elevated results during wet weather 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. Elevated results during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens.

Each potential pathogen source relevant to this segment is described in further detail below.

Urban Stormwater: Portions of the Quaboag River (segment MA36-15) watershed are highly developed with 11% of the land area identified as within MS4 and 2% as DCIA. The river corridor passes through or next to the village centers of West Brookfield, Warren, and West Warren. Stormwater runoff from urban areas is likely a contributing source of pathogens.

Illicit Sewage Discharges: With some of the watershed relying on municipal sewer and located within designated MS4 area, sewer-related risks are likely a source of pathogens. Such 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 discharges, which are large-capacity septic systems (non-residential), both located within the immediate drainage area. Given that most of the watershed is not sewered, malfunctioning on-site septic systems are also a possible source. It is likely that a portion of septic systems are not properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Agricultural activities account for a relatively large portion of the watershed at 10% of the total land area. Agricultural activities visible on recent aerial photos include open fields, row crops, and pastureland. Agricultural activities related to manure storage and spreading, if not well managed, are possible sources of pathogens to waterbodies. Stormwater runoff from agricultural lands is likely a large contributing source of pathogens to the impaired segment.

Pet Waste: There are a few parks and ballfields near the impaired segment, plus over 21,000 acres of Protected and Recreational Open Space within 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 and fields with a clear sightline to a waterbody, including the large open meadow wetlands just upstream of the segment, may attract large congregations of 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 Brookfield

Approximately 12% of the Town of Brookfield is identified as within an MS4 area; however, the town is not listed by EPA among Regulated MS4 Communities in Massachusetts. See: https://www.epa.gov/npdes-permits/regulated-ms4-massachusetts-communities (USEPA, 2020b).

Brookfield has the following ordinances and bylaws relevant to preventing, reducing or eliminating pathogenic pollution:

- Brookfield does not have supplementary regulations beyond the MassDEP regulations for stormwater management or wetland protection.
- Title 5 Supplemental Regulations:
- Pet Waste Bylaw: No
- Stormwater Utility: No

Brookfield's Master Plan (https://www.brookfieldma.us/open-space-master-plan/pages/master-plan-2011) (Town of Brookfield, 2011) does not mention stormwater or related topics, nor does it mention impaired streams or town sewer/septic infrastructure. It does mention a town beach. The Brookfield town website is https://www.brookfieldma.us/ (Town of Brookfield, 2020).

Open Space and Recreation Plan: The Brookfield Open Space and Recreation Plan is incorporated within the Master Plan (Town of Brookfield, 2011), and is available at https://www.brookfieldma.us/sites/g/files/vyhlif2871/f/uploads/iii.5._osrp_brookfieldmp.pdf.

Town of North Brookfield

A small portion of the Town of North Brookfield is designated as an MS4 area; however, the town is not listed by EPA among Regulated MS4 Communities in Massachusetts (USEPA, 2020b). See: https://www.epa.gov/npdes-permits/regulated-ms4-massachusetts-communities

- North Brookfield has the following ordinances and bylaws relevant to preventing, reducing or eliminating pathogenic pollution: North Brookfield does not have supplementary regulations beyond the MassDEP regulations for stormwater management or wetland protection.
- Title 5 Supplementary Regulations: Nothing beyond State of Massachusetts Title 5 Regulations
- Stormwater Utility: No
- Pet Waste: No

The Master Plan's Natural Features, Open Space, and Recreation chapter has a Water Resources section (Town of North Brookfield, 2007). The plan recommends developing a stormwater management policy and bylaw to further protect and improve the quality of surface waters. The Natural Resources chapter also includes a section on the town sewer infrastructure, noting that 69% of the town is tied into the municipal sewage system, with outlying residences and business still relying on septic.

Town website: https://www.northbrookfield.net/ (Town of North Brookfield, 2020)

Master Plan: Master Plan – The Document | Town of North Brookfield MA (Town of North Brookfield, 2007).

Town of Spencer. See Section 6.4

Town of Warren

A small portion of the Town of Warren appears to be designated as an MS4 area; however, the town is not listed by EPA among Regulated MS4 Communities in Massachusetts (USEPA, 2020b). See: https://www.epa.gov/npdes-permits/regulated-ms4-massachusetts-communities

Warren's Master Plan includes a section on "Topography, Geology, Hydrology" in Chapter 4, pg. 34. The Master Plan also has a section on the sewer department on pg. 75 and mentions stormwater. https://www.warren-ma.gov/sites/warrenma/files/uploads/wmass.pdf (Town of Warren, 2006). An Open Space and Recreation Plan for Warren could not be found, but the Master Plan has a chapter on Open Space and Natural Resources.

Town of West Brookfield

West Brookfield is not within a designated MS4 area.

West Brookfield hosts a Stormwater Authority page (https://www.wbrookfield.com/?SEC=DC8D4785-056B-41CC-93EB-EE93B4A5DF20) and has mapped all of its MS4 stormwater system (Town of West Brookfield, 2020). The Town adopted illicit discharge detection and elimination (IDDE), erosion and sediment control (ESC), and post-construction stormwater regulations in 2015-2017. There are no stormwater outfalls reported to impaired Quaboag River or tributary segments in the town.

West Brookfield has the following ordinances and bylaws relevant to preventing, reducing or eliminating pathogenic pollution:

- In the Town's General Bylaws, Chapter X, Section 13, Surface Water Drainage Control: https://www.wbrookfield.com/vertical/sites/%7BB56533C2-1DA3-4729-9D48-8DC44122BE48%7D/uploads/Town_gen_bylaws__842016.pdf (Town of West Brookfield, 2016)
- Stormwater Bylaw, Chapter XV page 52: https://www.wbrookfield.com/vertical/sites/%7BB56533C2-1DA3-4729-9D48-8DC44122BE48%7D/uploads/Town_gen_bylaws__842016.pdf (Town of West, Brookfield 2016).

In addition, the Town of West Brookfield's Master Plan mentions stormwater and has a Water Resources section on page 177 (CMRPC, 2017). It also has a section on "Lack of municipal sewer section" on page 118 and an exploration of wastewater management systems on page 245, http://online.fliphtml5.com/vvitm/tmni/

West Brookfield's Open Space and Recreation Plan: https://docs.wixstatic.com/ugd/353a35_82ddb5d7b14a46629d09116526137a03.pdf (Town of West Brookfield, 2011)

9. MA36-16 Quaboag River

9.1. Waterbody Overview

The Quaboag River segment, MA36-16, is 8.7 miles long and begins at the Warren Wastewater Treatment Plant discharge (NPDES: MA0101567; the downstream end of segment MA36-15), in Warren, MA. Segment MA36-16 flows south then west, acting as the town boundary between Palmer and Warren, Palmer and Brimfield, then Palmer and Monson. Segment MA36-16 ends at the MA-32 bridge at the Palmer and Monson town line.

Tributaries to this Quaboag River segment include Blodgett Mill Brook, Bottle Brook, Foskett Mill Stream, Penny Brook, Kings Brook, and many unnamed streams. Pathogen-impaired segment tributaries to MA36-16 include Sevenmile River segments MA36-11 and MA36-12, Quaboag River segment MA36-15, and Forget-Me-Not Brook segment MA36-18.

Key landmarks in the watershed include those mentioned for segment MA36-15, as well as the Quaboag River Conservation Area, Scottish Meadow Golf Course, and the I-90 corridor. Segment MA36-16 flows in a southern direction between MA-67 and the Boston Subdivision railroad and is crossed by I-90 (Brimfield), Washington Road (Palmer), and Brimfield Road/MA-20 (Monson).

This reach of the Quaboag River (segment MA36-16) drains an area of 180 square miles (mi^2), of which 8 mi^2 (4%) is covered with impervious surfaces and 3 mi^2 (2%) is considered to be directly connected impervious area (DCIA). In

Reduction from Highest Calculated Geomean: 84%

Watershed Area (Acres): 115,178

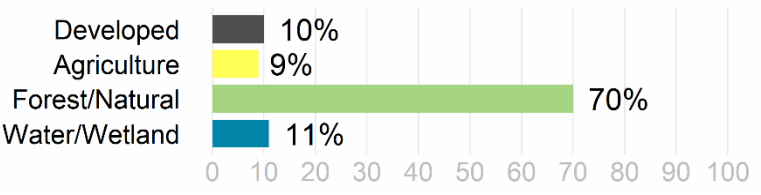
Segment Length (miles): 8.7

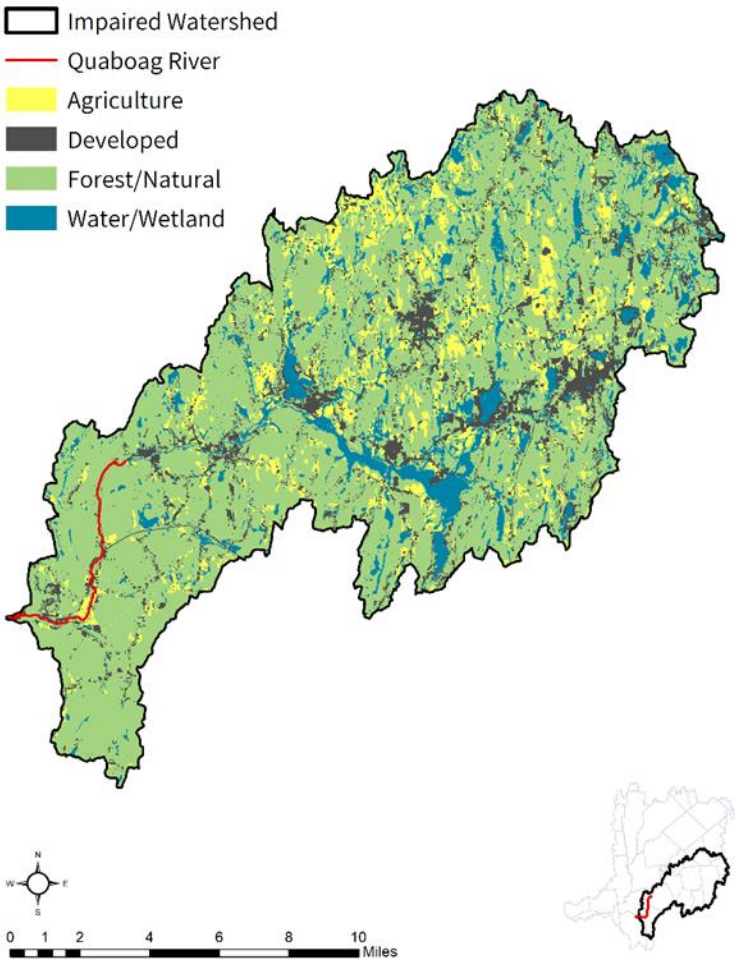
Impairment(s): *E. coli,* fecal coliform (Primary Contact Recreation)

Class (Qualifiers): B (Warm Water)

Impervious Area (Acres, %): 5,060 (4%)

DCIA Area (Acres, %): 1,847 (2%)





terms of land area, the watershed is partially[19] served by public sewer, and 10% is subject to stormwater regulations under the National Pollutant Discharge Elimination System (NPDES) General MS4 Stormwater Permit (USEPA, 2020a). Within the full segment watershed, there are three NPDES permits on file governing point source discharges of pollutants to surface waters (none within the immediate drainage area), and two MassDEP discharge to groundwater permits for on-site wastewater discharge (none within the immediate drainage area). There are also no combined sewer overflows, 13 landfills, and one unpermitted land disposal dumping ground in the watershed (Figure 9-1).

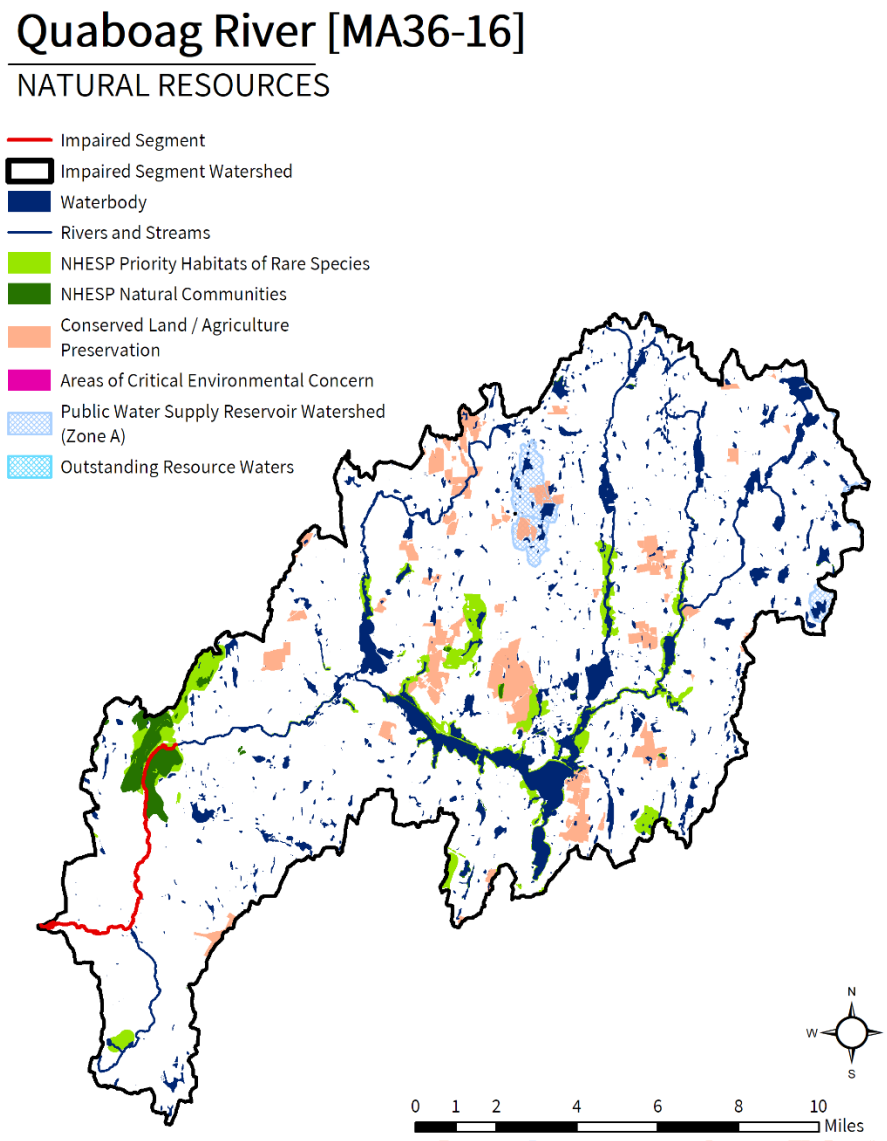
This segment of the Quaboag River (MA36-16) flows through a forested corridor for most of its reach, then emerges through open agricultural fields where flow changes direction from south to west.

In the watershed of the Quaboag River (MA36-16), under the Natural Heritage and Endangered Species Program, there are 7,166 acres (6%) identified as Priority Habitats of Rare Species and 2,118 acres (2%) of Priority Natural Vegetation Communities. There are 1,711 acres (1%) under Public Water Supply protection but no Areas of Critical Environmental Concern or Outstanding Resource Waters identified in this watershed. Over 5,541 acres (5%) of land are protected in perpetuity[20] within the segment watershed, which is part of a total of 24,589 acres (21%) of Protected and Recreational Open Space[21]. See Figure 9-1.

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

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

[21] 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 the State of Massachusetts).



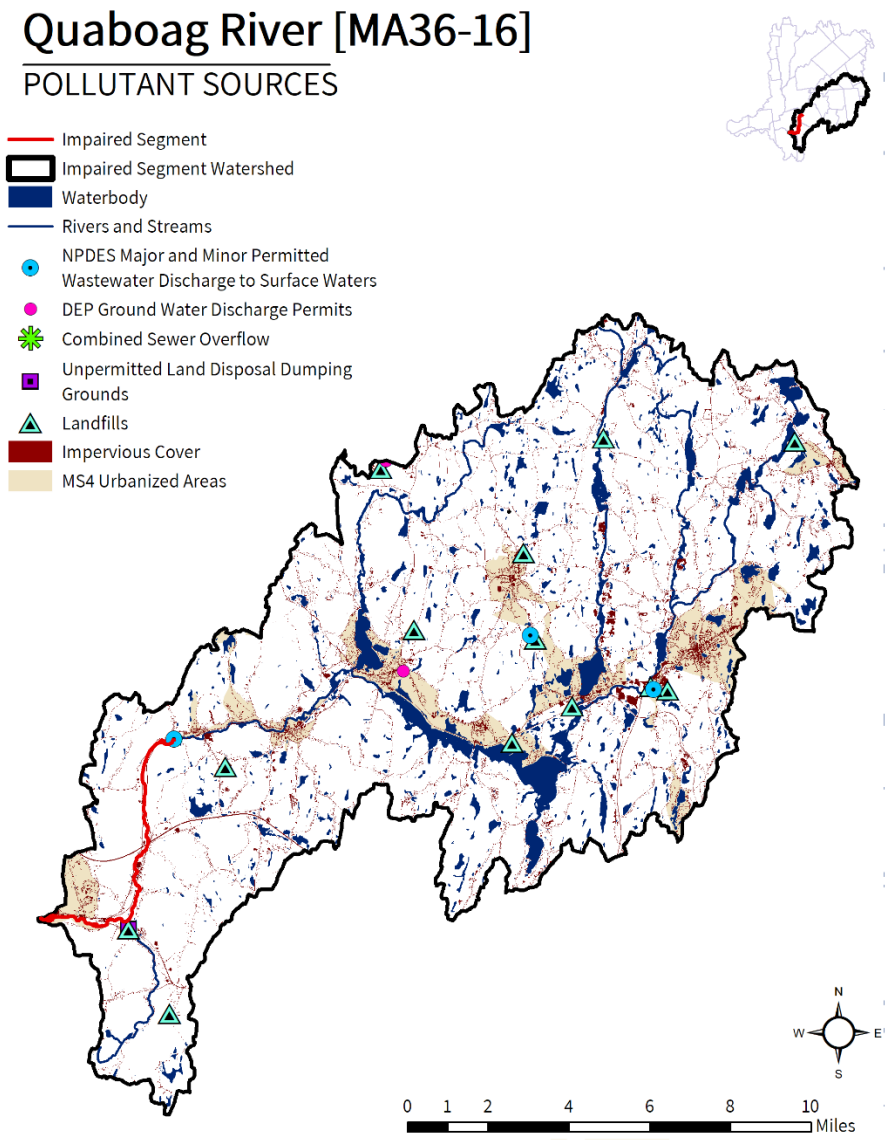


Figure 9-1. Natural resources and potential pollution sources draining to the Quaboag River segment MA36-16. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

9.2. Waterbody Impairment Characterization

The Quaboag River (segmentMA36-16) is a Class B, Warm Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS at the stations listed below (refer to Tables 9-1, 9-2; Figure 9-2), using the indicator bacteria *E. coli*. Data were evaluated against the SWQS geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria and the Statistical Threshold Value (STV) criterion of 410 CFU/100 mL for *E. coli.* The geomean and STV criteria for the impaired segment apply to data on a year-round, 30-day rolling basis.

- From 2007-2013, 31 samples were collected at W0491, 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 Statistical Threshold Value (STV) criterion was applied to single sample results. Out of 31 samples, none exceeded the STV criterion.
- In 2008, six samples were collected at W1868, 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 six samples, one exceeded the STV criterion during dry weather only.

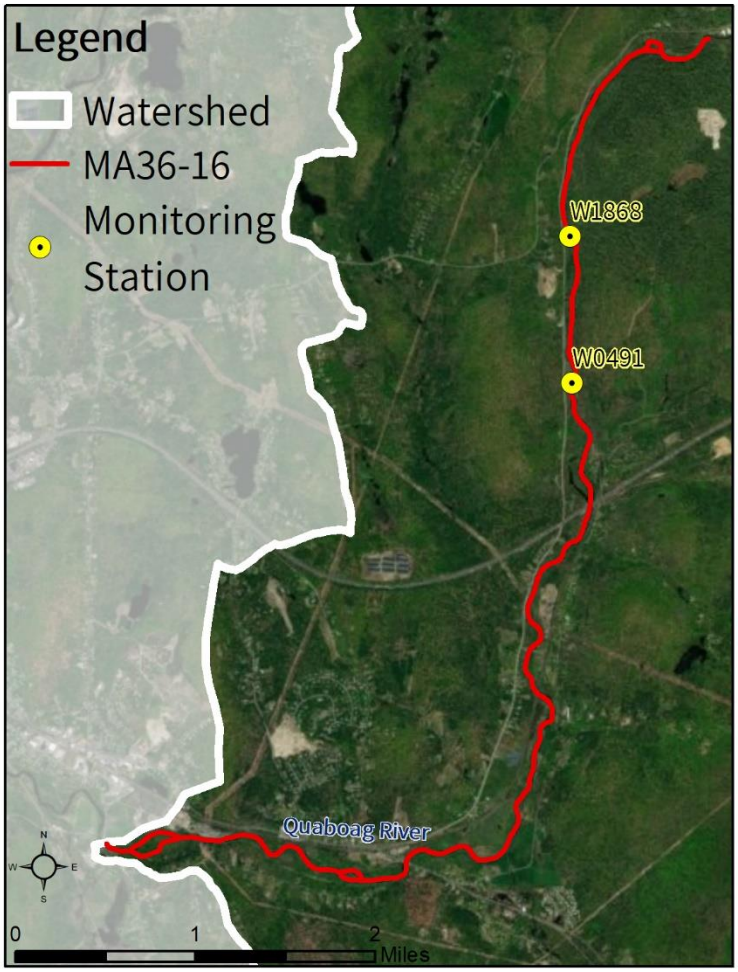


Figure 9-2. Location of monitoring station(s) along the impaired river segment.

Table 9-1. Summary of indicator bacteria sampling results by station for the Quaboag River (segment MA36-16). 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
W0491	8/28/2007	4/23/2013	31	172	3	0
W1868	5/20/2008	9/23/2008	6	800	3	1

Table 9-2. Indicator bacteria data by station, indicator, and date for the Quaboag River (segment MA36-16). 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 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 (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
W0491	*E. coli*	8/28/2007	DRY	58	58	
W0491	*E. coli*	10/16/2007	DRY	48	48	
W0491	*E. coli*	1/23/2008	DRY	11	11	
W0491	*E. coli*	3/25/2008	DRY	5	5	
W0491	*E. coli*	6/16/2008	DRY	76	76	
W0491	*E. coli*	7/22/2008	WET	47	47	
W0491	*E. coli*	8/18/2008	WET	54	50	
W0491	*E. coli*	9/23/2008	DRY	45	45	
W0491	*E. coli*	11/18/2008	WET	38	38	
W0491	*E. coli*	2/23/2009	DRY	12	12	
W0491	*E. coli*	4/28/2009	DRY	49	49	
W0491	*E. coli*	6/23/2009	DRY	172	172	
W0491	*E. coli*	8/25/2009	WET	93	93	
W0491	*E. coli*	10/27/2009	WET	44	44	
W0491	*E. coli*	2/9/2010	DRY	36	36	
W0491	*E. coli*	7/20/2010	WET	68	68	
W0491	*E. coli*	10/5/2010	DRY	64	64	
W0491	*E. coli*	11/16/2010	DRY	18	18	
W0491	*E. coli*	3/22/2011	DRY	20	20	
W0491	*E. coli*	4/26/2011	WET	33	33	
W0491	*E. coli*	6/21/2011	DRY	119	119	
W0491	*E. coli*	8/30/2011	WET	140	140	
W0491	*E. coli*	10/25/2011	DRY	39	39	
W0491	*E. coli*	1/24/2012	DRY	29	29	
W0491	*E. coli*	3/27/2012	DRY	101	101	
W0491	*E. coli*	5/23/2012	DRY	76	76	
W0491	*E. coli*	7/24/2012	DRY	172	172	
W0491	*E. coli*	9/25/2012	DRY	39	39	
W0491	*E. coli*	11/13/2012	DRY	88	88	
W0491	*E. coli*	2/26/2013	DRY	36	36	
W0491	*E. coli*	4/23/2013	DRY	15	15	
W1868	*E. coli*	5/20/2008	DRY	36	36	
W1868	*E. coli*	6/17/2008	WET	260	97	
W1868	*E. coli*	7/9/2008	DRY	280	270	
W1868	*E. coli*	7/22/2008	WET	90	159	
W1868	*E. coli*	8/19/2008	WET	110	99	
W1868	*E. coli*	9/23/2008	DRY	800	800	

9.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which 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 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).

The indicator bacteria data for the Quaboag River (MA36-16) were elevated during dry weather at sampling station W1868, suggesting baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens.

Each potential pathogen source is described in further detail below.

Urban Stormwater: Portions of the Quaboag River (MA36-16) watershed are moderately developed with 10% of the land area within designated MS4 areas and 2% as DCIA. These areas include residential development and transportation corridors. Stormwater runoff from urban areas is likely a contributing source of pathogens.

Illicit Sewage Discharges: With some of the watershed provided with municipal sewer service and 10% of the watershed designated as MS4 area, sewer-related risks are a possible source of pathogens to the impaired segment. Such 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 discharges, which are large-capacity septic systems (non-residential), though none are within the immediate drainage area. Given that most of the watershed is not covered by municipal sewer service, malfunctioning septic systems are also a possible source. It is likely that a portion of septic systems are not properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Agricultural activities in the watershed account for 9% of the total land area. Agricultural activities visible on recent aerial photos include many large hayfields adjacent to the river, in addition to open fields, row crops, and pastureland within the watershed. Agricultural activities related to manure storage and spreading, if not well managed, are possible sources of pathogens to waterbodies. Stormwater runoff from agricultural lands are likely a large contributing source of pathogens to the segment.

Pet Waste: Conservation lands, parks, ballfields, and residential neighborhoods 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 and fields with a clear sightline to a waterbody may attract large congregations of 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 Monson

A small portion of the Town of Monson is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit, and the town's Notice of Intent (NOI) was approved by EPA with Permit ID #MAR041015. The town has a Stormwater Management Plan on file at the Town Hall at 110 Main Street, Monson, MA (AECOM, 2019). The town has mapped all of its stormwater systems, and the map was submitted as an attachment to the NOI. The town adopted illicit discharge detection and elimination (IDDE), erosion and sediment control (ESC), and post-construction stormwater regulations in 2006. According to the NOI, there is one stormwater outfall into the pathogen-impaired Quaboag River segment MA36-16.

Monson has the following ordinance and bylaws relevant to preventing, reducing or eliminating pathogenic pollution:

- Monson does not have supplementary regulations beyond the MassDEP regulations for stormwater management or wetland protection.

- Title 5 Supplementary Regulations: Nothing beyond State of Massachusetts Title 5 Regulations
- Stormwater Utility: No
- Pet Waste: No

The Monson Master Plan has a Water Resources section in the Natural and Historic Resources chapter which includes a section on water quality threats, detailing sediment, phosphorus, nitrogen, metals, pesticides and herbicides, pathogens—including bacteria and viruses—and salts, as threats (Town of Monson, 2004). The plan mentions the Quaboag River, stating that though the segment is still impaired, the water quality has improved since the mid-1850s. The Municipal Services and Infrastructure chapter has a sewer system section, starting on page 60. Approximately 60 percent of the town uses on-site septic disposal.

Town website: https://www.monson-ma.gov/ (Town of Monson, 2020)

Master Plan: https://www.monson-ma.gov/planning-board/pages/monson-master-plan (Town of Monson, 2004)

Stormwater page: https://www.monson-ma.gov/sites/g/files/vyhlif926/f/uploads/monson_stormwater_management_program_june_25_2019.pdf (AECOM, 2019).

Source Water Protection Plan: https://www.monson-ma.gov/sites/g/files/vyhlif926/f/uploads/source_water_protection_plan.pdf#:~:text=Chicopee%20Brook%20%2D%20Bunyan%20Road%2C%20Monson%2C%20MA.&text=A%20Source%20Water%20Protection%20Plan,manage%20potentially%20contaminating%20land%20uses.&text=Assessment%20of%20the%20risks%20to,posed%20by%20contaminant%20sources%3B%204. (MassRWA, 2006)

Open Space and Recreation Plan: https://www.monson-ma.gov/sites/g/files/vyhlif926/f/uploads/open_space_plan.pdf (Town of Monson, 2005)

Town of North Brookfield. See Section 8.4

Town of Palmer. See Section 4.4

Town of Spencer. See Section 6.4

Town of Warren. See Section 8.4

Town of West Brookfield. See Section 8.4

10. MA36-17 Quaboag River

10.1. Waterbody Overview

The Quaboag River segment MA36-17 is 5.3 miles long and begins at the South Main St/Palmer Road/MA-32 Bridge at the Palmer and Monson town line (also the end of impaired Quaboag River segment MA36-16). The Quaboag River segment MA36-17 flows northwest to its confluence with the Ware River in Palmer, MA.

Tributaries to Quaboag River segment MA36-17 include Dumplin Brook. Pathogen-impaired segment tributaries to MA36-17 include Sevenmile River segments MA36-11 and MA36-12, Quaboag River segments MA36-15 and MA36-16, Forget-Me-Not Brook MA36-18, and Chicopee Brook MA36-21.

Key landmarks include the town centers of Palmer and Monson, Burleigh Brook #1 Recreation Area, Lavoilette Field, and the Quaboag Valley Golf Course. Segment MA36-17 flows in a northwestern direction following MA-32 and MA-181. The river is crossed by South Main Street/MA-32 (Palmer), the New England Central Railroad (three times), Wilbraham Street/MA-20 (Palmer), I-90 (Palmer), and others (Palmer and Monson).

The Quaboag River (MA36-17) drains an area of 212 square miles (mi^2), of which 10 mi^2 (5%) is covered with impervious surfaces and 4 mi^2 (2%) is considered directly connected impervious area (DCIA). In terms of land area, the watershed is

Reduction from Highest Calculated Geomean: 68%

Watershed Area (Acres): 135,813

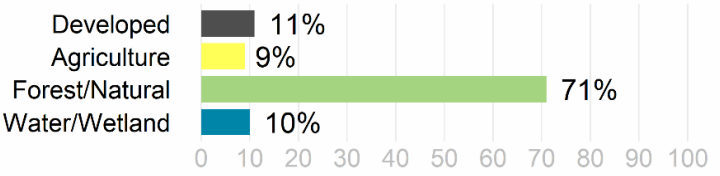
Segment Length (miles): 5.3

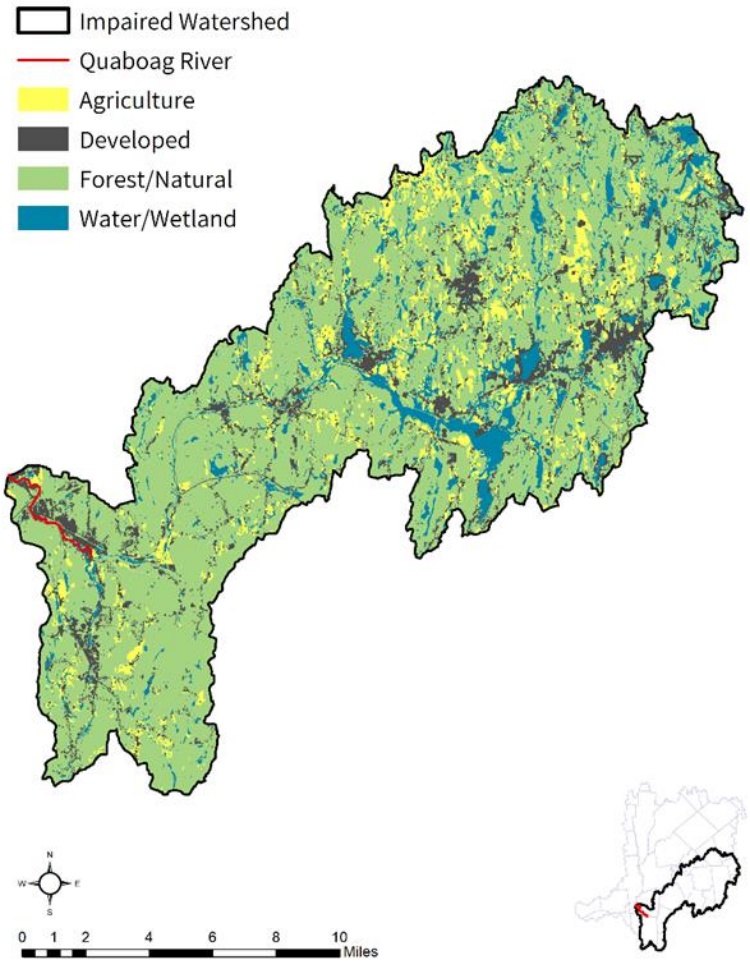
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifiers): B (Warm Water)

Impervious Area (Acres, %): 6,514 (5%)

DCIA Area (Acres, %): 2,526 (2%)





partially[22] served by public sewer and 12% is subject to stormwater regulations under the National Pollutant Discharge Elimination System (NPDES) General MS4 Stormwater Permit (USEPA, 2020a). There are three NPDES permits on file governing point source discharges of pollutants to surface waters within the watershed (none within the immediate drainage area), and two MassDEP discharge to groundwater permits for on-site wastewater discharges within the watershed (none within the immediate drainage area). There are also no combined sewer overflows, 15 landfills, and one unpermitted land disposal dumping ground within the segment watershed (Figure 10-1).

The Quaboag River segment MA36-17 flows through forest and mixed medium density residential, commercial, and industrial land uses. There is also prominent transportation infrastructure, including an interstate highway and rail corridor. Although there are scattered areas of agricultural land use in the watershed, those near the segment itself appear to be mowed fields.

In the watershed of the Quaboag River (MA36-17), under the Natural Heritage and Endangered Species Program, there are 7,493 acres (6%) identified as Priority Habitats of Rare Species and 2,119 acres (2%) of Priority Natural Vegetation Communities. There are 1,955 acres (1%) under Public Water Supply protection but no Areas of Critical Environmental Concern or Outstanding Resource Waters identified in this watershed. Over 6,028 acres (4%) of land are protected in perpetuity[23] within the segment watershed, which is part of a total of 29,635 acres (22%) of Protected and Recreational Open Space[24]. See Figure 10-1.

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

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

[24] 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 the State of Massachusetts).

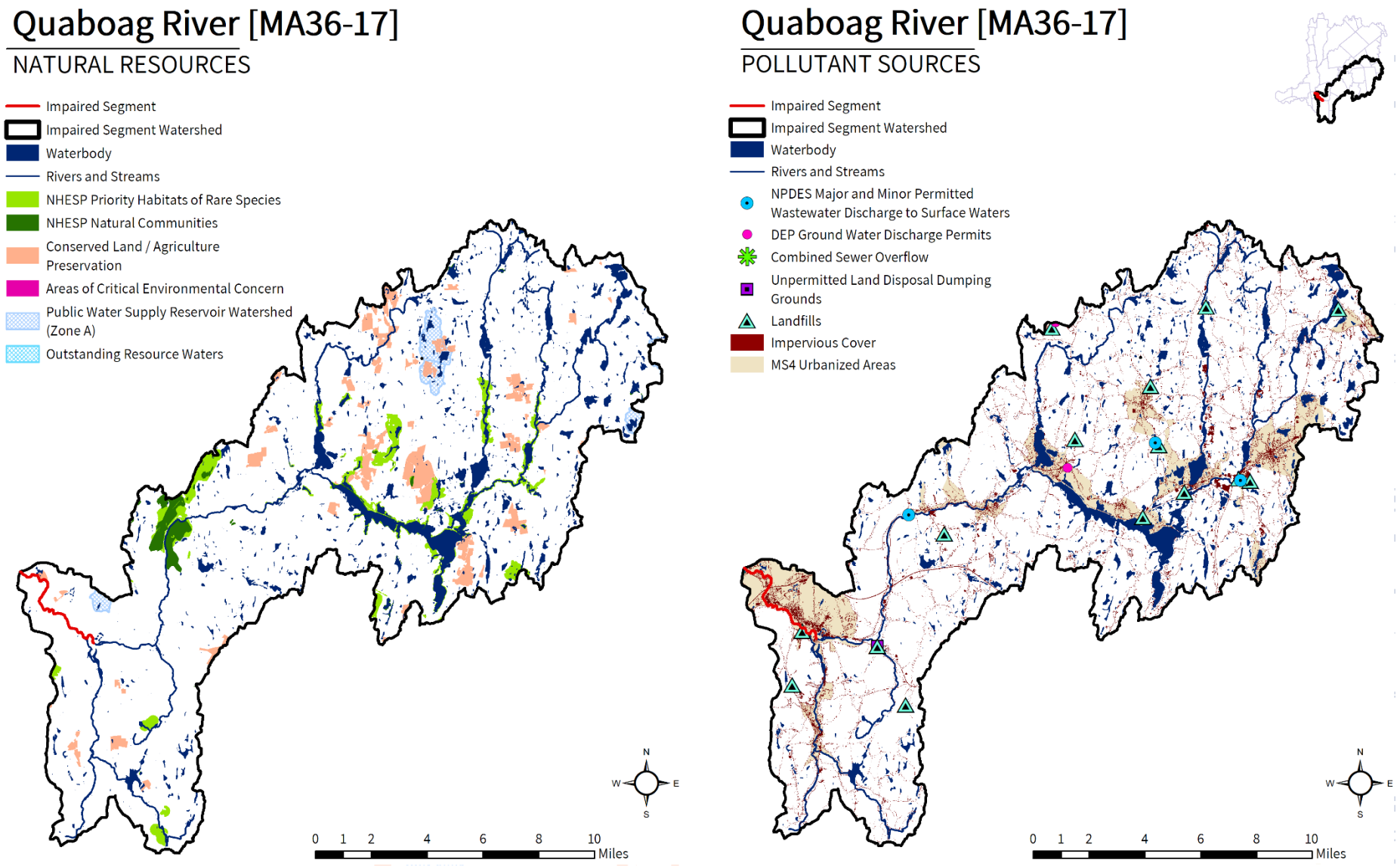


Figure 10-1. Natural resources and potential pollution sources draining to the Quaboag River (MA36-17). The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

10.2. Waterbody Impairment Characterization

The Quaboag River (MA36-17) is a Class B, Warm Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS at the stations listed below (refer to Tables 10-1, 10-2; Figure 10-2), 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, 30-day rolling basis.

- In 2008, six samples were collected at W1015, 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 Statistical Threshold Value (STV) criterion was applied to single sample results. Out of six samples, one exceeded the STV criterion during wet weather.
- In 2008, six samples were collected at W1875, 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 wet weather.

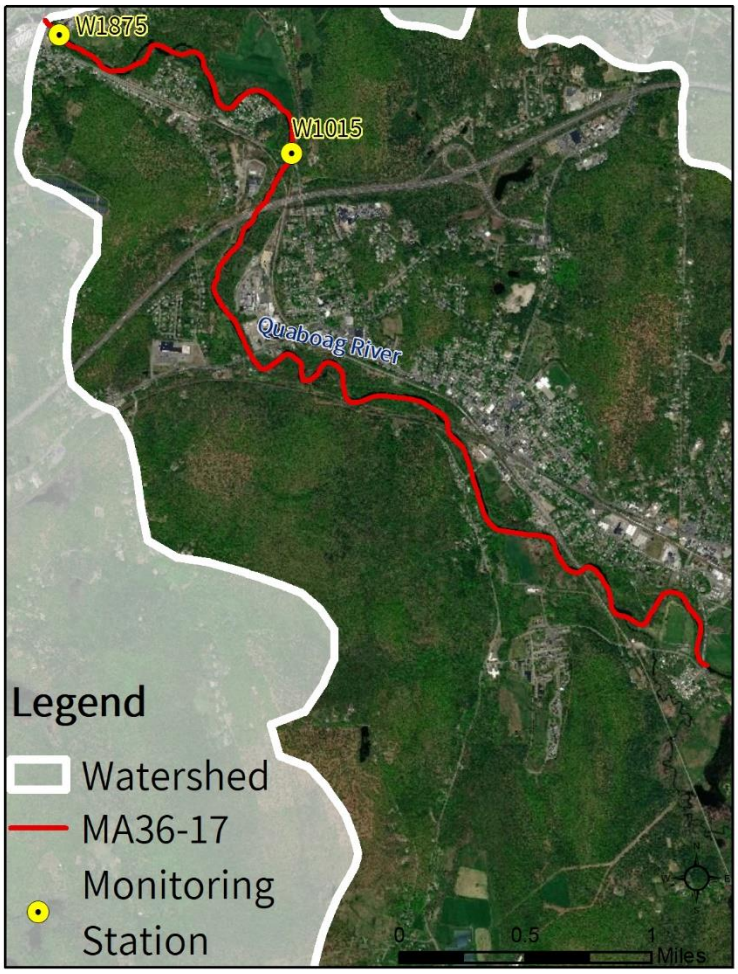


Figure 10-2. Location of monitoring station(s) along the impaired river segment.

Table 10-1. Summary of indicator bacteria sampling results by station for the Quaboag River (segment MA36-17). 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
W1015	5/20/2008	9/23/2008	6	399	3	1
W1875	5/20/2008	9/23/2008	6	306	5	1

Table 10-2. Indicator bacteria data by station, indicator, and date for the Quaboag River (segment MA36-17). Each sample date was designated as representing wet or dry weather conditions with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text 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 (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
W1015	*E. coli*	5/20/2008	DRY	64	64	
W1015	*E. coli*	6/17/2008	WET	200	113	
W1015	*E. coli*	7/9/2008	DRY	250	224	
W1015	*E. coli*	7/22/2008	WET	200	224	
W1015	*E. coli*	8/19/2008	WET	796	399	
W1015	*E. coli*	9/23/2008	DRY	120	120	
W1875	*E. coli*	5/20/2008	DRY	118	118	
W1875	*E. coli*	6/17/2008	WET	200	154	
W1875	*E. coli*	7/9/2008	DRY	240	219	
W1875	*E. coli*	7/22/2008	WET	170	202	
W1875	*E. coli*	8/19/2008	WET	550	306	
W1875	*E. coli*	9/23/2008	DRY	140	140	

10.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which 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 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).

The indicator bacteria data for the Quaboag River (segment MA36-17) were elevated during wet weather at both sampling stations (W1015 and W1875). These results are consistent with urban stormwater, pet waste, and wildlife pathogen sources. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated wet weather indicator bacteria levels.

Each potential pathogen source relevant to the segment is described in further detail below.

Urban Stormwater: Portions of the Quaboag River watershed (segment MA36-17) are highly developed with 12% of the land identified as within MS4 area and 2% as DCIA. There are areas of dense commercial and residential neighborhoods along interstate highway and rail transportation corridors. Stormwater runoff from urban areas is likely a significant source of pathogens.

Illicit Sewage Discharges: With some of the watershed serviced by a municipal sewer system and 12% of the watershed designated as MS4 area, sanitary sewers are a possible source. 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 groundwater discharge permits for on-site wastewater discharge, which are large-capacity septic systems (non-residential), though none are within the immediate drainage area. Given that most of the watershed is not served by a municipal sewer service, malfunctioning residential on-site 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: Agricultural activities in the watershed account for 9% of the total land use. Agricultural activities visible on recent aerial photos include open fields and hay fields. Agricultural activities related to manure storage and spreading, if not well managed, are possible sources of pathogens to waterbodies. Stormwater runoff from agricultural lands is likely a contributing source of pathogens to the impaired segment.

Pet Waste: The upper reaches of the watershed contain conservation lands, parks, and residential development. Several large recreational lands are adjacent to the river, such as the Water Street Recreation Area and Lavoilette Field. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent possible sources of pathogens.

Wildlife Waste: Conservation and recreational lands with large open mowed areas with a clear sightline to a waterbody may attract large congregations of 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 Monson. See Section 9.4

Town of North Brookfield. See Section 8.4

Town of Palmer. See Section43.4

Town of Spencer. See Section 6.4

Town of Warren. See Section 8.4

11. MA36-18 Forget-Me-Not Brook

11.1. Waterbody Overview

The Forget-Me-Not Brook segment MA36-18 is 1.2 miles long and begins in a wetland adjacent to an open field 0.1 miles north of Ward Street in North Brookfield, MA. Segment MA36-18 flows south and ends at the North Brookfield Wastewater Treatment Plant (WWTP) discharge (NPDES: MA0101061).

Tributaries to the Forget-Me-Not Brook segment MA36-18 include 0.8 miles of unnamed streams.

Key landmarks in the watershed include the western half of downtown North Brookfield. The segment is crossed by Ward Street, East Brookfield Road (three times), and Donovan Road, all within North Brookfield.

Forget-Me-Not Brook (segment MA36-18) drains an area of 1.3 square miles (mi^2), of which 0.14 mi^2 (11%) is covered with impervious surfaces and 0.06 mi^2 (5%) is considered directly connected impervious area (DCIA). The

Reduction from Highest Calculated Geomean: 57%

Watershed Area (Acres): 798

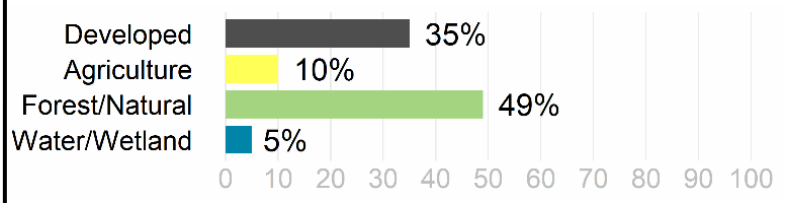
Segment Length (miles): 1.2

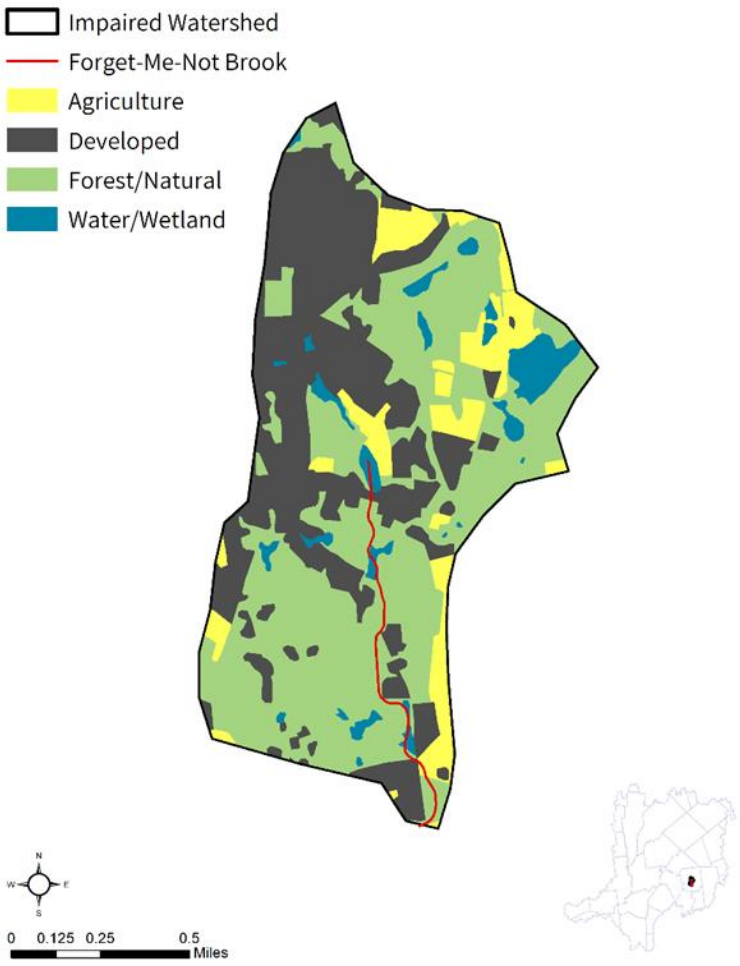
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifiers): B (Cold Water, High Quality Water)

Impervious Area (Acres, %): 88 (11%)

DCIA Area (Acres, %): 41 (5%)





watershed is partially[25] served by public sewer, and 49% is subject to stormwater regulations under the National Pollutant Discharge Elimination System (NPDES) General MS4 Stormwater Permit (USEPA, 2020a). There is one NPDES permit on file governing point source discharges of pollutants to surface waters within the watershed (Table 11-1). There are no MassDEP discharge to groundwater permits for on-site wastewater discharges within this watershed, no combined sewer overflows, no landfills, and no unpermitted land disposal dumping grounds within the watershed. See Figure 11-1.

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

Table 11-1. 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
MA0101061	NORTH BROOKFIELD WWTP	NORTH BROOKFIELD	MUN

Forget-Me-Not Brook (segment MA36-18) flows primarily through forest and low density mixed residential and commercial land uses. The largest concentration of developed land occurs in the northwestern portion of the watershed near the town center of North Brookfield. The agricultural land at the start of the segment appears to be hay fields, and near the end of the segment, there is a fenced-in area for livestock. There are also large tree farms in the watershed.

In the watershed of Forget-Me-Not Brook (segment MA36-18), under the Natural Heritage and Endangered Species Program, there are no areas identified as Priority Habitats of Rare Species or Priority Natural Vegetation Communities. There are 2.7 acres (<1%) of land under Public Water Supply protection but no Areas of Critical Environmental Concern or Outstanding Resource Waters identified in this watershed. No areas of land are protected in perpetuity[26] within the segment watershed, which would otherwise be part of the total of 52 acres (7%) of Protected and Recreational Open Space[27]. See Figure 11-1.

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

[27] 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 the State of Massachusetts).

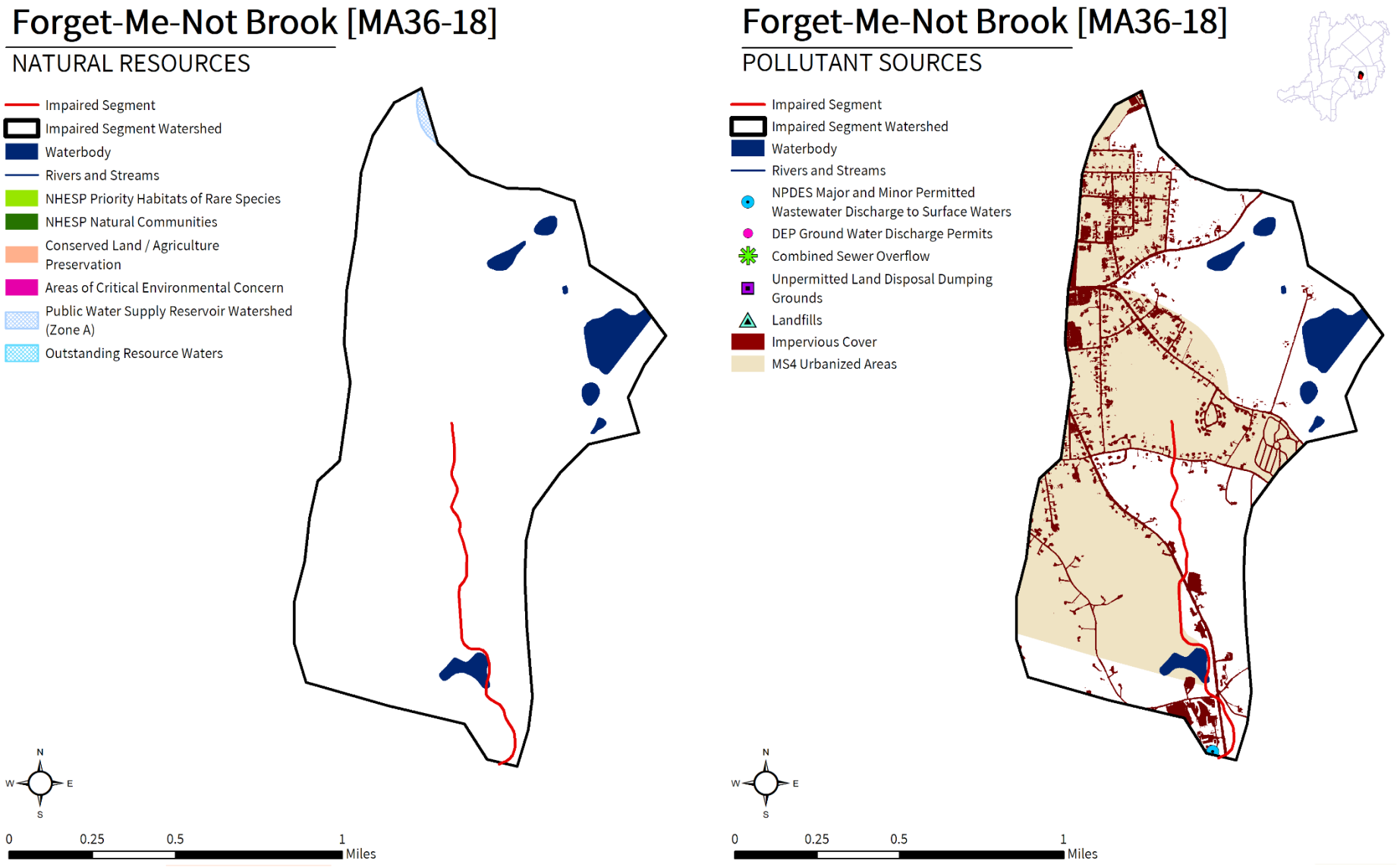


Figure 11-1. Natural resources and potential pollution sources draining to the Forget-Me-Not Brook segment MA36-18. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

11.2. Waterbody Impairment Characterization

Forget-Me-Not Brook (segment MA36-18) is a Class B, Cold Water and High Quality Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS at the station listed below (refer to Tables 11-2, 11-3; Figure 11-2), 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 2008, six samples were collected at W1040, 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 Statistical Threshold Value (STV) criterion was applied to single sample results. Out of six samples, one exceeded the STV criterion during dry weather.

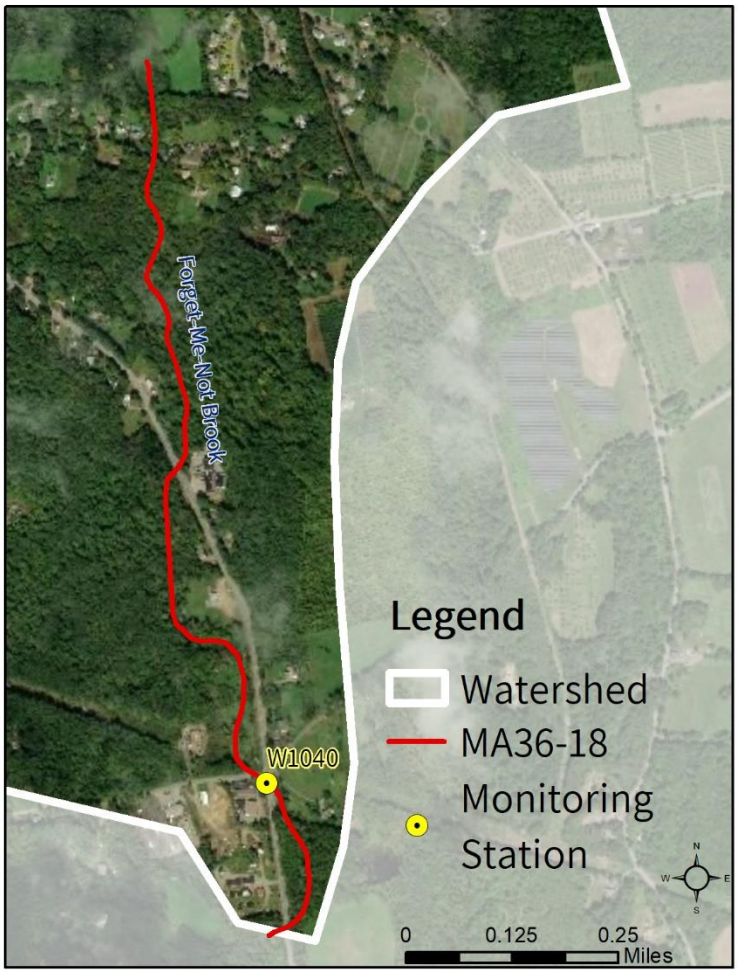


Figure 11-2. Location of monitoring station(s) along the impaired river segment.

Table 11-2. Summary of indicator bacteria sampling results by station for Forget-Me-Not Brook (segment MA36-18). 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
W1040	5/20/2008	9/23/2008	6	291	6	1

Table 11-3. Indicator bacteria data by station, indicator, and date for Forget-Me-Not Brook (segment MA36-18). 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 (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W1040	*E. coli*	5/20/2008	DRY	248	248	
W1040	*E. coli*	6/17/2008	WET	340	290	
W1040	*E. coli*	7/9/2008	WET	130	222	
W1040	*E. coli*	7/22/2008	WET	260	231	
W1040	*E. coli*	8/19/2008	DRY	620	291	
W1040	*E. coli*	9/23/2008	DRY	20	143	

11.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which 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 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).

The indicator bacteria data for Forget-Me-Not Brook (segment MA36-18) were elevated during dry weather, which suggests baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens. Given the relatively small sample set, additional sampling under both wet and dry conditions, ideally at more than one location, would likely help in identifying the sources of pollutants.

Each potential pathogen source relevant to the segment is described in further detail below.

Urban Stormwater: Portions of the Forget-Me-Not Brook (segment MA36-18) watershed are highly developed with 49% of the land identified as within an MS4 area and 5% as DCIA. Development is concentrated around the North Brookfield town center (located just outside the watershed boundary) and consists primarily of residential infrastructure but also contains commercial and industrial land uses in the headwaters. Stormwater runoff from urban areas is likely a significant source of pathogens.

Illicit Sewage Discharges: With likely half of the watershed serviced by municipal sewer and half (49%) designated as MS4 area, illicit storm drain connections and/or illicit discharges from failing infrastructure such as leaky sewer lines or SSOs represent a major potential source of pathogens. 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 only a portion of the land area served by municipal sewers, malfunctioning on-site 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: Agricultural activities in the watershed account for 10% of the total land area. Agricultural activities visible on recent aerial photos include open fields, hayfields, and tree farms. Agricultural activities related to

manure storage and spreading, if not well managed, are possible sources of pathogens to waterbodies. Stormwater runoff from agricultural lands are likely a source of pathogens to this segment.

Pet Waste: Much of the segment is flanked by forested and natural areas with 7% of the watershed as Protected and Recreational Open Space. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent possible sources of pathogens.

Wildlife Waste: There are mowed fields adjacent to the segment. Conservation and recreational lands with large open mowed areas with a clear sightline to a waterbody may attract large congregations of waterfowl and elevate indicator bacteria 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 North Brookfield. See Section 8.4

12. MA36-21 Chicopee Brook

12.1. Waterbody Overview

The Chicopee Brook segment MA36-21 is 9.9 miles long and begins at the outlet of a wetland along Crow Hill Road east of Peaked Mountain in Monson, MA. Segment MA36-21 flows north through Chicopee Brook Pond (formerly segment MA36031) to its confluence with the Quaboag River segment MA36-17 in Monson, MA.

Tributaries to Chicopee Brook segment MA36-21 include Conant Brook and many unnamed streams. Lakes and ponds in the watershed include Smith Pond and Zero Mill Pond 9small impoundments on Chicopee Brook), and Paradise Lake, Calkins Pond, Monson Reservoir, Squire Pond, Duck Pond, the Norcross Ponds, Vinca Pond, Woodman Pond, Dean Pond, and East Hill Road Pond, elsewhere in the watershed.

Key landmarks in the watershed include the town center of Monson and the Quaboag Valley Golf Course. Segment MA36-21 is crossed by Stafford Road/MA-32 twice, Main Street/MA-32, Palmer Road/MA-32, and others, all within Monson. The New England Central Railroad crosses the brook several times.

Chicopee Brook (segment MA36-21) drains an area of 24 square miles (mi^2), of which 1.2 mi^2 (5%) is covered with impervious surfaces and 0.4 mi^2 (2%) is considered directly connected impervious area (DCIA). In terms of land area, the watershed

Reduction from Highest Calculated Geomean: 65%

Watershed Area (Acres): 15,375

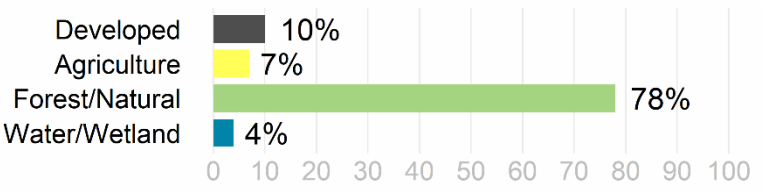
Segment Length (miles): 9.9

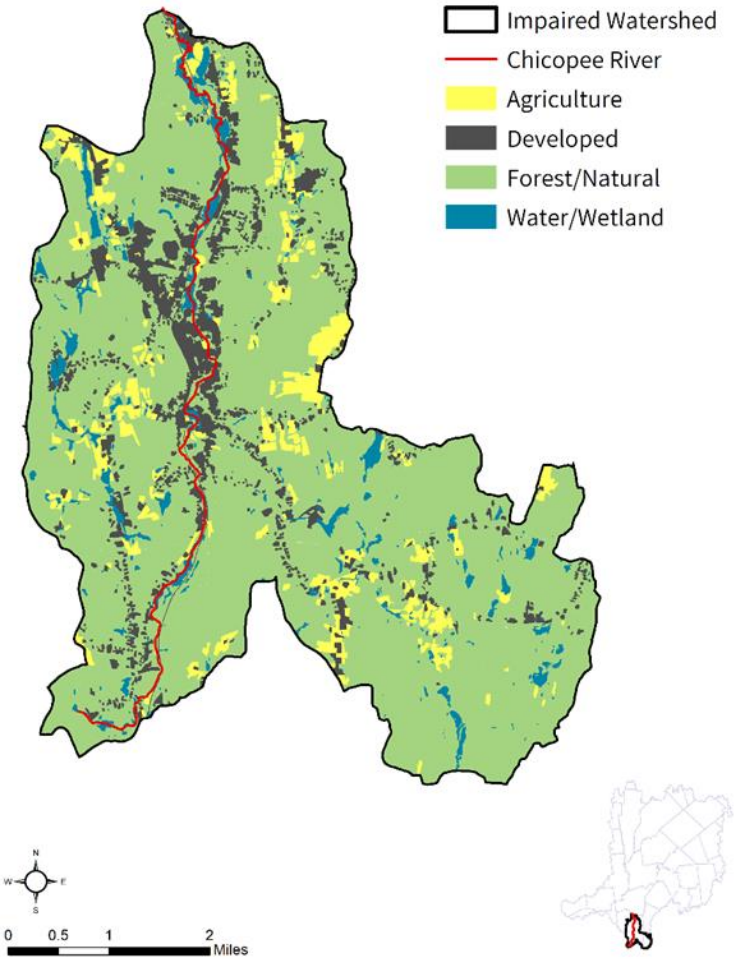
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifiers): B (Cold Water)

Impervious Area (Acres, %): 750 (5%)

DCIA Area (Acres, %): 282 (2%)





is partially[28] served by public sewer and 7% is subject to stormwater regulations under the National Pollutant Discharge Elimination System (NPDES) General MS4 Stormwater Permit (USEPA, 2020a). There are no NPDES permits on file governing point source discharges of pollutants to surface waters in the watershed. There are no MassDEP discharge to groundwater permits for on-site wastewater discharge, no combined sewer overflows, one landfill, and no unpermitted land disposal dumping grounds within the watershed. See Figure 12-1.

Although the watershed is predominantly forested, Chicopee Brook flows through low to medium density mixed residential and commercial development, and by vegetated wetlands in some areas. Rail and road transportation infrastructure, including some large parking lots, are also adjacent to the brook in several locations. The largest concentration of developed land occurs in the center of the segment watershed surrounding the Monson town center.

In the watershed of Chicopee Brook (segment MA36-21), under the Natural Heritage and Endangered Species Program, there are 291 acres (2%) identified as Priority Habitats of Rare Species and 0.3 acres (<1%) of Priority Natural Vegetation Communities. There are no areas of Public Water Supply protection, Areas of Critical Environmental Concern, or Outstanding Resource Waters identified in this watershed. Over 389 acres (3%) of land are protected in perpetuity[29] within the segment watershed, which is part of a total of 4,201 acres (27%) of Protected and Recreational Open Space[30]. See Figure 12-1.

[28] 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.

[29] Land protected in perpetuity include several interests such as conservation restriction, 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.

[30] 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 the State of Massachusetts).

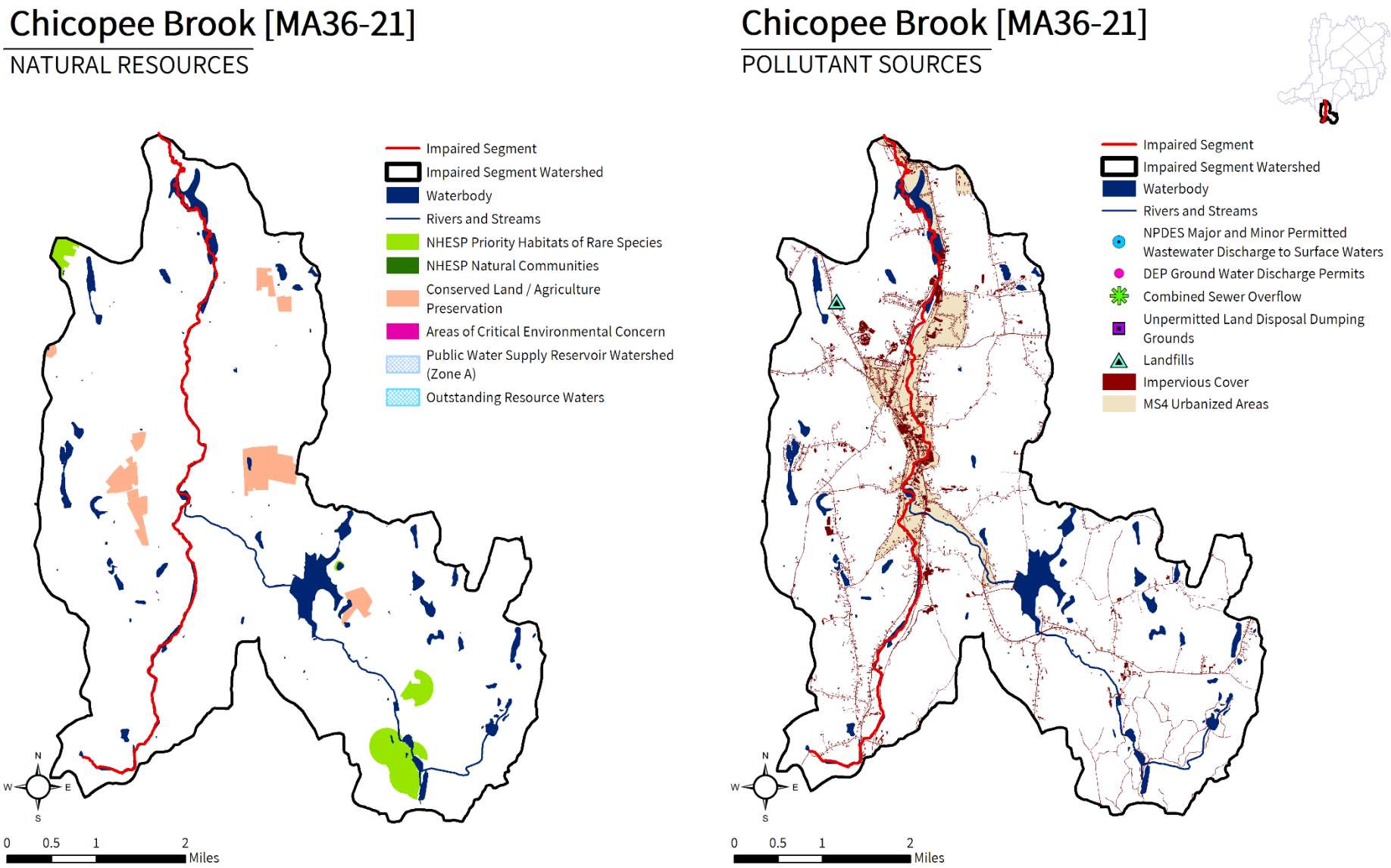


Figure 12-1. Natural resources and potential pollution sources draining to the Chicopee Brook segment MA36-21. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

12.2. Waterbody Impairment Characterization

Chicopee Brook (segment MA36-21) is a Class B, Cold Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS at the stations listed below (refer to Tables 12-1, 12-2; Figure 12-2), 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.

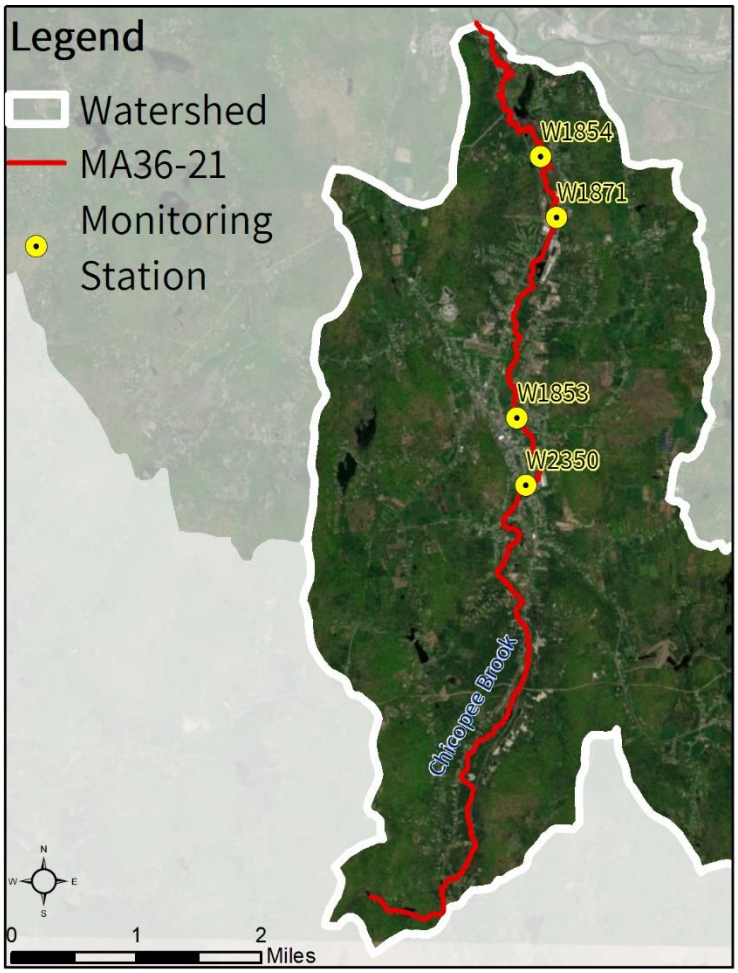


Figure 12-2. Location of monitoring station(s) along the impaired river segment.

- In 2008, six samples were collected at W1853, 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 Statistical Threshold Value (STV) criterion was applied to single sample results. Out of six samples, one exceeded the STV criterion during wet weather.
- In 2008, six samples were collected at W1854, 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, none exceeded the STV criterion.
- In 2008, six samples were collected at W1871, 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.
- In 2014, five samples were collected at W2350, 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, none exceeded the STV criterion.

Table 12-1. Summary of indicator bacteria sampling results by station for Chicopee Brook (segment MA36-21). The maximum 90-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the 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
W1853	5/20/2008	9/23/2008	6	290	5	1
W1854	5/20/2008	9/23/2008	6	299	6	0
W1871	5/20/2008	9/23/2008	6	359	5	1
W2350	5/6/2014	8/21/2014	5	198	3	0

Table 12-2. Indicator bacteria data by station, indicator, and date for Chicopee Brook (segment MA36-21). Each sample date was designated as representing wet or dry weather conditions with wet weather defined as more than 0.5 inches of precipitation in the previous 72 hours. Red text 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 (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W1853	*E. coli*	5/20/2008	DRY	102	102	
W1853	*E. coli*	6/17/2008	WET	200	143	
W1853	*E. coli*	7/9/2008	DRY	260	174	
W1853	*E. coli*	7/22/2008	WET	440	220	
W1853	*E. coli*	8/19/2008	WET	310	290	
W1853	*E. coli*	9/23/2008	DRY	40	194	
W1854	*E. coli*	5/20/2008	DRY	138	138	
W1854	*E. coli*	6/17/2008	WET	200	166	
W1854	*E. coli*	7/9/2008	DRY	280	198	
W1854	*E. coli*	7/22/2008	WET	410	237	
W1854	*E. coli*	8/19/2008	WET	350	299	
W1854	*E. coli*	9/23/2008	DRY	160	283	
W1871	*E. coli*	5/20/2008	DRY	82	82	
W1871	*E. coli*	6/17/2008	WET	200	128	
W1871	*E. coli*	7/9/2008	DRY	230	156	
W1871	*E. coli*	7/22/2008	WET	410	198	
W1871	*E. coli*	8/19/2008	WET	800	350	
W1871	*E. coli*	9/23/2008	DRY	220	359	
W2350	*E. coli*	5/6/2014	DRY	44	44	
W2350	*E. coli*	6/2/2014	DRY	201	94	
W2350	*E. coli*	7/2/2014	DRY	365	148	
W2350	*E. coli*	7/29/2014	WET	261	170	
W2350	*E. coli*	8/21/2014	DRY	81	198	

12.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which 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 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).

The indicator bacteria data for Chicopee Brook (segment MA36-21) were elevated during wet weather, 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 relevant to the segment is described in further detail below.

Urban Stormwater: Portions of the Chicopee Brook watershed (segment MA36-21) are developed, with 7% of the land identified as within MS4 area and 2% as DCIA. The MS4 areas and highest density development are concentrated around the river corridor. There are medium and low-density residential developments in the central part of the segment, along with medium density commercial and transportation land uses, including large parking lots. Stormwater runoff from urban areas is likely a significant source of pathogens.

Illicit Sewage Discharges: With portions of the land concentrated around the segment served by municipal sewer and/or designated as MS4 area, illicit storm drain connections and/or illicit discharges from failing infrastructure, such as leaky sewer lines or SSOs, are potential sources of pathogens.

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

Agriculture: Based on land use data and aerial imagery review, agricultural activities in the watershed account for 7% of the total land area and include open fields, hayfields, row crops, and pastureland. Agricultural activities related to manure storage and spreading, if not well managed, are possible sources of pathogens to waterbodies. Stormwater runoff from agricultural lands is also a likely source of pathogens to the impaired Chicopee Brook segment.

Pet Waste: There are many ballparks and recreational fields adjacent to the segment, and the stream flows primarily through residential neighborhoods. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent possible sources of pathogens.

Wildlife Waste: While most of the segment has a wide forested buffer, there are several open fields next to the segment. Conservation and recreational lands and large open mowed areas with a clear sightline to a waterbody may attract large congregations of 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 Monson. See Section 9.4

Town of Wales
Wales is not within a designated MS4 area, and no relevant ordinances and bylaws were found.

Wales is beginning its Master Plan process, including the development of an Open Space and Recreation plan,

and evaluating the need to create a stormwater management bylaw: https://www.townofwales.net/sites/g/files/vyhlif1371/f/uploads/community_forum.pdf (town of Wales, 2019)

No Open Space and Recreation Plan was found.

13. MA36-22 Chicopee River

13.1. Waterbody Overview

The Chicopee River segment MA36-22 is 2.8 miles long and begins at the confluence of the Ware River segment MA36-07 and the Quaboag River segment MA36-17 in Palmer, MA. The segment flows west to the Red Bridge Impoundment Dam (NATID: MA00723) along the Wilbraham and Ludlow town border.

Tributaries to Chicopee River segment MA36-22 include the pathogen-impaired segments Ware River (MA36-07) and Quaboag River (MA36-17), as well as several unnamed streams. Much of the segment flows through the Red Bridge Impoundment/Chicopee River Reservoir in the towns of Ludlow and Wilbraham. An unnamed impoundment, fed by Broad Brook, is separated from the Red Bridge Impoundment by a berm. Both impoundments and about half of the impaired segment are within the Red Bridge State Park. Upstream pathogen-impaired segments include the Ware River segments MA36-05 and MA36-06; Prince River segment MA36-08; Sevenmile River segments MA36-11 and MA36-12; Quaboag River segments MA36-15, MA36-16, and MA36-17; Forget-Me-Not Brook segment MA36-18; Chicopee Brook segment MA36-21; and Danforth Brook segment MA36-50.

Key landmarks in the surrounding watershed include the town centers of Belchertown, Bondsville (a village within Palmer), New Salem, Nichewaug (a village within Petersham), Pelham, Petersham, and Thorndike (a village within Palmer). Cold Spring Country Club and Golf Course, Mill Valley Golf Links, Swift River Wildlife Management Area, Cold Spring Conservation Area, Warner Road Conservation Area, Jabish Brook Conservation Area, Babbit Wildlife Sanctuary, the Shutesbury State Forest, and the New Salem State Forest are located within this watershed as well. Segment MA36-22 is crossed by Bridge Street 0.06 miles from the start of the segment in the village of Three Rivers (Palmer). The remainder of the segment does not intersect any roadways.

Reduction from Highest Calculated Geomean: 86%

Watershed Area (Acres): 424,521

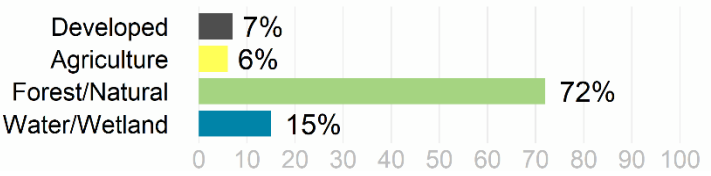
Segment Length (miles): 2.8

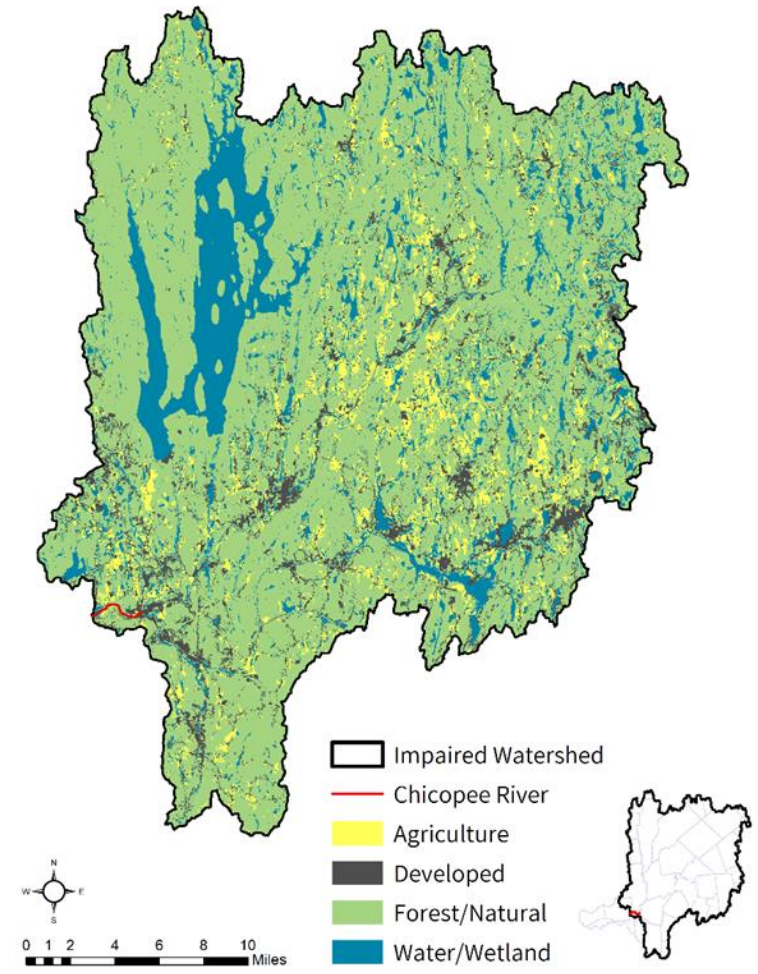
Impairment(s): *E. coli* (Primary Contact Recreation)

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

Impervious Area (Acres, %): 14,280 (3%)

DCIA Area (Acres, %): 4,743 (1%)





The Chicopee River (segment MA36-22) drains an area of 663 square miles (mi^2), of which 22 mi^2 (3%) is covered with impervious surfaces and 7 mi^2 (1%) is

considered directly connected impervious area (DCIA). In terms of land area, the watershed is partially[31] served by public sewer and 7% is subject to stormwater regulations under the National Pollutant Discharge Elimination System (NPDES) General MS4 Stormwater Permit (USEPA, 2020a). There are eight NPDES permits on file governing point source discharges of pollutants to surface waters within the watershed, one of which is within the immediate drainage area (Table 13-1); and two MassDEP discharge to groundwater permits for on-site wastewater discharges, none within the immediate drainage area. There are also no active combined sewer overflows (though the CSO qualifier is maintained for the entire Chicopee River), 36 landfills, and three unpermitted land disposal dumping grounds within the watershed. See Figure 13-1.

Table 13-1. NPDES permits for Wastewater Treatment Facilities (WWTF) in the segment watershed. Only permits unique to this segment watershed are shown. WWTFs are identified as either municipal (MUN) or other (OTH), if applicable.

NPDES ID	NAME	TOWN	WWTF
MA0101168	PALMER WPCF	PALMER	MUN

Most of Chicopee River segment MA36-22 flows through wide forest buffers. The upstream portion of the segment in the village of Three Rivers (Palmer) is low density residential and mixed commercial and industrial land uses. Downstream, the segment is near several large, mowed fields mapped as agricultural land use. The full segment watershed contains the large Quabbin Reservoir (23,931 acres), and there is only slightly more developed land (30,276 acres, 7%) than agricultural land (26,275 acres, 6%).

In the watershed of the Chicopee River (segment MA36-22), under the Natural Heritage and Endangered Species Program, there are 53,944 acres (13%) identified as Priority Habitats of Rare Species and 3,777 acres (1%) of Priority Natural Vegetation Communities. There are 195,707 acres (46%) under Public Water Supply protection but no Areas of Critical Environmental Concern or Outstanding Resource Waters identified in this watershed. Over 25,974 acres (6%) of land are protected in perpetuity[32] within the segment watershed, which is part of a total of 161,940 acres (38%) of Protected and Recreational Open Space[33]. See Figure 13-1.

[31] 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.

[32] Land protected in perpetuity include several interests such as conservation restriction, 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.

[33] 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 the State of Massachusetts).

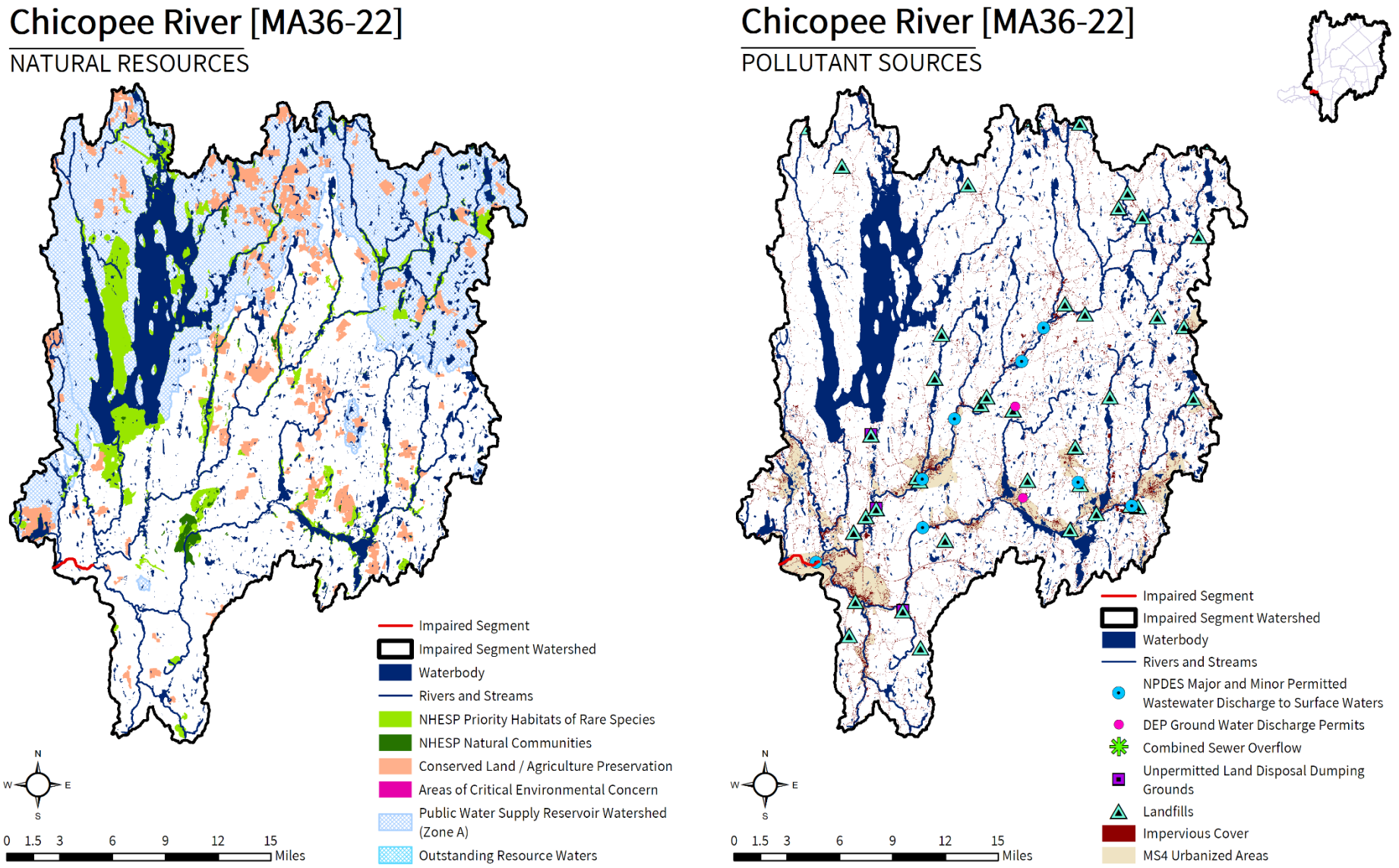


Figure 13-1. Natural resources and potential pollution sources draining to the Chicopee River segment MA36-22. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

13.2. Waterbody Impairment Characterization

The Chicopee River (segment MA36-22) is a Class B, Warm Water and CSO Receiving Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS at the station listed below (refer to Tables 13-2, 13-3; Figure 13-2), 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, 30-day rolling basis.

- In 2008, six samples were collected at W1033, 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 Statistical Threshold Value STV criterion was applied to single sample results. Out of six samples, two exceeded the STV criterion during both wet and dry weather.

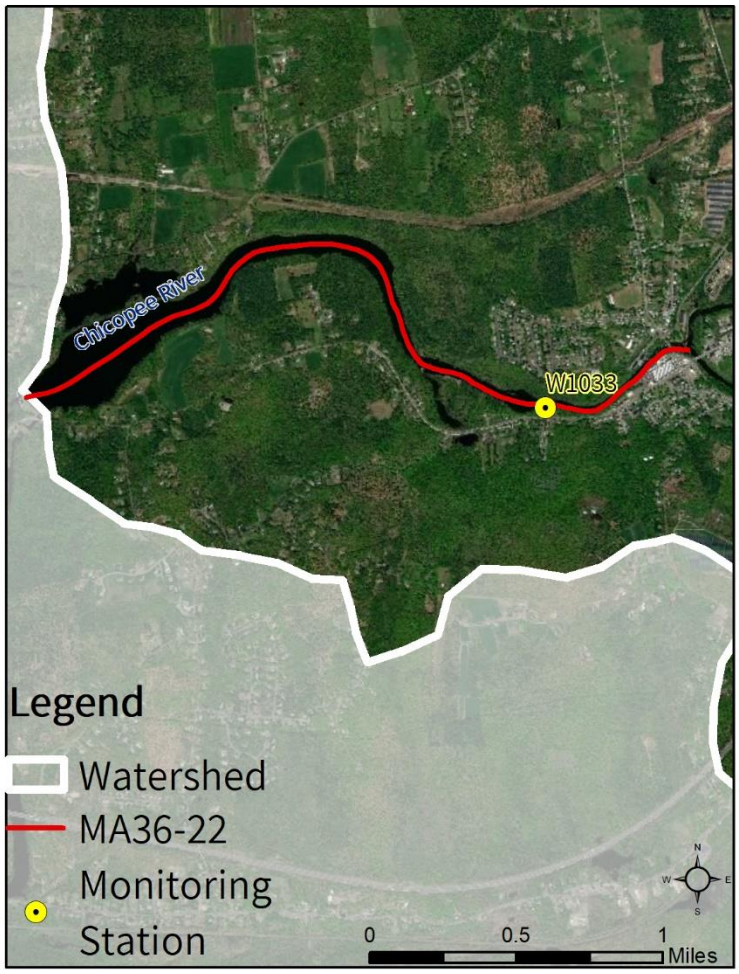


Figure 13-2. Location of monitoring station(s) along the impaired river segment.

Table 13-2. Summary of indicator bacteria sampling results by station for the Chicopee River (segment MA36-22). 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
W1033	5/20/2008	9/23/2008	6	900	4	2

Table 13-3. Indicator bacteria data by station, indicator, and date for the Chicopee River (segment MA36-22). 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 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 (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
W1033	*E. coli*	5/20/2008	DRY	58	58	
W1033	*E. coli*	6/17/2008	WET	200	108	
W1033	*E. coli*	7/9/2008	DRY	180	190	
W1033	*E. coli*	7/22/2008	WET	210	194	
W1033	*E. coli*	8/19/2008	WET	420	297	
W1033	*E. coli*	9/23/2008	DRY	900	900	

13.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which 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 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 the Chicopee River (segment MA36-22) were elevated during both wet and dry weather at sampling. Results exceeding the SWQS during wet weather are consistent with urban stormwater, pet waste, and wildlife pathogen sources. Certain types of septic system malfunctions, such as rainwater infiltration or saturated disposal fields which overflow during precipitation, may also result in elevated wet weather indicator bacteria levels. Elevated indicator bacteria levels during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens.

Each potential pathogen source relevant to the segment is described in further detail below.

Urban Stormwater: Portions of the Chicopee River (MA36-22) watershed are highly developed (including multiple town centers as the watershed covers roughly 6% of the state of MA), with 7% of the land identified as within MS4 area and 1% as DCIA. In the direct drainage area, development consists of low residential development and mixed commercial and industrial land uses. This Chicopee River segment is entirely within an MS4 area. Stormwater runoff from urban areas is likely a significant source of pathogens.

Illicit Sewage Discharges: With a portion of the land served by municipal sewer and some (7%) of the watershed designated as MS4 area, including the area surrounding the segment itself, 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), though none are within the direct drainage area. Since much of the residential development in the watershed uses on-site 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: Agricultural activities in the watershed account for 6% of the total land area, nearly as much as the developed areas (7%). Agricultural activities visible on recent aerial photos within the immediate drainage area include open fields and hayfields, some of which are adjacent to the segment. Agricultural activities related to manure storage and spreading, if not well managed, are possible sources of pathogens to waterbodies. Stormwater runoff from agricultural lands is a likely source of pathogens to the segment.

Pet Waste: There are several parks and ballfields within the direct drainage area to the segment. Conservation lands, parks, ballfields, and neighborhoods popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent possible sources of pathogens.

Wildlife Waste: Conservation and recreational lands with large open mowed areas and fields with a clear sightline to a waterbody may attract large congregations of 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 Ludlow

About half of Ludlow is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Ludlow (Permit ID #MAR041014) has an EPA approved Notice of Intent (NOI).The town has recently completed a Stormwater Management Program (SWMP) which is available at http://www.ludlow.ma.us/reports/dpw/stormwater/stormwater_mgmnt_plan-complete.pdf and on file at 198 Sportsmen Road, Ludlow (Town of Ludlow, 2020a). The town has mapped all of its stormwater outfall systems, and the map is included as Appendix H in the SWMP. Ludlow adopted illicit discharge detection and elimination (IDDE), erosion and sediment control (ESC), and post-construction stormwater regulations in 2006. According to the NOI, there are ten stormwater outfalls into the pathogen-impaired Chicopee River (segment MA36-24). The Department of Public Works web page, available at http://www.ludlow.ma.us/html/dpw/more.htm, provides links to: the town's Stormwater Management Plan; pollution prevention information for homeowners, businesses, industries, and during construction; and "Get Educated On Storm Water", including education on a variety of stormwater-specific topics (Town of Ludlow, 2020b).

Ludlow has the following ordinances and bylaws relevant to preventing, reducing or eliminating pathogenic pollution:

- Ludlow does not have supplementary regulations beyond the MassDEP regulations for stormwater management or wetland protection.
- Title 5 Supplementary Regulations: Nothing beyond State of Massachusetts Title 5 Regulations
- Stormwater Utility: No
- Pet Waste: No

The Ludlow Master Plan has a Natural Resources chapter with a section on watershed resources, mentioning the Chicopee River, the impaired segment within the town (PVPC, 2011). The plan notes that the two main areas of concern for Ludlow's water resources are the lack of adequate riparian buffers and that many areas surrounding surface waters are unprotected and threatened by development. The plan also has a limited wastewater section. The town is a member of the Connecticut River Stormwater Committee.

Town website: http://www.ludlow.ma.us/home.htm (Town of Ludlow 2020c)

Master Plan: http://ludlow.ma.us/masterplan/docs/master-plan/ludlow-mp-FINAL.pdf (PVPC, 2011)

Open Space and Recreation Plan: http://www.ludlow.ma.us/masterplan/docs/Ludlow%20Open%20Space%20Plan_FINAL.pdf (Town of Ludlow, 2006)

Town of Palmer. See Section 4.4

Town of Wilbraham

Most of Wilbraham is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Wilbraham (Permit ID #MAR041025) has an EPA approved Notice of Intent (NOI). Wilbraham has a Stormwater Management page https://www.wilbraham-ma.gov/494/Stormwater-Information(Town of Wilbraham, 2020a), and the Stormwater Management Plan is on file at the DPW Office, 240 Springfield Street, Wilbraham (Tighe & Bond, 2019). The town has mapped all of its MS4 stormwater systems. It adopted illicit discharge detection and elimination (IDDE), erosion and sediment control (ESC), and post-construction stormwater regulations in 2007. There are seven stormwater outfalls to the pathogen-impaired Chicopee River (segment MA36-24); five stormwater outfalls to the wetlands/tributaries to the same segment and one stormwater outfall to the wetlands/tributaries to the pathogen-impaired Chicopee River (segment MA36-22).

Wilbraham has the following ordinances and bylaws:

- Stormwater Management Plan: https://www.wilbraham-ma.gov/DocumentCenter/View/3196/Town-of-Wilbraham-Stormwater-Management-Plan_reduced (Tighe & Bond, 2019)
- Stormwater Phase II comprehensive bylaw https://www.wilbraham-ma.gov/DocumentCenter/View/190/Town-Bylaws?bidId= (Town of Wilbraham, 1996)
- Pet waste: Dog Bylaw (604.5) https://www.wilbraham-ma.gov/DocumentCenter/View/190/Town-Bylaws?bidId= (Town of Wilbraham, 1996)

The Town of Wilbraham's Master Plan has a Water Supply and Sanitary Sewerage section, Chapter 9. https://www.wilbraham-ma.gov/DocumentCenter/View/780/Master-Plan-1963?bidId= (TPA, 1963)

Wilbraham's Open Space and Recreation Plan: https://www.wilbraham-ma.gov/DocumentCenter/View/1534/OSRP-2014-2021?bidId= (Town of Wilbraham, 2014)

Wilbraham Water Division: https://www.wilbraham-ma.gov/194/Water (Town of Wilbraham, 2020b)

14. MA36-24 Chicopee River

14.1. Waterbody Overview

The Chicopee River segment MA36-24 is 8.8 miles long and begins at the Wilbraham Pumping Station (formerly the Wilbraham wastewater treatment plant) along the town boundary between Wilbraham and Ludlow, MA. The segment flows west to the Chicopee Falls Dam (NATID: MA00719) in Chicopee, MA.

Tributaries to Chicopee River segment MA36-24 include Minechoag Brook, pathogen-impaired Fuller Brook (MA36-41), pathogen-impaired unnamed tributary (also called Poor Brook) (MA36-39), Cooley Brook (MA36-38), and several other unnamed streams. Upstream pathogen-impaired segments include the Ware River segments MA36-05 and MA36-06, Prince River segment MA36-08, Sevenmile River segments MA36-11 and MA36-12, Quaboag River segments MA36-15, MA36-16, and MA36-17, Forget-Me-Not Brook segment MA36-18, Chicopee Brook segment MA36-21, Chicopee River segment MA36-22, and Danforth Brook segment MA36-50.

Key landmarks in the watershed are the Ludlow town center, the Westover Metro Airport-CEF, and the Chicopee Country Club and Golf Course. The Chicopee Memorial State Park, a state conservation area west of the Chicopee Reservoir, Lake Lorraine Conservation Area, Ludlow State Forest, Red Bridge State Park, Twelve Mile Brook Conservation Area, Delta Hills Conservation Area, and Thayer Brook Conservation Area are also located in the watershed. The segment is crossed by Center Street/MA-21 (Ludlow-Springfield), West Street (Ludlow-Springfield), and I-291 and Technology Drive (Chicopee).

The Chicopee River (segment MA36-24) drains an area of 714 square miles (mi^2), of which 31 mi^2 (4%) is covered with impervious surfaces and 13 mi^2 (2%) is considered directly connected impervious area (DCIA). In terms of land area, the watershed

Reduction from Highest Calculated Geomean: 21%

Watershed Area (Acres): 457,169

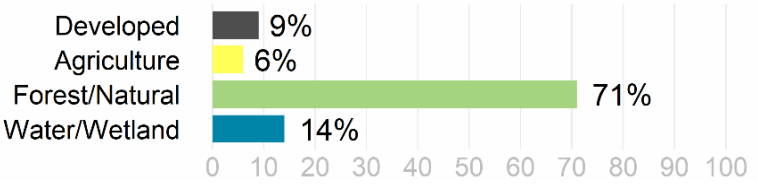
Segment Length (Miles): 8.8

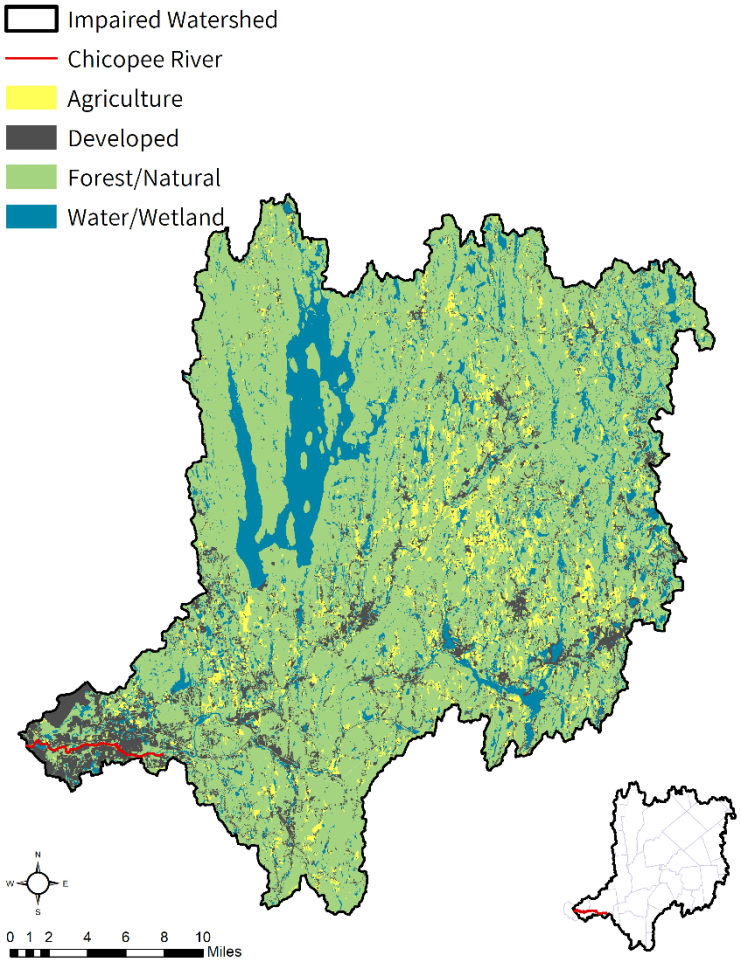
Impairment(s): *E. coli,* fecal coliform (Primary Contact Recreation)

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

Impervious Area (Acres, %): 19,644 (4%)

DCIA Area (Acres, %): 8,177 (2%)





is partially[34] served by public sewer, and 10% is subject to stormwater regulations under the National Pollutant Discharge Elimination System (NPDES) General MS4 Stormwater Permit (USEPA, 2020a). There are eight NPDES permits on file governing point source discharges of pollutants to surface waters within the full segment watershed, though none within the immediate drainage area. There is one NPDES Industrial Stormwater discharge permit in the segment watershed (Table 14-1). There are two MassDEP discharge to groundwater permits for on-site wastewater discharges within the watershed, none within the immediate drainage area. There are also five combined sewer overflows (all within the immediate drainage area, Table 14-2), 46 landfills, and three unpermitted land disposal dumping grounds within the watershed (Figure 14-1).

Table 14-1. National Pollutant Discharge Elimination System (NPDES) permit for Industrial Discharge in the segment watershed. Only permits unique to this segment watershed are shown.

NPDES ID	NAME	TOWN
MA0001147	SOLUTIA, INC.	SPRINGFIELD

Table 14-2 Combined Sewer Overflows (CSOs) discharging to the segment.

NPDES ID	NAME	TOWN	DEP OUTFALL ID
MA0101508	CHICOPEE WPC/CS	CHICOPEE	CHI37
MA0101613	SPRINGFIELD CSO	SPRINGFIELD	SPR034
MA0101613	SPRINGFIELD CSO	SPRINGFIELD	SPR035
MA0101613	SPRINGFIELD CSO	SPRINGFIELD	SPR036A
MA0101613	SPRINGFIELD CSO	SPRINGFIELD	SPR037

Although this river segment has several lengths of wooded buffer along its reach and only 9% of the overall watershed is developed, the lands surrounding the segment (MA36-24) are predominantly medium to high density mixed residential and commercial development in MS4-designated areas that are the most densely developed areas within the watershed.

In the watershed of the Chicopee River (segment MA36-24), under the Natural Heritage and Endangered Species Program, there are 59,673 acres (13%) identified as Priority Habitats of Rare Species and 3,882 acres (1%) of Priority Natural Vegetation Communities. There are 195,720 acres (43%) under Public Water Supply protection but no Areas of Critical Environmental Concern or Outstanding Resource Waters identified in this watershed. Over 26,393 acres (6%) of land are protected in perpetuity[35] within the segment watershed, which is part of a total of 165,949 acres (36%) of Protected and Recreational Open Space[36]. See Figure 14-1.

[34] 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.

[35] Land protected in perpetuity include several interests such as conservation restriction, 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.

[36] 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 the State of Massachusetts).

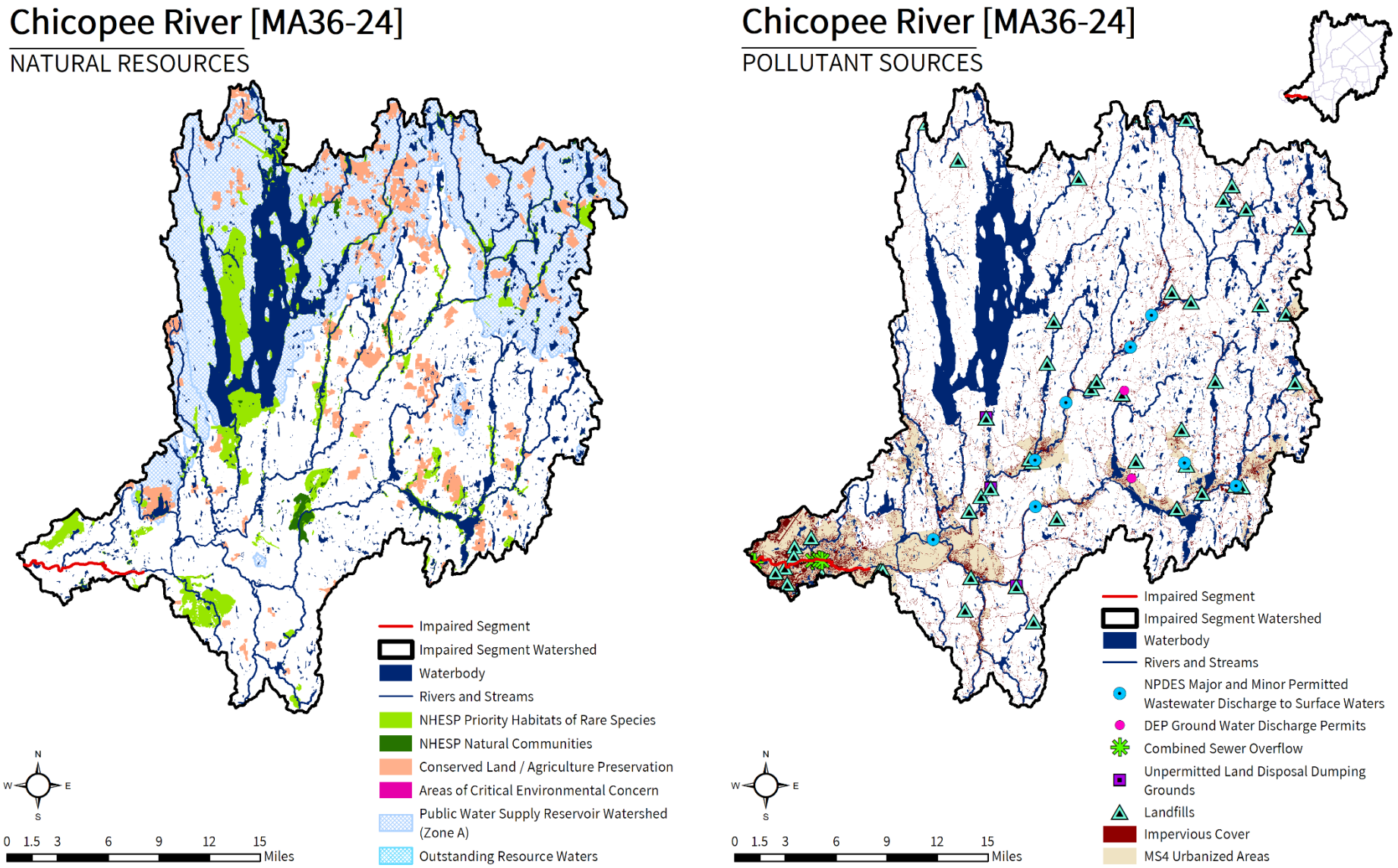


Figure 14-1. Natural resources and potential pollution sources draining to the Chicopee River segment MA36-24. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

14.2. Waterbody Impairment Characterization

The Chicopee River (segment MA36-24) is a Class B, Warm Water and CSO Receiving Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS at the station listed below (refer to Tables 14-3, 14-4; Figure 14-2), 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, 30-day rolling basis.

- In 2008, six samples were collected at W1031, 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 Statistical Threshold Value (STV) criterion was applied to single sample results. Out of six samples, one exceeded the STV criterion during wet weather.

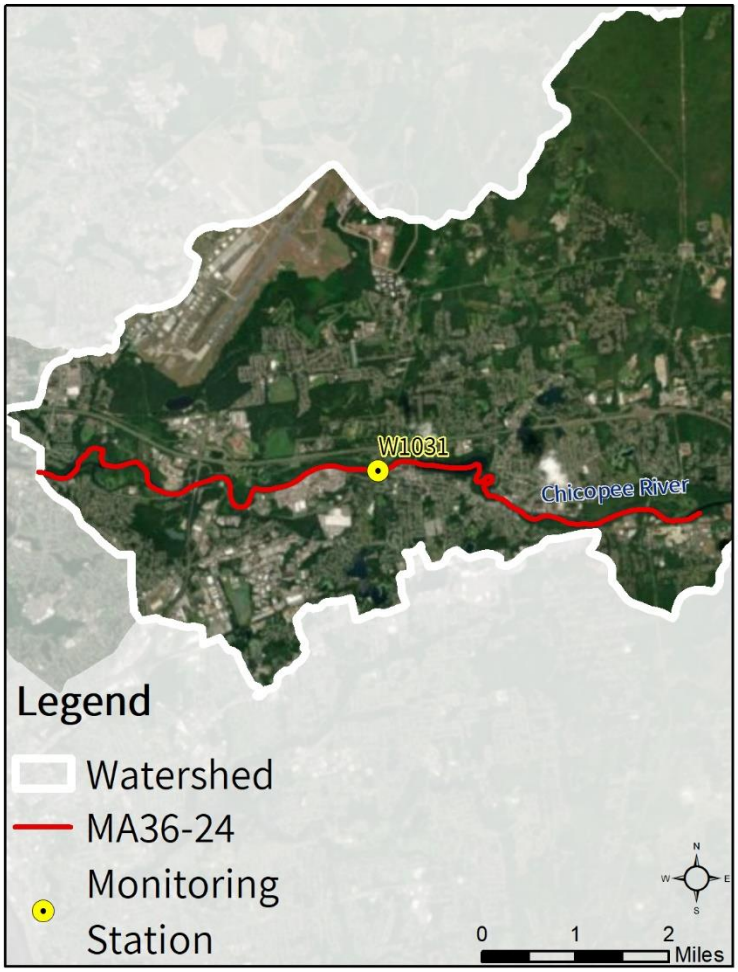


Figure 14-2. Location of monitoring station(s) along the impaired river segment.

Table 14-3. Summary of indicator bacteria sampling results by station for the Chicopee River (segment MA36-24). 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
W1031	5/20/2008	9/23/2008	6	160	2	1

Table 14-4. Indicator bacteria data by station, indicator, and date for the Chicopee River (segment MA36-24). 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 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 (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
W1031	*E. coli*	5/20/2008	DRY	32	32	
W1031	*E. coli*	6/17/2008	WET	510	128	
W1031	*E. coli*	7/9/2008	DRY	50	160	
W1031	*E. coli*	7/22/2008	WET	130	81	
W1031	*E. coli*	8/19/2008	DRY	90	108	
W1031	*E. coli*	9/23/2008	DRY	40	40	

14.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which 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 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).

The indicator bacteria data for the Chicopee River (segment MA36-24) were elevated during wet weather. This suggests urban stormwater, pet waste, and wildlife pathogen sources are likely to be major sources of pathogens. 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 relevant to the segment is described in further detail below.

Combined Sewer Overflow (CSO): There are five CSOs in the direct drainage area to this segment which, by design, release untreated wastewater to surface waters when storm plus sewage flows exceed system capacity. For this reason, CSOs are the highest priority pathogen source, and must be eliminated.

Urban Stormwater: Portions of the Chicopee River (segment MA36-24) watershed are highly developed (including multiple town centers, as the watershed covers roughly 7% of the geographic area of the state of MA), with 10% of the land area in designated MS4 areas and 2% as DCIA. The direct drainage area around the segment contains the highest density urban development in the overall watershed, with mixed residential and commercial land uses in Ludlow, Chicopee, and Springfield. Stormwater runoff from urban areas is likely a significant source of pathogens.

Illicit Sewage Discharges: With a portion of the land area served by municipal sewer systems, some (10%) of the watershed designated as MS4 area, and a dense urban landscape surrounding much of the segment, leaky sewer lines and illicit connections to storm drains are likely sources of pathogens. 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), though none within the direct drainage area. Much of the residential development in the watershed uses on-site septic systems for wastewater treatment. It is likely that a portion of such systems are not properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Agricultural activities in the watershed account for 6% of the total land area. There are few agricultural areas within the direct drainage area to the impaired segment. Agricultural fields and pasturelands near the headwaters and tributaries to the segment can be a source of pathogens. Agricultural activities related to manure storage and spreading, if not well managed, are possible sources of pathogens to waterbodies. Stormwater runoff from agricultural lands are likely a source of pathogens to the impaired segment.

Pet Waste: There are several parks and ballfields within the direct drainage area to the segment. Conservation lands, parks, ballfields, and residential neighborhoods popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent possible sources of pathogens.

Wildlife Waste: There are conservation and recreational lands, large wetlands, and other open mowed areas with a clear sightline to a waterbody throughout the watershed, including Ludlow Country Cub golf course along the impaired segment. These open areas with a water view may attract large congregations of 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.

City of Chicopee

The entire land area within the City of Chicopee is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit. Chicopee (Permit ID #MAR041003) has an EPA approved Notice of Intent (NOI). Chicopee has a Stormwater Management Plan available at https://ecode360.com/6480440 (City of Chicopee, 2019). The town has mapped all of its MS4 stormwater system, available by request from the City Engineer, (City of Chicopee, 2020). It adopted illicit discharge detection and elimination (IDDE), erosion and sediment control (ESC), and post-construction stormwater regulations in 2003. According to the NOI, there are two outfalls to the pathogen-impaired tributary Fuller Brook segment MA36-41 (including a wetland/tributary). There are 16 outfalls into the pathogen-impaired Chicopee River segment MA36-24. There are 69 outfalls into the pathogen-impaired Chicopee River segment MA36-25 (including wetlands/tributaries), 46 outfalls into the pathogen-impaired Connecticut River segment MA34-05 (including wetlands/tributaries), one outfall into pathogen-impaired Stony Brook MA34-19, and two outfalls into the pathogen-impaired unnamed tributary or Poor Brook segment MA36-39.

Chicopee has the following ordinances and bylaws:

- Stormwater Management Ordinance: https://ecode360.com/6480440 (City of Chicopee, 2019)
- Wetlands Protection Ordinance: https://www.chicopeema.gov/DocumentCenter/View/784/Conservation-Commission-Local-Wetland-Regulations-PDF (City of Chicopee, 2010)
- Stormwater Utility: https://www.chicopeema.gov/DocumentCenter/View/8156/Storm-Fee-and-Sewer-Use-Fee-Rate-Schedule (City of Chicopee, 2017)
- Title 5 Supplementary Regulations: No
- Pet Waste: No
- Contact Recreation Regulations or Bylaws: No

Chicopee's Master Plan is currently in development (2019). The Chicopee Open Space and Recreation Plan has a water resources section in the Environmental Inventory and Analysis section. The plan notes that "In 1999, Chicopee was the first community in Massachusetts to adopt a user fee for stormwater management." The plan

also details the town's stormwater system and participation in the NPDES program. Information on the town's sewer service can be found in the Community Setting section of the plan.

Open and Space/Recreation Plan: https://www.chicopeema.gov/DocumentCenter/View/3018/Chicopee2015OSRP?bidId= (City of Chicopee, 2015)

Town of Ludlow. See Section 13.4

Town of Wilbraham. See Section 13.4

15. MA36-25 Chicopee River

15.1. Waterbody Overview

The Chicopee River segment MA36-25 is three miles long and begins at the Chicopee Falls Dam (NATID: MA00719) in Chicopee, MA. Segment MA36-25 flows west and ends at its confluence with the Connecticut River in Chicopee, MA. This is the most downstream segment of the Chicopee River.

Tributaries to this Chicopee River segment include pathogen-impaired Abbey Brook (segment MA36-40, comprising Bemis Pond), Hearthstone Quarry Brook, Crowfoots Brook, and several smaller unnamed streams. Upstream pathogen-impaired segments include the Ware River segments MA36-05 and MA36-06, Prince River segment MA36-08, Sevenmile River segments MA36-11 and MA36-12, Quaboag River segments MA36-15, MA36-16, and MA36-17, Forget-Me-Not Brook segment MA36-18, Chicopee Brook segment MA36-21, Chicopee River segment MA36-22, and Danforth Brook segment MA36-50. Major lakes and ponds within the watershed include the Quabbin Reservoir and many smaller waterbodies.

Key landmarks in the watershed include the urban centers of Chicopee and Chicopee Falls, the junction of I-90 and I-391, and 11 urban parks and playgrounds. The segment is crossed by Deady Memorial Bridge/Bridge Street/MA-141, Davitt Memorial Bridge/Springfield Street/MA-116, I-391, and the Connecticut River Main Line railroad, all in Chicopee, MA. The river encounters the Dwight Dam just upstream of Spring Street.

Chicopee River segment MA36-25 drains an area of 723 square miles (mi^2), of which 34 mi^2 (5%) is covered with impervious surfaces and 15 mi^2 (2%) is considered directly connected impervious area (DCIA). The watershed of this segment comprises the entire Chicopee River watershed. In terms of

Reduction from Highest Calculated Geomean: 82%

Watershed Area (Acres): 462,582

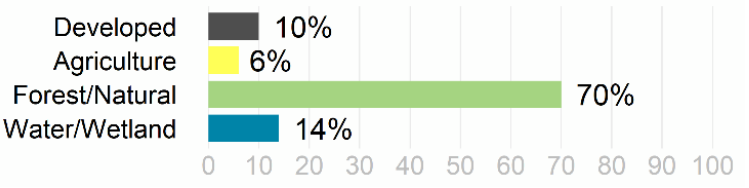
Segment Length (miles): 3.0

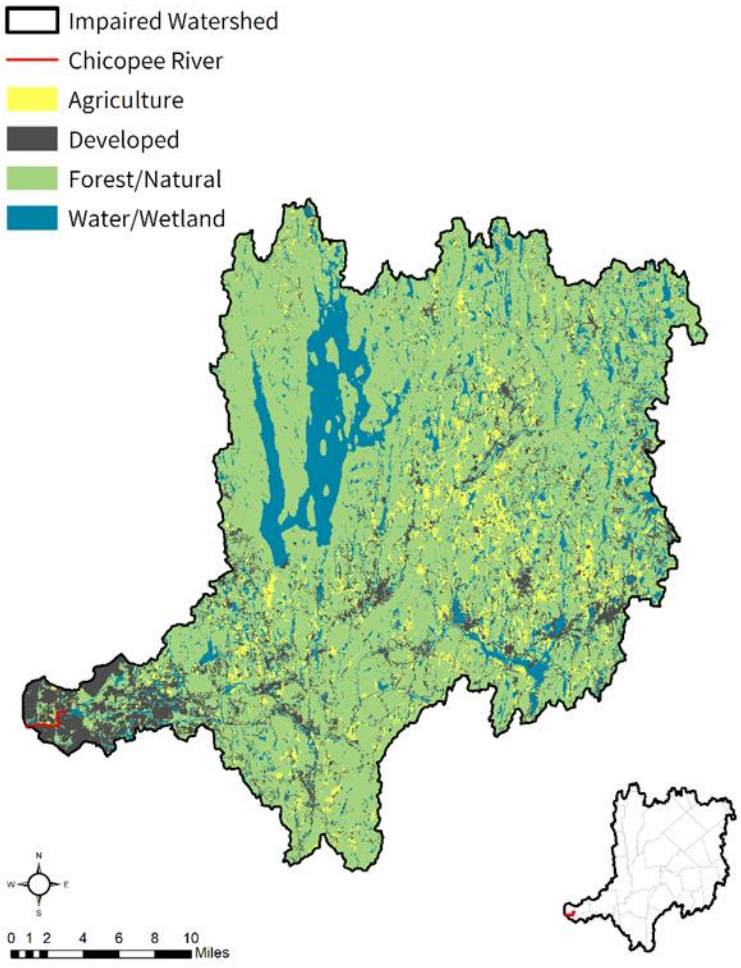
Impairment(s): *E. coli* (Primary Contact Recreation)

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

Impervious Area (Acres, %): 21,743 (5%)

DCIA Area (Acres, %): 9,838 (2%)





land area, the watershed is partially[37] served by public sewer, and 12% is subject to stormwater regulations under the National Pollutant Discharge Elimination System (NPDES) General MS4 Stormwater Permit (USEPA, 2020a). There are eight NPDES permits governing point source discharges of pollutants to surface waters within the Chicopee River watershed, though none within the immediate drainage area. There are two MassDEP discharge to groundwater permits for on-site wastewater discharge within the watershed, though none within the immediate drainage area. There are also six combined sewer overflows, 47 landfills, and three unpermitted land disposal dumping grounds within the segment watershed (Figure 15-1).

Table 15-1. Combined Sewer Overflows (CSOs) discharging to the segment.

NPDES ID	NAME	TOWN	DEP OUTFALL ID
MA0101508	CHICOPEE WPC/CS	CHICOPEE	CHI26
MA0101508	CHICOPEE WPC/CS	CHICOPEE	CHI27
MA0101508	CHICOPEE WPC/CS	CHICOPEE	CHI32A
MA0101508	CHICOPEE WPC/CS	CHICOPEE	CHI32B
MA0101508	CHICOPEE WPC/CS	CHICOPEE	CHI34
MA0101508	CHICOPEE WPC/CS	CHICOPEE	CHI40

This Chicopee River segment flows through a heavily urbanized landscape, with high density mixed residential, commercial, and industrial land uses, plus rail and interstate highway corridors. Nearly one mile of the left bank downstream of the MA-141 bridge is armored with riprap and, in places, a cement wall. Additional stream bank armoring occurs in the areas around the MA-116 and I-391 bridges, where repurposed mill buildings and associated parking lots are immediately adjacent to the river. Most other areas along the river segment have between five and 50 meters of wooded buffers.

In the watershed of the Chicopee River (segment MA36-25), under the Natural Heritage and Endangered Species Program, there are 59,682 acres (13%) of identified as Priority Habitats of Rare Species and 3,882 acres (1%) of Priority Natural Vegetation Communities. There are 195,720 acres (42%) under Public Water Supply protection, but no Areas of Critical Environmental Concern or Outstanding Resource Waters identified in this watershed. Over 26,393 acres (6%) of land are protected in perpetuity[38] within the segment watershed, which is part of a total of 166,318 acres (36%) of Protected and Recreational Open Space[39]. See Figure 15-1.

[37] 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.

[38] Land protected in perpetuity include several interests such as conservation restriction, 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.

[39] 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 the State of Massachusetts).

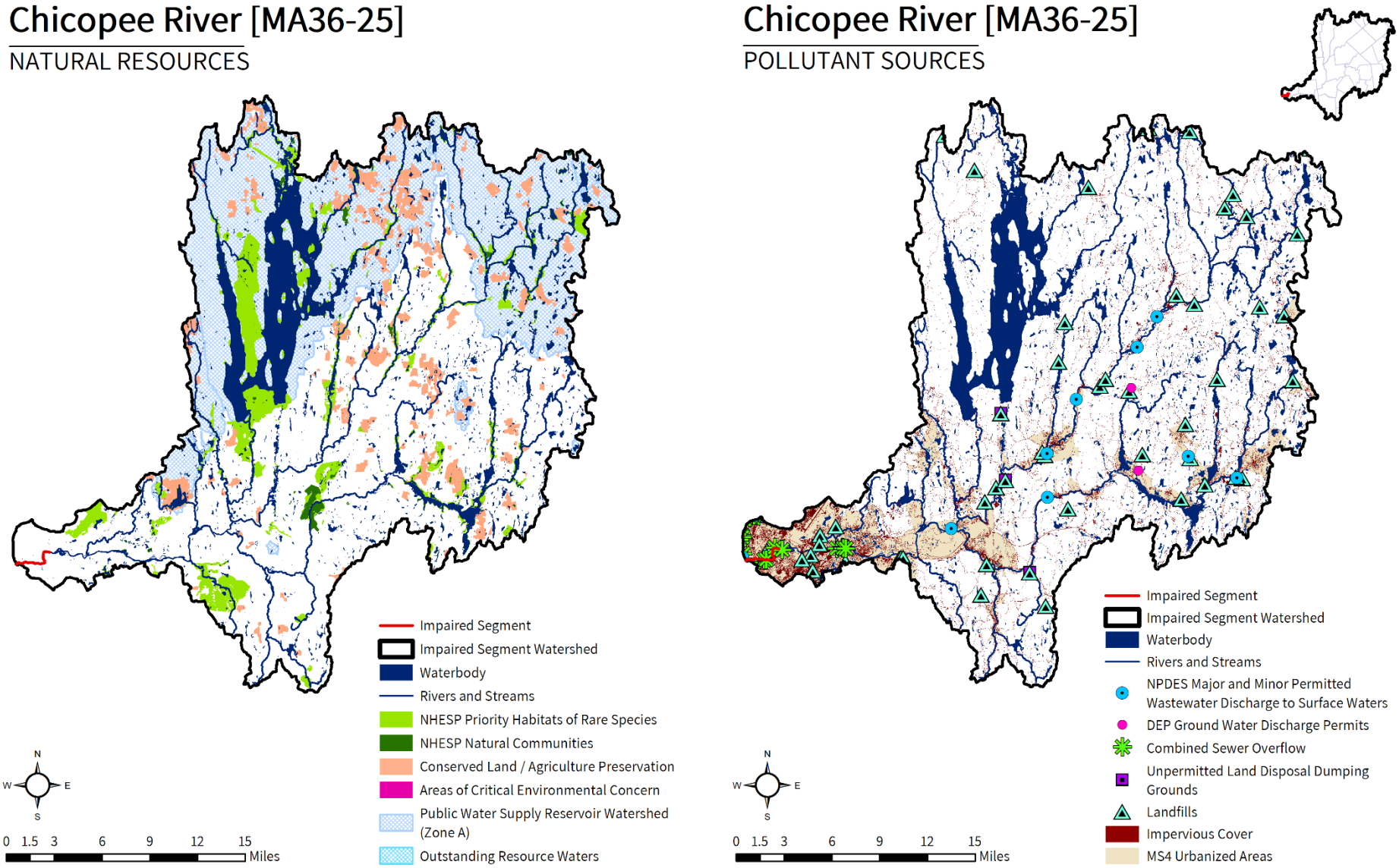


Figure 15-1. Natural resources and potential pollution sources draining to the Chicopee River segment MA36-25. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

15.2. Waterbody Impairment Characterization

The Chicopee River segment MA36-25 is a Class B, Warm Water and CSO Receiving Water (MassDEP, 2021).

- The Primary Contact Recreation use was assessed for attainment of SWQS at the stations listed below (refer to Tables 15-2, 15-3; Figure 15-2) 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, 30-day rolling basis. In 2008, six samples were collected at W0475, 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 Statistical Threshold Value (STV) criterion was applied to single sample results. Out of six samples, two exceeded the STV criterion during wet and dry weather.
- In 2008, five samples were collected at W2055, 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, two exceeded the STV criterion during wet and dry weather.
- In 2008, six samples were collected at W2056, 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 six samples, three exceeded the STV criterion during wet and dry weather.

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

Table 15-2. Summary of indicator bacteria sampling results by station for the Chicopee River (segment MA36-25). 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 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
W0475	5/20/2008	9/23/2008	6	355	4	2
W2055	5/20/2008	9/23/2008	5	443	3	2
W2056	5/20/2008	9/23/2008	6	693	4	3

Table 15-3. Indicator bacteria data by station, indicator, and date for the Chicopee River (MA36-25). 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 highlights criteria exceedances of 410 CFU/100 mL (applied to single-sample "Result" since there were no more than 10 samples in a year to calculate the STV) and 126 CFU/100 mL (applied to rolling 30-day geomean) for *E. coli* indicator bacteria.

Unique Station ID	Indicator	Date	Wet/Dry	Result (CFU/100mL)	30-Day Rolling Geomean (CFU/100mL)	30-Day Rolling STV (CFU/100mL)
W0475	*E. coli*	5/20/2008	DRY	40	40	
W0475	*E. coli*	6/17/2008	WET	760	174	
W0475	*E. coli*	7/9/2008	DRY	120	302	
W0475	*E. coli*	7/22/2008	WET	210	159	
W0475	*E. coli*	8/19/2008	DRY	600	355	
W0475	*E. coli*	9/23/2008	DRY	50	50	
W2055	*E. coli*	5/20/2008	DRY	30	30	
W2055	*E. coli*	6/17/2008	WET	770	152	
W2055	*E. coli*	7/22/2008	WET	280	280	
W2055	*E. coli*	8/19/2008	DRY	700	443	
W2055	*E. coli*	9/23/2008	DRY	90	90	
W2056	*E. coli*	5/20/2008	DRY	18	18	
W2056	*E. coli*	6/17/2008	WET	890	127	
W2056	*E. coli*	7/9/2008	DRY	140	353	
W2056	*E. coli*	7/22/2008	WET	600	290	
W2056	*E. coli*	8/19/2008	DRY	800	693	
W2056	*E. coli*	9/23/2008	DRY	40	40	

15.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which 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 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).

The indicator bacteria data for the Chicopee River (MA36-25) were elevated during both wet and dry weather. Elevated indicator bacteria counts during wet weather 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. Elevated indicator bacteria counts during dry weather suggest that baseflow sources, such as leaking pipes, illegal cross connections, other illicit discharges, and failing septic systems, are likely to be major sources of pathogens.

Each potential pathogen source relevant to the segment is described in further detail below.

Combined Sewer Overflow (CSO): There are six CSOs in the direct drainage area to the segment and five more within the watershed immediately upstream which, by design, release untreated wastewater to surface

waters when storm plus sewage flows exceed system capacity. For this reason, CSOs are the highest priority pathogen source, and must be eliminated.

Urban Stormwater: Portions of the Chicopee River (segment MA36-25) watershed are highly developed, including multiple town centers, as the watershed covers roughly 7% of the geographic area of the state of MA, and 12% of the land area is MS4 and 2% is DCIA. In the direct drainage area, development consists of primarily high density mixed residential and commercial development, including many expansive parking lots adjacent to the river. There are also two interstate highway corridors near the impaired segment. Stormwater runoff from urban areas is likely a significant source of pathogens.

Illicit Sewage Discharges: With almost all the direct drainage area served by municipal sewer systems, leaky sewer lines and illicit connections to storm drains are also possible pathogen 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 discharges, which are large-capacity septic systems (non-residential), though none are within the direct drainage area. Much of the residential development in the watershed uses on-site septic systems for wastewater treatment. It is likely that a portion of the upstream septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: Agricultural activities are not prevalent within the direct drainage area of the segment due to the urban character of the landscape surrounding the segment. Agricultural fields and pasturelands near the headwaters and upstream tributaries can transport be a source of pathogens to the segment. Agricultural activities related to manure storage and spreading, if not well managed, are also possible sources of pathogens to waterbodies. Stormwater runoff from agricultural lands are likely a contributing source of pathogens to the segment.

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

Wildlife Waste: Conservation and recreational lands with large open mowed areas, fields, and wetlands with a clear sightline to a waterbody, such as those surrounding the armored riverbanks, may attract large congregations of 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.

City of Chicopee. See Section 14.4

16. MA36-39 Unnamed Tributary

16.1. Waterbody Overview

The Unnamed Tributary segment MA36-39 (also known as “Poor Brook”) is 2.2 miles long and begins near the Berkshire Subdivision/Conrail railroad in Springfield, MA, then flows northwest to end at its confluence with the Chicopee River in Chicopee, MA.

This segment has no tributaries. Key landmarks in the watershed include the East Springfield neighborhood, and the Delta Hills and Peter Carando Conservation Areas. The impaired Poor Brook segment begins just downstream of the Berkshire Subdivision railroad, then flows approximately 0.6 miles before entering a 0.1 mile-long culvert under Industry Avenue, a parking lot, and Cottage Street. The stream then daylights and is crossed by the Athol Industrial Track railroad, then flows under multiple ramps and roadways of the I-291/US-20 junction in Springfield. The brook then flows through a large, wooded area before crossing under MA-141 in Chicopee, just upstream from the confluence with the Chicopee River.

The unnamed tributary (MA36-39) drains an area of 1.7 square miles (mi^2), of which 0.7 mi^2 (43%) is covered with impervious surfaces and 0.6 mi^2 (35%) is considered directly connected impervious area (DCIA). In terms of land area, the

Reduction from Highest Calculated Geomean: 17%

Watershed Area (Acres): 1,074

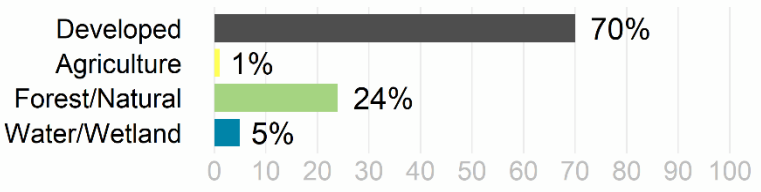
Segment Length (miles): 2.2

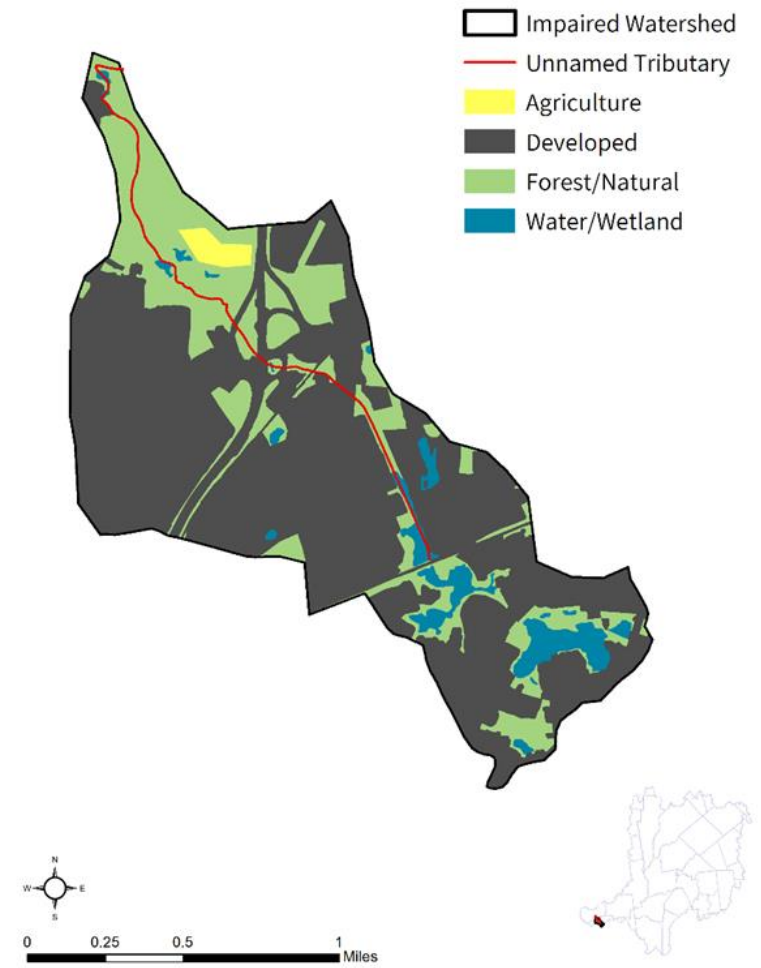
Impairment(s): *E. coli* (Primary Contact Recreation)

Class (Qualifiers): B

Impervious Area (Acres, %): 466 (43%)

DCIA Area (Acres, %): 375 (35%)





watershed is mostly[40] served by public sewer and the entire watershed is subject to stormwater regulations under the National Pollutant Discharge Elimination System (NPDES) General MS4 Stormwater Permit (USEPA, 2020a). There are no NPDES permits governing point source discharges of pollutants to surface waters, combined sewer overflows (CSOs), or MassDEP discharge to groundwater permits for on-site wastewater discharges within this watershed. There are two landfills, and no known unpermitted land disposal dumping grounds within the segment watershed.

The upstream half of the segment flows through large parcels with office, industrial, and transportation logistics development with expansive parking lots on the left bank; and a large ground-mounted solar installation on the right bank (Peter Carando Conservation Area). The stream channel in this area appears to have been straightened. Developed lands (754 acres) account for 70% of the parcels within the segment watershed, far surpassing the amount of forested and natural land (258 acres, 24%). There is a small area mapped as within agricultural land use, but recent aerial photos show a ground-mounted solar installation covering the entire area.

In the watershed of the unnamed tributary (segment MA36-39), under the Natural Heritage and Endangered Species Program, there are 20 acres (2%) identified as Priority Natural Vegetation Communities. There are no Areas of Critical Environmental Concern, areas under Public Water Supply protection, or Outstanding Resource Waters. There are no areas of land protected in perpetuity[41] within the segment watershed, which would otherwise be part of the total of 64 acres (6%) of Protected and Recreational Open Space[42]. See Figure 16-1.

[40] 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.

[41] Land protected in perpetuity include several interests such as conservation restriction, 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.

[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 the State of Massachusetts).

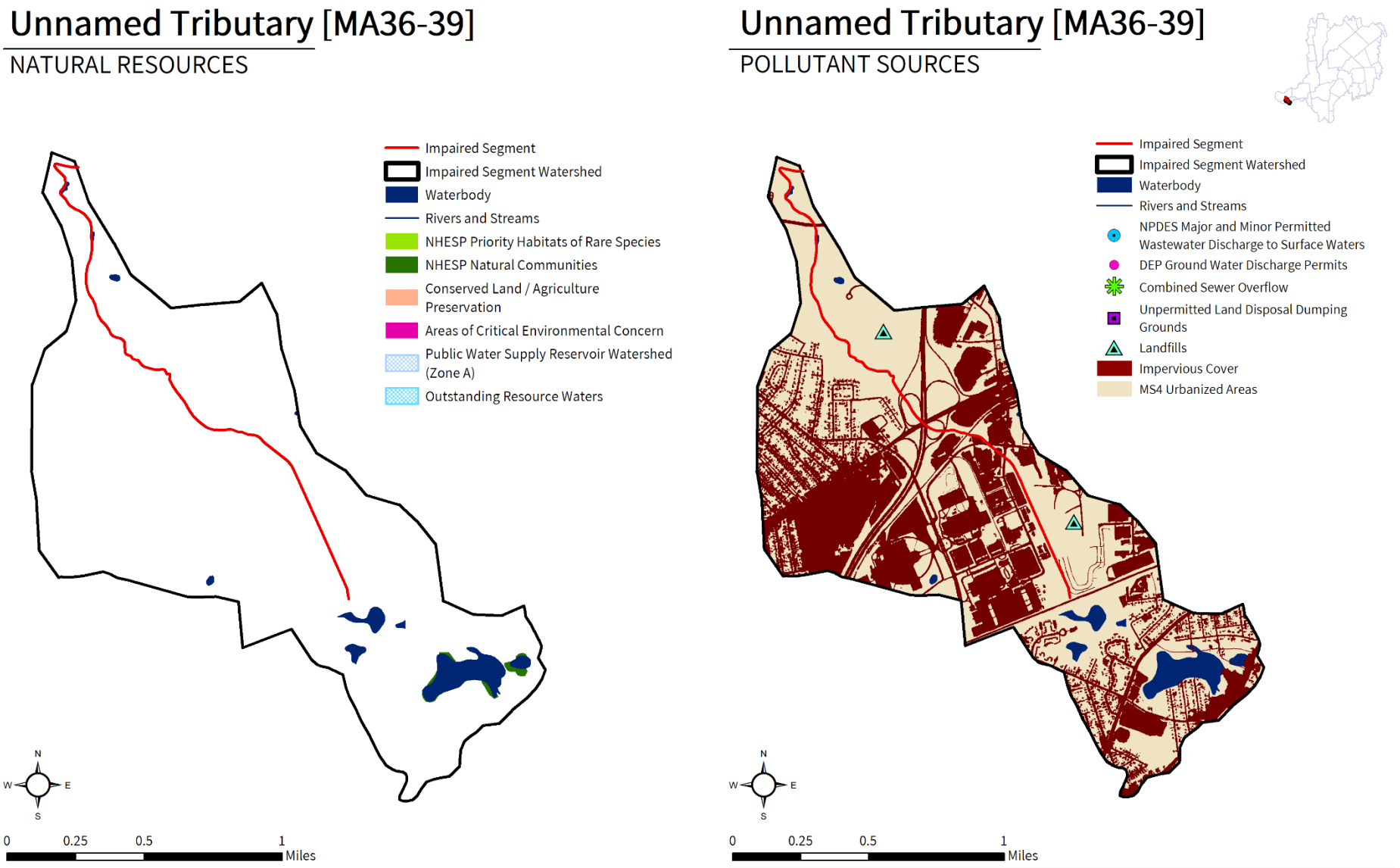


Figure 16-1. Natural resources and potential pollution sources draining to the unnamed tributary segment MA36-39. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

16.2. Waterbody Impairment Characterization

The unnamed tributary (MA36-39) is a Class B Water (MassDEP, 2021).

The Primary Contact Recreation use was assessed for attainment of SWQS at the station listed below (refer to Tables 16-1, 16-2; Figure 16-2) 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 2008, six samples were collected at W1865, 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 Statistical Threshold Value (STV) criterion was applied to single sample results. Out of six samples, none exceeded the STV criterion.

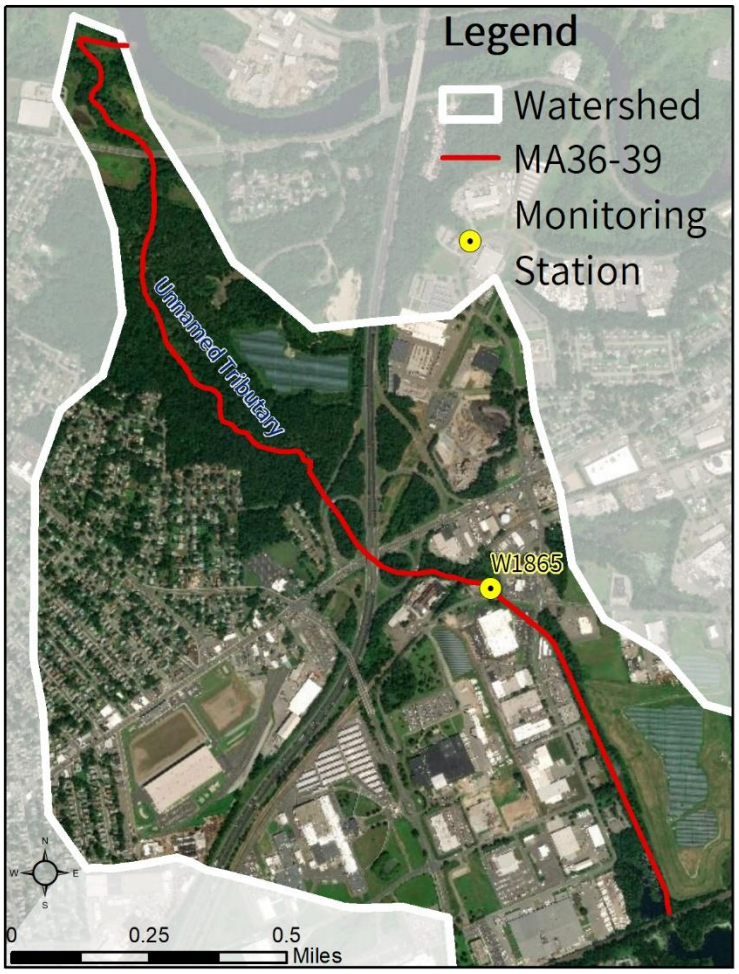


Figure 16-2. Location of monitoring station(s) along the impaired river segment.

Table 16-1. Summary of indicator bacteria sampling results by station for the unnamed tributary (segment MA36-39). The maximum 90-day rolling geometric mean (geomean), the number of days exceeding the geomean criterion of 126 CFU/100 mL for *E. coli* indicator bacteria, and the number of single samples exceeding the STV criterion of 410 CFU/100 mL for *E. coli* indicator bacteria are shown. The STV criterion is applied to the single sample results if less than 10 samples were collected within a calendar year at a site. The highest maximum 90-day rolling geomean of the sites is used to calculate the percent load reduction required to meet SWQS.

Unique Station ID	First Sample	Last Sample	Count	Maximum 90-Day Rolling Geomean (CFU/100mL)	Number Geomean Exceedances	Number STV Exceedances
W1865	5/20/2008	9/23/2008	6	152	5	0

Table 16-2. Indicator bacteria data by station, indicator, and date for the unnamed tributary (MA36-39). 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 highlights criteria exceedances of 410 CFU/100 mL (applied to single-sample "Result" since there were no more than 10 samples in a year to calculate the STV) and 126 CFU/100 mL (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)
W1865	*E. coli*	5/20/2008	DRY	96	96	
W1865	*E. coli*	6/17/2008	WET	200	139	
W1865	*E. coli*	7/9/2008	DRY	120	132	
W1865	*E. coli*	7/22/2008	WET	110	126	
W1865	*E. coli*	8/19/2008	DRY	200	152	
W1865	*E. coli*	9/23/2008	DRY	120	133	

16.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which 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 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).

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 the sources of pollutants.

Each potential pathogen source relevant to this segment is described in further detail below.

Urban Stormwater: Most of the watershed is highly developed, with all land area in MS4 and 35% as DCIA. Development within the watershed consists of large industrial, commercial, and transportation infrastructure, plus high-density residential neighborhoods. Additionally, the City of Springfield lists 29 stormwater outfalls to the segment in their MS4 General Permit reports. Stormwater runoff from urban areas is likely a significant source of pathogens.

Illicit Sewage Discharges: With the entire watershed likely served by municipal sewer systems and 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: Some of the residential development in the watershed may use septic systems for wastewater treatment. It is likely that a portion of on-site septic systems are not being properly maintained and are discharging untreated effluent to groundwater.

Agriculture: There is only one small area mapped as agricultural land use within the watershed, which now according to recent aerial photos appears to be a ground-mounted solar installation. Agricultural pollutant sources are likely not a significant source of pathogens to this segment.

Pet Waste: There are high-density residential neighborhoods in the watershed. Any areas with dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent possible sources of pathogens.

Wildlife Waste: Most of the segment has at least a thin wooded buffer; however, there are large and open wetlands in the downstream portion of the watershed. Any large open areas with a clear sightline to a waterbody may attract large congregations of 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.

City of Chicopee. See Section 14.4

City of Springfield

All of Springfield is subject to stormwater regulations under the NPDES General MS4 Stormwater Permit (Permit ID #MAR041023) and has an EPA-approved Notice of Intent (NOI). Springfield has a Stormwater Management Plan on file at 70 Tapley Street, Department of Public Works and has mapped all of its MS4 stormwater system. It adopted illicit discharge detection and elimination (IDDE), erosion and sediment control (ESC), and post-construction stormwater regulations on September 9, 2013. Springfield reports 13 outfalls to the pathogen-impaired Connecticut River segment MA34-05, eight stormwater outfalls to the pathogen-impaired Mill River segment MA34-29, 22 outfalls to the pathogen-impaired Chicopee River segment MA36-24, and 29 outfalls to the pathogen-impaired Poor Brook segment MA36-39 (“unnamed tributary”).

Springfield has the following ordinances and bylaws:

- Stormwater Regulations: https://ecode360.com/32304263 (City of Springfield, 2013)
- Title 5 Supplemental Regulations: Article III Building Sewers and Separate Sewers https://ecode360.com/14666151?highlight=sewer&searchId=6051534394334268#14666151 (City of Springfield, 2019)
- Wetland Bylaws: Chapter 417 https://ecode360.com/14667728 (City of Springfield, 1993)
- Pet Waste: Section 110-11 Animal Waste https://ecode360.com/32320250 (City of Springfield, 2016)

A Master Plan for Springfield was not found online.

Springfield’s Open Space and Recreation Plan is at: https://www.springfield-ma.gov/planning/fileadmin/Planning_files/Open_Space_Plan/OpenSpace_FINAL_2015.pdf (City of Springfield, 2015).

17. MA36-40 Abbey Brook

17.1. Waterbody Overview

Abbey Brook segment MA36-40 is 1.5 miles long and begins approximately 0.4 miles west of the intersection of Saint James Avenue and Carew Street in Springfield, MA. Segment MA36-40 flows east until Liberty Street, then north through Bemis Pond (formerly segment MA36011). Segment MA36-40 ends at its confluence with the pathogen-impaired Chicopee River (segment MA36-25), in Chicopee, MA.

Abbey Brook has no tributaries. Landmarks in the watershed include Szot Park and ballfields, the Marshall Roy Park, Fairview Cemetery, and the Springfield Plaza. Road crossings along Abbey Brook (segment MA36-40) include Liberty Street (Springfield), Abbey Memorial Drive upstream of Bemis Pond (Chicopee), and Front Street near the Chicopee Parks and Recreation Department (Chicopee).

The Chicopee River (segment MA36-40) drains an area of 1.3 square miles (mi^2), of which 0.54 mi^2 (41%) is covered with impervious surfaces and 0.46 mi^2 (35%) is considered directly connected impervious area (DCIA). In terms of land area, the

Reduction from Highest Calculated Geomean: *NA*

Watershed Area (Acres): 843

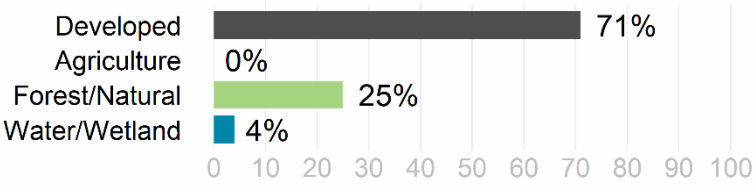
Segment Length (Miles): 1.5

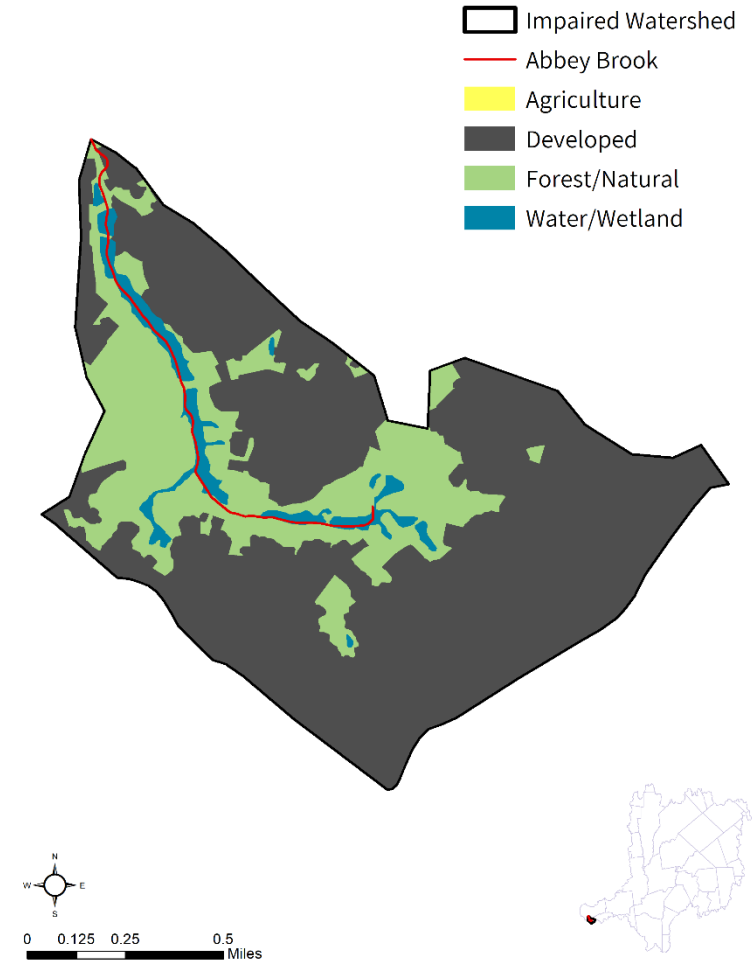
Impairment(s): *E. coli* (Primary Contact Recreation)

Class: B

Impervious Area (Acres, %): 348 (41%)

DCIA Area (Acres, %): 291 (35%)





watershed is mostly[43] served by public sewer and the entire watershed is subject to stormwater regulations under the National Pollutant Discharge Elimination System (NPDES) General MS4 Stormwater Permit (USEPA, 2020a). There are no NPDES permits on file governing point source discharges of pollutants to surface waters, no MassDEP discharge to groundwater permits for on-site wastewater discharges, no combined sewer overflows, no landfills, and no known unpermitted land disposal dumping grounds within the watershed. See Figure 17-1.

The segment flows through a forested riparian corridor surrounded by high density residential and commercial development. The Springfield Plaza and nearby commercial areas include expansive parking lots. There is no agricultural land within the watershed.

In the watershed of Abbey Brook (segment MA36-40), under the Natural Heritage and Endangered Species Program, there are no areas of Priority Natural Vegetation Communities or Priority Habitats of Rare Species. There are no Areas of Critical Environmental Concern, areas under Public Water Supply protection, or Outstanding Resource Waters identified in this watershed. There are no areas of land protected in perpetuity[44] within the segment watershed, which would otherwise be part of the total of 164 acres (19%) of Protected and Recreational Open Space[45]. See Figure 17-1.

[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.

[44] Land protected in perpetuity include several interests such as conservation restriction, 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.

[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 the State of Massachusetts).

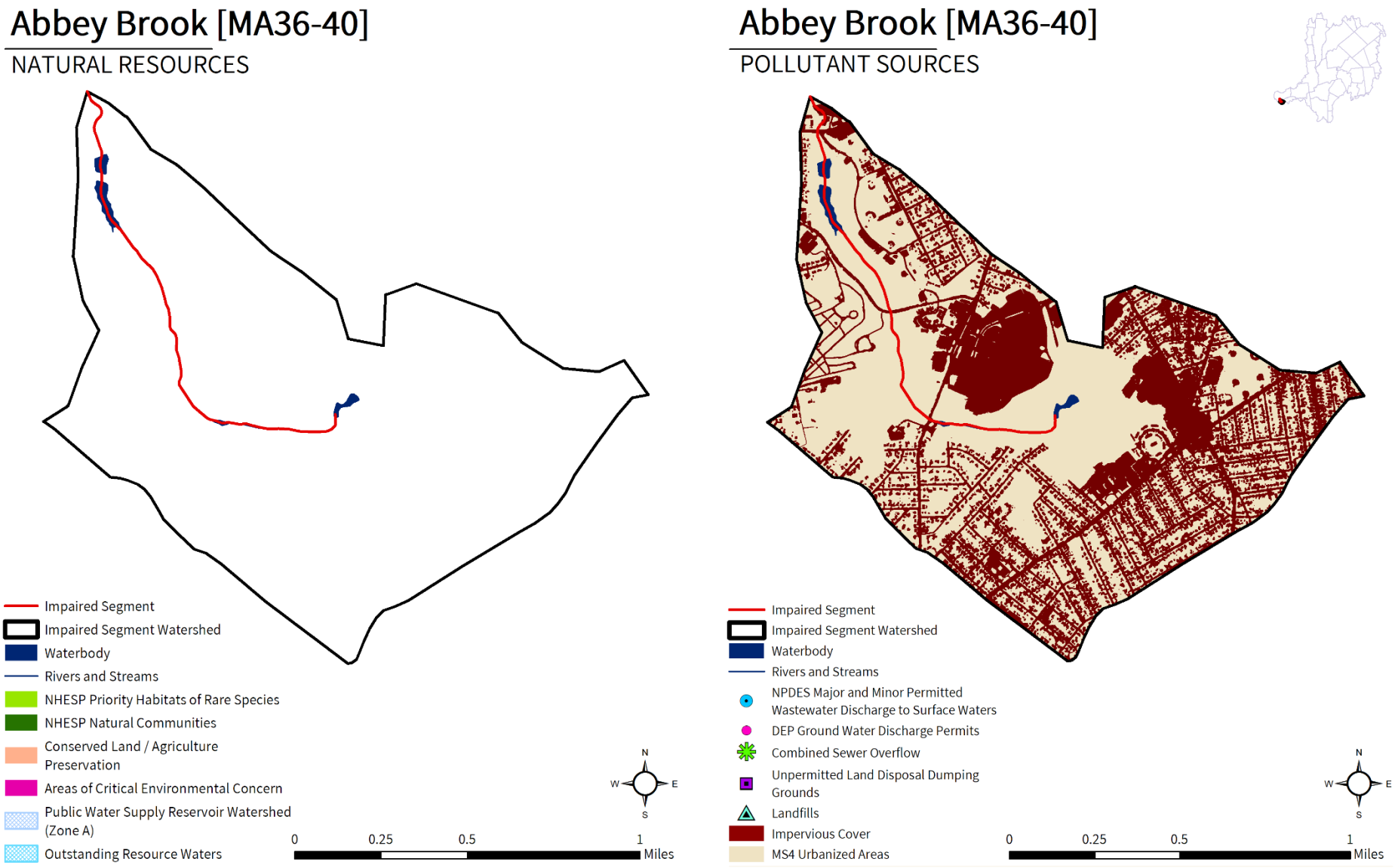


Figure 17-1. Natural resources and potential pollution sources draining to the Abbey Brook segment MA36-40. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

17.2. Waterbody Impairment Characterization

Abbey Brook (MA36-40) is a Class B Water (MassDEP, 2021). The indicator bacteria *E. coli* should be used to assess attainment of SWQS for the Primary Contact Recreation use, but no recent data are available to present here (Figure 17-2 shows a historic monitoring station). The Chicopee River Watershed 2003 Water Quality Assessment Report (MassDEP, 2008) documents previous assessment rationale and *E. coli* water quality data. The City of Chicopee (NPDES permit MA0101508) (1 CSO outfall) is permitted to discharge to this segment. A presumptive impairment decision was applied since this segment does not have a CSO variance in place.

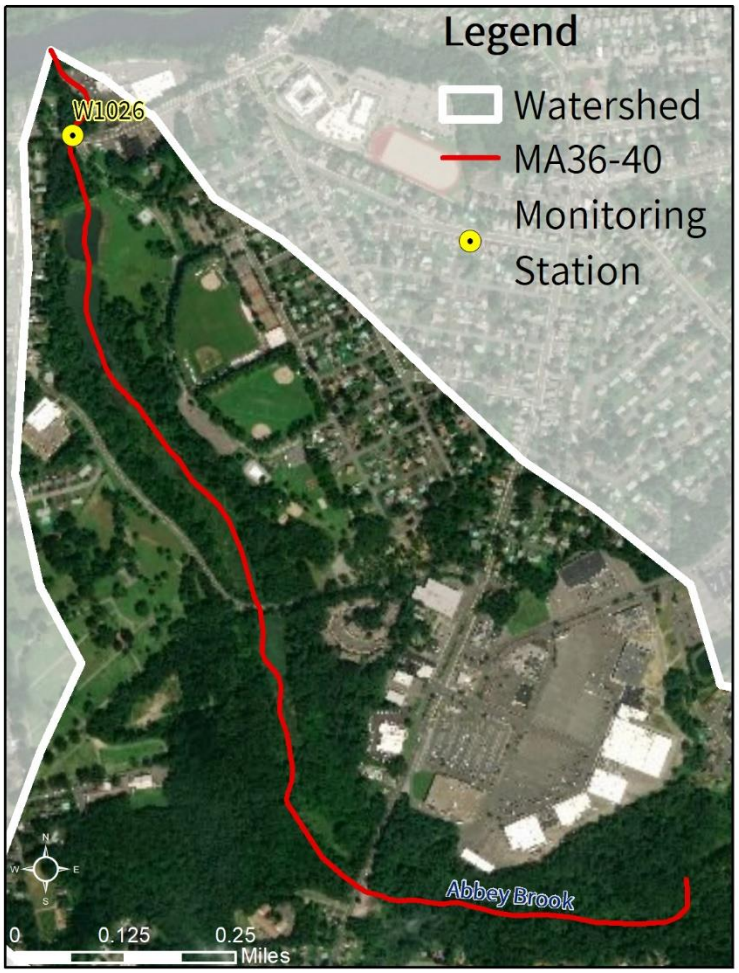


Figure 17-2. Location of monitoring station(s) along the impaired river segment.

17.3. Potential Pathogen Sources

Each potential pathogen source relevant to this segment is described in further detail below.

Urban Stormwater: Although Abbey Brook flows mostly through a forested/natural corridor, the watershed is highly urbanized, with all land area in MS4 and 35% as DCIA. Development within the watershed consists of commercial and industrial infrastructure along with high density residential neighborhoods and some urban arterial streets. Stormwater runoff from urban areas is likely a significant source of pathogens.

Illicit Sewage Discharges: With the entire watershed likely served by municipal sewer systems and designated as MS4, 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 may be some older septic systems serving properties that have not connected to sewer. While it is likely that on-site septic systems are not a major source of pathogens to the watershed, it may still be worthwhile to research whether isolated properties are still served by septic systems.

Pet Waste: There are several ballfields and parks adjacent to the downstream portion of the brook, and much of the watershed is high-density residential neighborhoods. Conservation lands, parks, ballfields, and neighborhoods popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent possible sources of pathogens.

Wildlife Waste: There are large, mowed fields adjacent to the impaired segment where it flows through Bemis Pond. Conservation and recreational lands with large open mowed areas with a clear sightline to a waterbody may attract large congregations of 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.

City of Chicopee. See Section 14.4

A watershed-based plan has been created for this watershed by the City of Chicopee and Geosyntec Consultants, Inc. (Geosyntec, 2019).

City of Springfield. See Section 16.4

18. MA36-41 Fuller Brook

18.1. Waterbody Overview

The Fuller Brook segment MA36-41 is 1.9 miles long and begins at the municipal boundary between Ludlow and Chicopee, MA, 0.2 miles north of where Lombard Road becomes Cady Street. Fuller Brook flows southwest through forest and wetlands for most of its reach before ending at its confluence with the pathogen-impaired Chicopee River (segment MA36-24) in Chicopee, MA.

Tributaries to Fuller Brook include the reach of the brook upstream of the start of the impaired segment. Upstream tributaries include Higher Brook, Harris Brook, and Harris Pond.

Key landmarks in the watershed include Litwin Park and ballfields, Ludlow High School, and the Chapin Elementary School. Road crossings along the segment include Lombard Road, an access road for the Chicopee Landfill, I-90, and Shawinigan Road, all in the downstream portion of the segment in Chicopee.

Fuller Brook (segment MA36-41) drains an area of 11 square miles (mi^2), of which 1.4 mi^2 (13%) is covered with impervious surfaces and 0.8 mi^2 (7%) is considered directly connected impervious area (DCIA). In terms of land area, the watershed

Reduction from Highest Calculated Geomean: *NA*

Watershed Area (Acres): 7,124

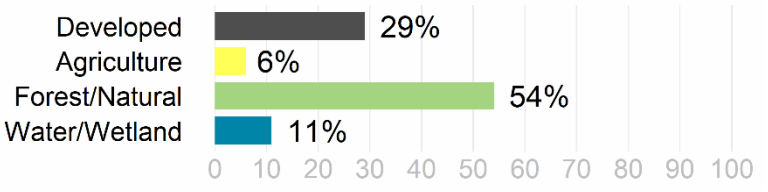
Segment Length (Miles): 1.9

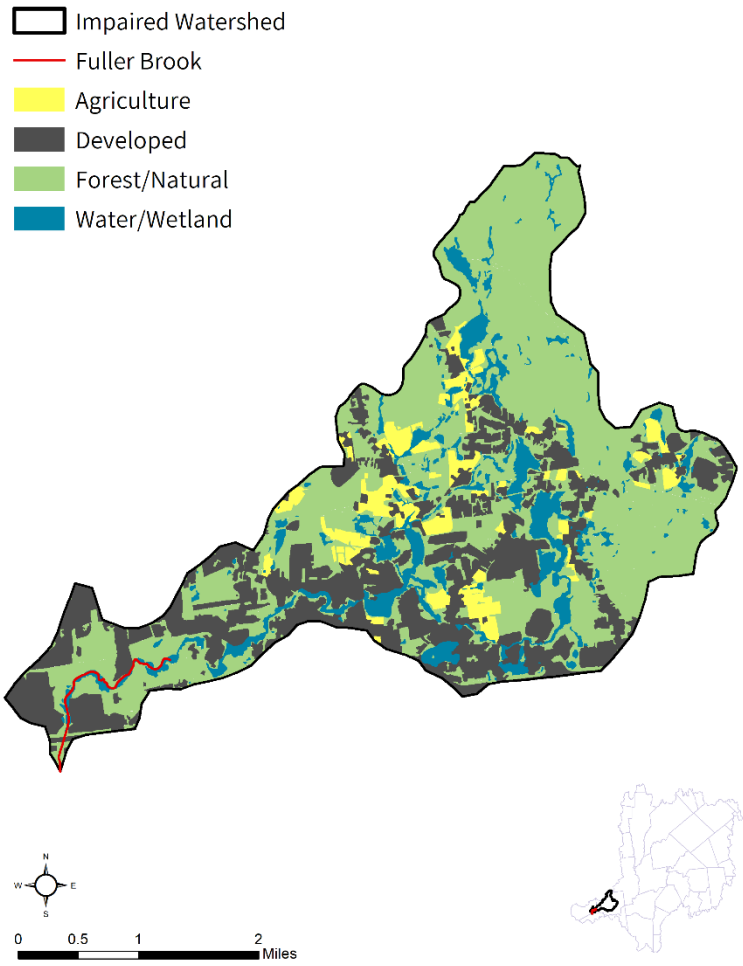
Impairment(s): *E. coli* (Primary Contact Recreation)

Class: B

Impervious Area (Acres, %): 893 (13%)

DCIA Area (Acres, %): 501 (7%)





is mostly[46] served by public sewer and 49% is subject to stormwater regulations under the National Pollutant Discharge Elimination System (NPDES) General MS4 Stormwater Permit (USEPA, 2020a). There are no NPDES permits on file governing point source discharges of pollutants to surface waters within the full segment watershed, and no MassDEP discharge to groundwater permits for on-site wastewater discharges within the watershed. There are also no combined sewer overflows, three landfills, and no known unpermitted land disposal dumping grounds within the watershed. See Figure 18-1.

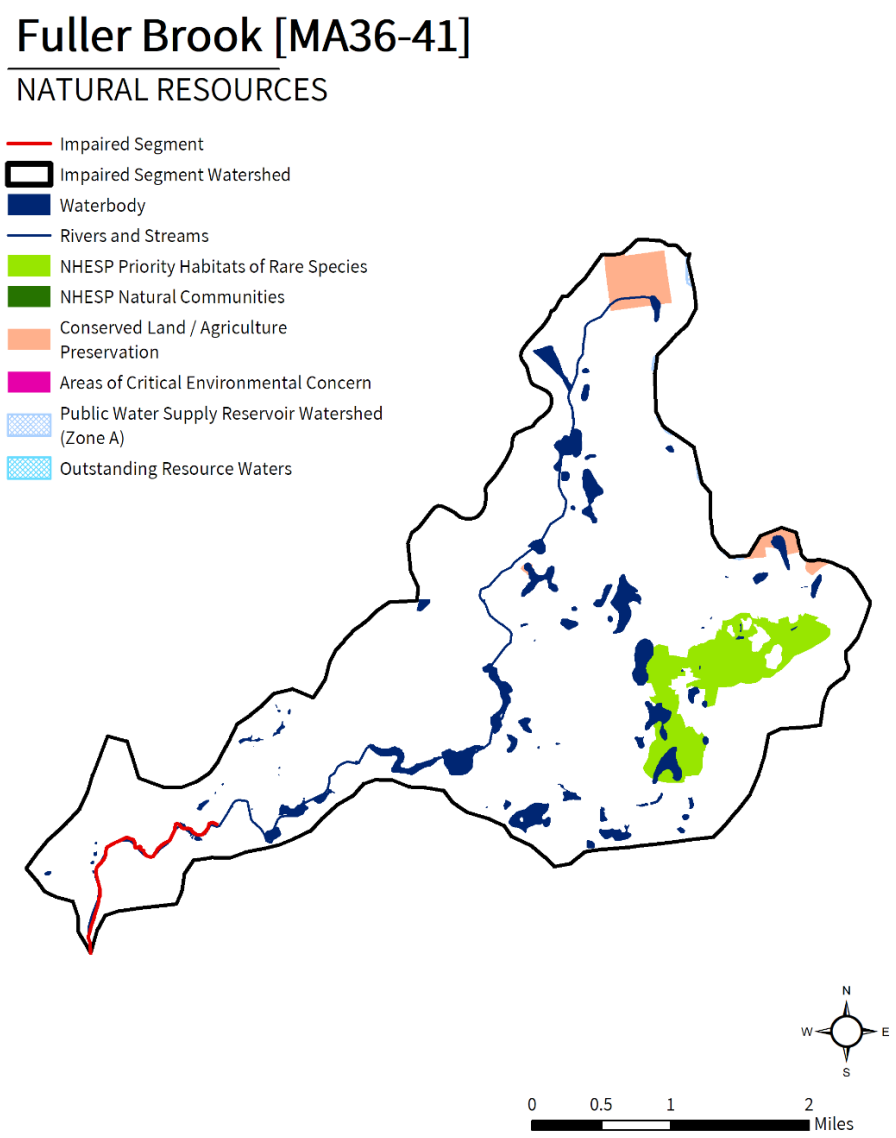
Most of the segment flows through open meadow and forested wetlands and forest land. Medium density residential development encroaches near the segment at Murphy Lane in Chicopee. The downstream half of the segment flows through the Chicopee Landfill complex, under an interstate highway, and through a wide utility corridor containing an electrical substation. Overall, 29% of the segment's watershed is developed. The watershed is mapped as 6% agricultural, much greater than nearby watersheds of pathogen-impaired segments MA36-39 and MA3-40, both of similar size.

In the Fuller Brook watershed (segment MA36-41), under the Natural Heritage and Endangered Species Program, there are 385 acres (5%) of Priority Habitats of Rare Species. There are 11 acres (<1%) under Public Water Supply protection but no Areas of Critical Environmental Concern or Outstanding Resource Waters identified in this watershed. Over 153 acres (2%) of land are protected in perpetuity[47] within the segment watershed, which is part of a total of 1,406 acres (20%) of Protected and Recreational Open Space[48]. See Figure 18-1.

[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, wetland restrictions, aquifer protection, historic preservation, etc. Refer to Mass GIS metadata for the Protected and Recreational Open Space data layer.

[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 the State of Massachusetts).



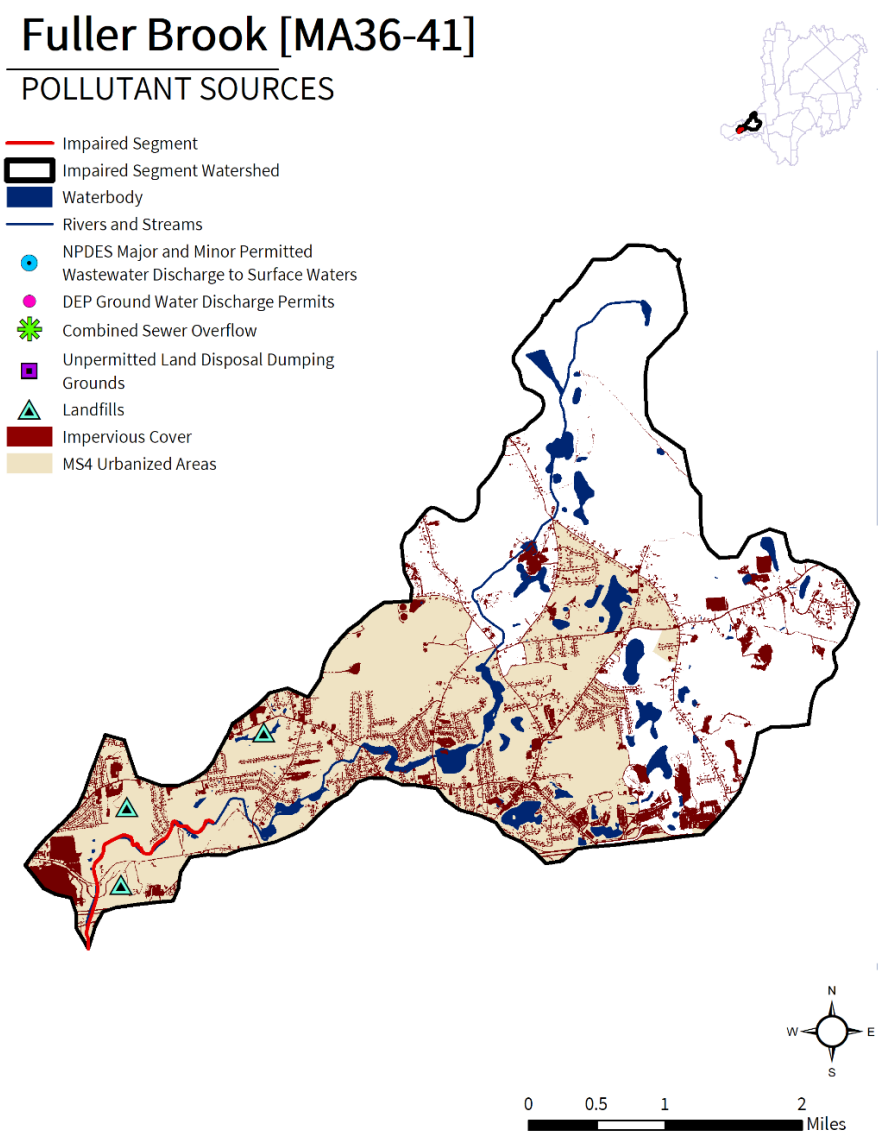


Figure 18-1. Natural resources and potential pollution sources draining to the Fuller Brook segment MA36-41. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

18.2. Waterbody Impairment Characterization

Fuller Brook (MA36-41) is a Class B Water (MassDEP, 2021). The indicator bacteria *E. coli* should be used to assess attainment of SWQS for the Primary Contact Recreation use, but no recent data are available to present here (Figure 18-2 shows a historic monitoring station). The Chicopee River Watershed 2003 Water Quality Assessment Report (MassDEP, 2008) documents previous assessment rationale and *E. coli* water quality data.

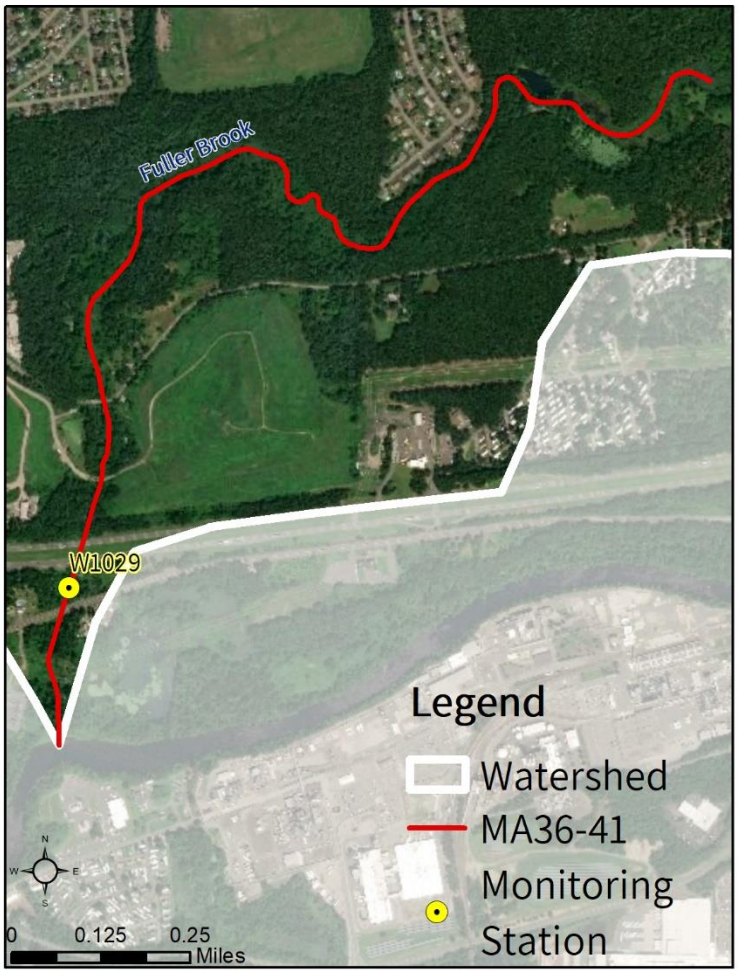


Figure 18-2. Location of monitoring station(s) along the impaired river segment.

18.3. Potential Pathogen Sources

Each potential pathogen source relevant to this segment is described in further detail below.

Urban Stormwater: Portions of the watershed are highly developed, with 49% of the land area in MS4 and 7% as DCIA. Urban development within the watershed consists of medium density residential development in addition to industrial, commercial, and transportation land uses. Stormwater runoff from urban areas is likely a significant source of pathogens.

Illicit Sewage Discharges: With a portion of the land area served by municipal sewer systems, most (if not all) of the land area adjacent to the impaired segment in sewer service, and 49% 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 significant risk.

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

Agriculture: Agriculture accounts for 6% of the watershed land area, including areas of row crops, hayfields, and open fields. Agricultural activities related to manure storage and spreading, if not well managed, are possible sources of pathogens to waterbodies.

Pet Waste: There are many medium density residential areas in the watershed near the segment or upstream tributaries. Conservation lands, parks, and ballfields popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent possible sources of pathogens.

Wildlife Waste: There are open meadow wetlands around Harris Pond, just upstream of the segment. Further upstream along Harris Brook in the area around Church and Rood streets, there are expansive mowed fields to the water's edge. Conservation and recreational lands with large open mowed areas or fields with a clear sightline to a waterbody may attract large congregations of 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.

City of Chicopee. See Section 14.4

Town of Ludlow. See Section 13.4

19. MA36-50 Danforth Brook

19.1. Waterbody Overview

The Danforth Brook pathogen-impaired segment MA36-50 is 5.8 miles long and begins east of Charity Road and west of Jackson Road in Hardwick, MA. The brook flows generally south to its confluence with the pathogen-impaired Ware River segment MA36-05 in Hardwick, MA.

Tributaries to this Danforth Brook segment include approximately 8.5 miles of unnamed streams. Key landmarks in the watershed include the Quabbin Aqueduct in the north, downtown Hardwick in the center, and the village of Gilbertville to the south. Eight roadways cross Danforth Brook within Hardwick including Jackson Road, Barre Road, Hardwick Road/MA-32A, Prospect Street, and Main Street/MA-32.

Danforth Brook (segment MA36-50) drains an area of 5.5 square miles (mi^1), of which 0.2 mi^2 (3%) is covered with impervious surfaces and 0.1 mi^2 (1%) is considered directly connected impervious area (DCIA). In terms of land area, the

Reduction from Highest Calculated Geomean: 48%

Watershed Area (Acres): 3,490

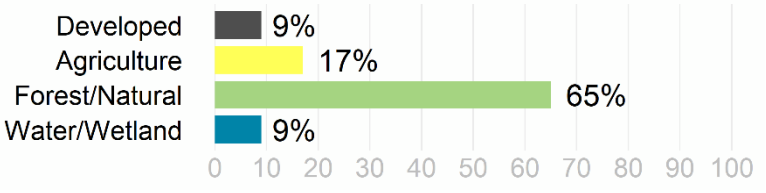
Segment Length (Miles): 5.8

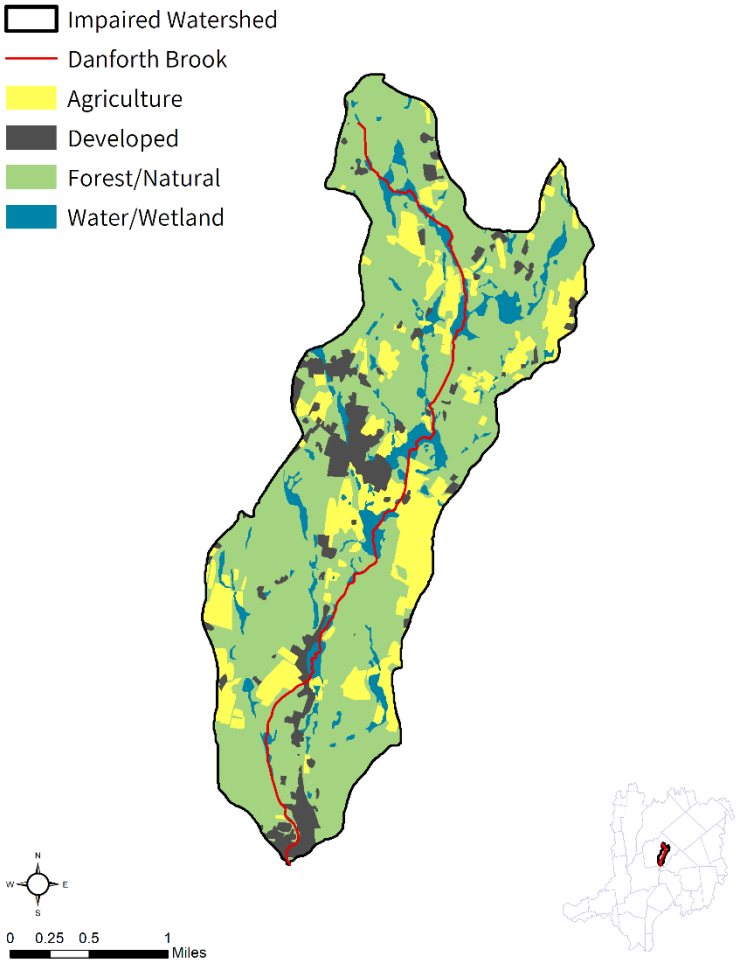
Impairment(s): *E. coli* (Primary Contact Recreation)

Class: B

Impervious Area (Acres, %): 115 (3%)

DCIA Area (Acres, %): 30 (1%)





watershed is likely partially[49] served by public sewer and none of the watershed is subject to stormwater regulations under the National Pollutant Discharge Elimination System (NPDES) General MS4 Stormwater Permit (USEPA, 2020a). There are no NPDES permits on file governing point source discharges of pollutants to surface waters, no MassDEP discharge to groundwater permits for on-site wastewater discharges, no combined sewer overflows, no landfills, and no known unpermitted land disposal dumping grounds within the watershed. See Figure 19-1.

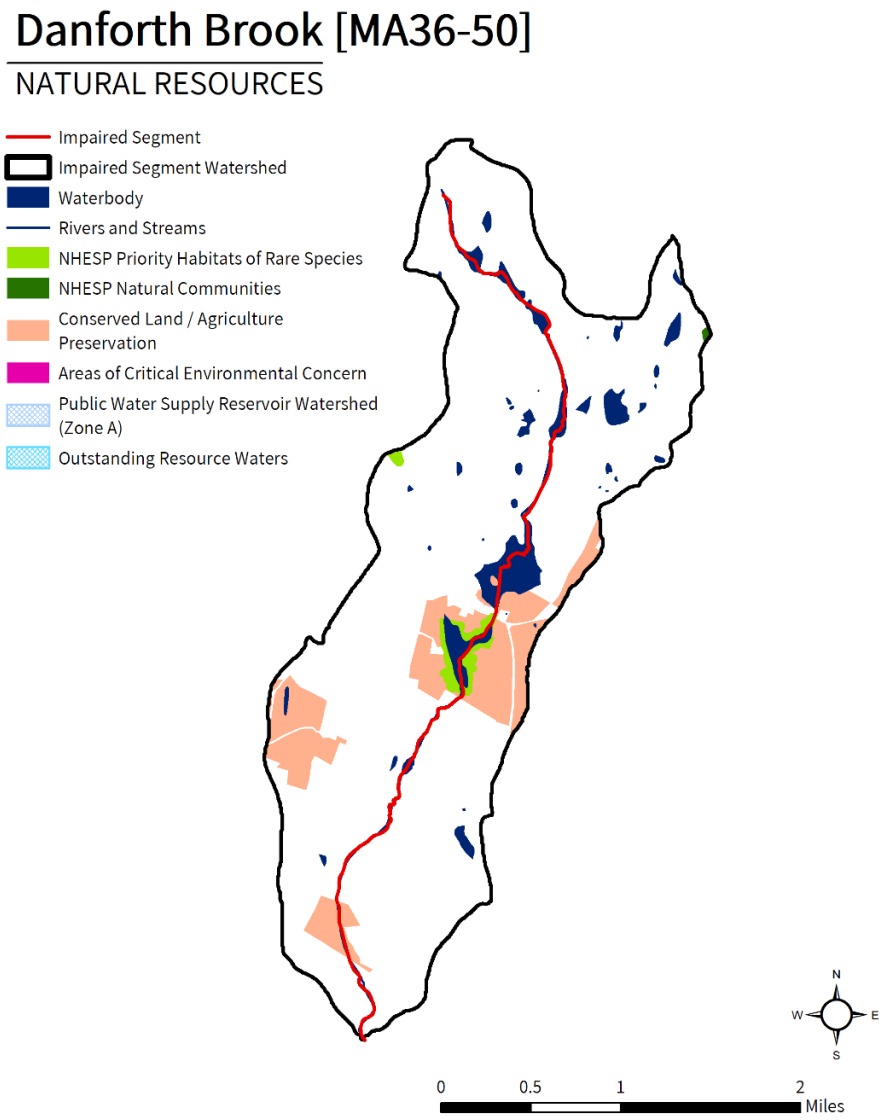
The segment flows through a patchwork of forest, agricultural lands, and low-density residential neighborhoods. Danforth Brook has the second highest percentage of agricultural lands in the Chicopee River basin, after the Ware River impaired segment MA36-05. Agricultural land use (602 acres) is about double the developed areas (297 acres) within the Danforth Brook watershed.

In the Danforth Brook watershed (segment MA36-50), under the Natural Heritage and Endangered Species Program, there are 59 acres (2%) of Priority Habitats of Rare Species and two acres (<1%) of Priority Natural Vegetation Communities. There are no Areas of Critical Environmental Concern, areas under Public Water Supply protection, or Outstanding Resource Waters identified in this watershed. Over 409 acres (12%) of land are protected in perpetuity[50] within the segment watershed, which is part of a total of 647 acres (19%) of Protected and Recreational Open Space[51]. See Figure 19-1.

[49] 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.

[50] Land protected in perpetuity include several interests such as conservation restriction, 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.

[51] 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 the State of Massachusetts).



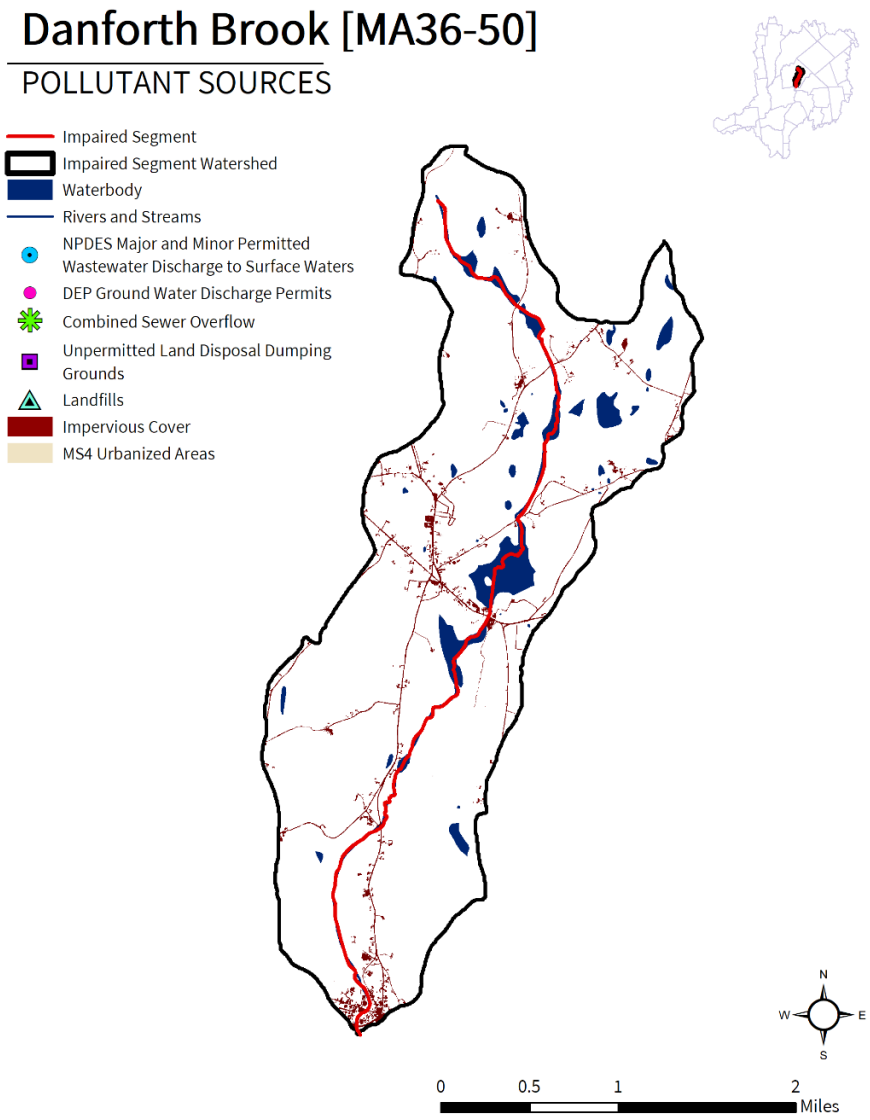


Figure 19-1. Natural resources and potential pollution sources draining to the Danforth Brook segment MA36-50. The map on the left shows critical habitat, water features, and conserved land. The map on the right indicates potential and known pollution sources, including impervious cover, MS4 areas, and permitted facilities.

19.2. Waterbody Impairment Characterization

Danforth Brook (MA36-50) is a Class B Water (MassDEP, 2021).

The Primary Contact Recreation uses for MA36-50 were assessed for attainment of SWQS at the station listed below (refer to Tables 19-1, 19-2; Figure 19-2) 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 2008, six samples were collected at W1860, 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 Statistical Threshold Value (STV) criterion was applied to single sample results. Out of six samples, two exceeded the STV criterion during wet weather.

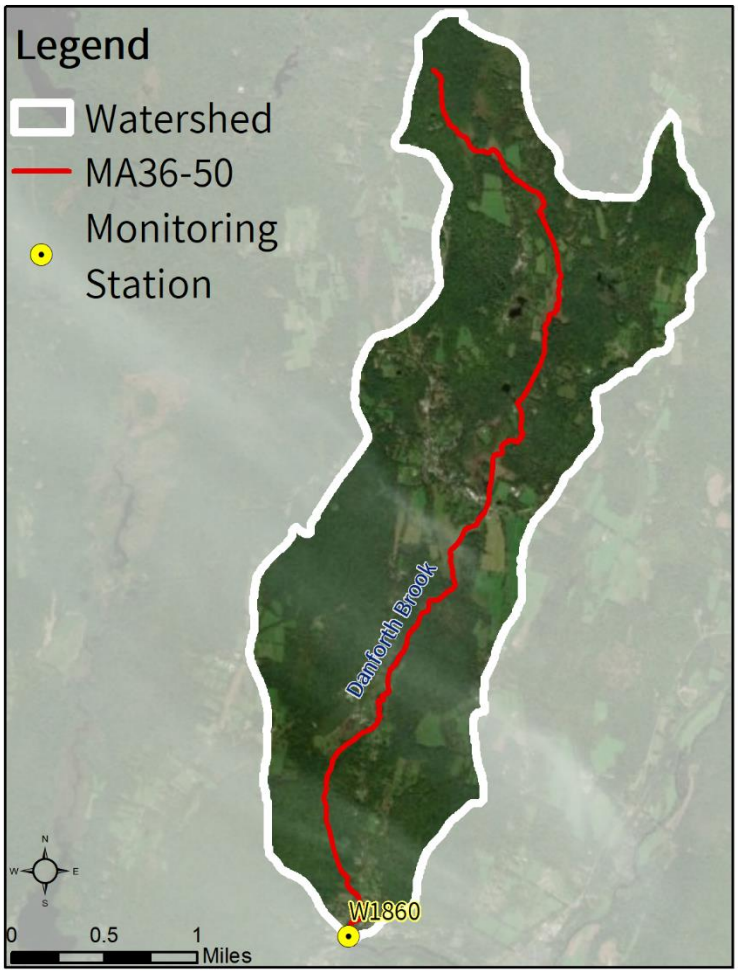


Figure 19-2. Location of monitoring station(s) along the impaired river segment.

Table 19-1. Summary of indicator bacteria sampling results by station for Danforth Brook (MA36-50). 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
W1860	5/20/2008	9/23/2008	6	242	5	2

Table 19-2. Indicator bacteria data by station, indicator, and date for Danforth Brook (MA36-50). 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 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 (CFU/100mL)	90-Day Rolling Geomean (CFU/100mL)	90-Day Rolling STV (CFU/100mL)
W1860	*E. coli*	5/20/2008	DRY	68	68	
W1860	*E. coli*	6/17/2008	WET	770	229	
W1860	*E. coli*	7/9/2008	DRY	40	128	
W1860	*E. coli*	7/22/2008	WET	140	131	
W1860	*E. coli*	8/19/2008	WET	800	242	
W1860	*E. coli*	9/23/2008	DRY	200	173	

19.3. Potential Pathogen Sources

Comparing data collected during wet weather versus dry weather conditions provides an indication of the types of sources present, information which 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 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).

The indicator bacteria data for Danforth Brook (segment MA36-50) were elevated during wet weather. This 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: The watershed is lightly developed, with no designated MS4 area and 1% identified as DCIA. Development accounts for 9% of the watershed and is comprised mostly of low-density residential development. Stormwater runoff from urban areas is a likely source of pathogens.

Illicit Sewage Discharges: A portion of the watershed may be served by a municipal sewer system. There may be private wastewater infrastructure, such as building wastewater drains, which may intersect with storm drainage. Leaky wastewater lines and illicit connections are possible sources of pathogens.

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

Agriculture: Agricultural activities in the watershed account for 17% of the land area. Agricultural activities visible on recent aerial photos include row crops, hayfields, and pastureland. Activities related to manure storage and spreading, if not well managed, are possible sources of pathogens to waterbodies. Stormwater runoff from agricultural lands is also likely to be a significant source of pathogens to the impaired segment.

Pet Waste: There are conservation and recreational lands including ballfields in the watershed, and the brook flows through the village of Gilbertville. Conservation lands, parks, ballfields, and residential areas popular for dog-walking, especially where paths are adjacent to rivers, ponds, or wetlands, represent possible sources of pathogens.

Wildlife Waste: There are large meadow wetlands and open fields around portions of Danforth Brook, especially south of Barre Road. Conservation and recreational lands with large open mowed areas and fields with a clear sightline to a waterbody may attract large congregations of 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 Hardwick. See Section 3.4

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