Massachusetts Department of Transportation
Semi Annual Submittal under MassDOT's Impaired Water Program

Attachment 2: Impaired Waters Assessments, Progress Reports

MA41-02 Quinebaug River

MA51002 Aldrich Pond

MA51-02 Middle River

MA51-04 Blackstone River including Rice City Pond and Riverdale Impoundment

MA51-17 Poor Farm Brook and City Farm Pond

MA51050 Flint Pond

MA51093 Marble Pond

MA51120 Pondville Pond

MA51125 Lake Quinsigamond

MA51188 Flint Pond

MA51-05 Blackstone River

MA51-06 Blackstone River

MA51-10 Mill River including Fiske Millpond and Spindleville Pond

MA51135 Lake Ripple

MA51-14 Mumford River including Gilboa Pond and Meadow Pond

MA51-15 Tatnuck Brook

MA51196 Shirley Street Pond

MA61-06 Mount Hope Bay

MA62-04 Taunton River

MA72-03 Charles River

MA72-28 Beaver Brook

MA73003 Russell Pond

MA73-26 Unquity Brook

MA73-30 Gulliver Creek

MA74-04 Mill River

MA74-09 Town Brook

MA82A-08 Concord River

Impaired Waters Assessment for Quinebaug River (MA41-02) – Progress Report

Impaired Waterbody

Name: Quinebaug River

Location: Southbridge, MA

Water Body ID: MA41-02

Impairments

Quinebaug River (MA41-02) is listed under Category 5, "Waters requiring a TMDL", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). According to this list, Quinebaug River segment MA41-02 is impaired for the following:

- (debris/floatables/trash*)
- turbidity
- excess algal growth

MassDEP's *French and Quinebaug River Watersheds 2004-2008 Water Quality Assessment Report* (MassDEP, 2009) listed the Aquatic Life Use with an "Alert" status because of evidence of instream toxicity to P. promelas. All other uses were not assessed.

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *314 CMR 4.05 (3)(b) 6 Color and Turbidity.* These waters shall be free from color and turbidity in concentrations or combinations that are aesthetically objectionable or would impair any use assigned to this class.
- *314 CMR 4.05 (5) (b) Bottom Pollutants or Alterations*. All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.
- *314 CMR 4.05 (5) (c) Nutrients*. Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established by the Department pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of

nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.

Site Description

The Quinebaug River Segment MA41-02 flows for 6.5 miles from the Sturbridge WWTP outfall to the confluence with Cady Brook in Southbridge. Much of the segment is protected and undeveloped because it is within the boundary of the US Army Corps of Engineers Westville Dam Flood Control Project. The total watershed is shown in Figure 1 and the subwatershed is shown in Figure 2.

Stomwater runoff from MassDOT property is conveyed to the segment through a system of catch basins, drainage pipes, swales and unnamed streams. The MassDOT property directly contributing stormwater runoff to the segment is described below and illustrated on Figures 3 and 4.

Stormwater runoff from Interstate Route 84 is collected in catch basins and routed through drain pipes and grass swales to an unnamed stream running parallel with the highway, as shown in Figure 3. The unnamed stream discharges to Quinebaug River Segment MA41-02. Approximately 1,200 feet north of the Quinebaug River, the unnamed stream flows through a large area of wetlands. Runoff flowing through the wetlands is considered an indirect discharge to impaired waters, and runoff entering the unnamed stream downstream of the wetlands is considered a direct discharge.

Stormwater runoff from Route 131 is collected in catch basins and routed through drain pipes and ditches to the Quinebaug River. The ditches have significant pitch, limited vegetation, and are eroded in some areas. The Route 131 directly contributing area starts approximately 135 feet uphill of Fiske Hill Road and continues to the Quinebaug River, as shown in Figure 4.

Assessment under BMP 7U

None of the impairments for the Quinebaug River have been addressed by a TMDL. Therefore, MassDOT assessed the impairments using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of storm water on many impairments. For this water body, MassDOT used the IC method to assess the following impairments:

- turbidity
- excess algal growth

According to MassDEP's final *Massachusetts Year 2012 Integrated List of Waters*, the impairment for (debris/floatables/trash*) is not caused by pollutants (MassDEP, 2013). Therefore, this impairment is not considered further.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction necessary to attain the percent imperviousness in the watershed at which stormwater is not likely the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity.

IC data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer. In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for Quinebaug River (MA41-02):

Table 1. Site Parameters for Quinebaug River (MA41-02)

Total Watershed		
Watershed Area	66,420	acres
Impervious Cover (IC) Area	3,195	acres
Percent Impervious	4.8	%
Subwatershed		
Subwatershed Area	4,166	acres
Impervious Cover (IC) Area	604	acres
Percent Impervious	14.5	%
IC Area at 9% Goal	375	acres
Target Reduction % in IC	37.9	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	7.2	acres
MassDOT's Target Reduction in Effective IC (37.9% of DOT Directly Contributing IC)	2.7	acres

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 37.9%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 2.7 acres.

Existing BMPs

Based on the site visit, there are no existing BMPs within MassDOT's directly contributing watershed to Quinebaug River segment MA41-02 that are mitigating potential storm water quality impacts. Therefore, no effective IC reduction is provided by existing MassDOT BMPs.

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 2.7 acres, MassDOT will consider the implementation of new BMPs. In conjunction with the proposed FY15 resurfacing of Interstate 84, a desktop analysis for potential BMP locations was recently completed. The March 2013 memorandum recommended the construction and maintenance of structural BMPs to reduce effective impervious cover within the watershed of Quinebaug River (MA41-02), and noted that there is available, open land within the highway median where three linear, structural BMPs could potentially be constructed. This impaired waters assessment coupled with the preliminary BMP siting analysis will provide the basis for future detailed BMP design.

Conclusions

MassDOT used the IC Method to assess Quinebaug River segment MA41-02 for the impairments identified in MassDEP's final *Massachusetts Year 2012 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed by 2.7 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Quinebaug River segment MA41-02 and found that there are no existing BMPs and therefore no existing reduction in effective IC. This information is summarized in Table 3 below.

Table 3. Effective IC Reductions under Existing & Proposed Conditions

MassDOT Direct Contributing IC	7.2	acres
MassDOT Target Reduction in Effective IC	2.7	acres
Effective IC Reduction under Existing Conditions	0	acres
Remaining Target Reduction with Proposed BMPs	**2.7**	**acres**

MassDOT should reduce its effective IC within the directly contributing watershed by 2.7 acres to achieve the targeted reduction in IC. MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs to treat directly contributing IC as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide the target IC reduction or treatment to the maximum extent practicable.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of additional BMPs, and finalized assessments including reductions achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

References

ENSR. (2006). Stormwater TMDL Implementation Support Manual for US Environmental Protection Agency Region 1. ENSR International & EPA Region 1, Boston, MA. Project No.: 10598-001-500. Retrieved from: http://www.epa.gov/region1/eco/tmdl/pdfs/Stormwater-TMDL-Implementation-Support-Manual.pdf

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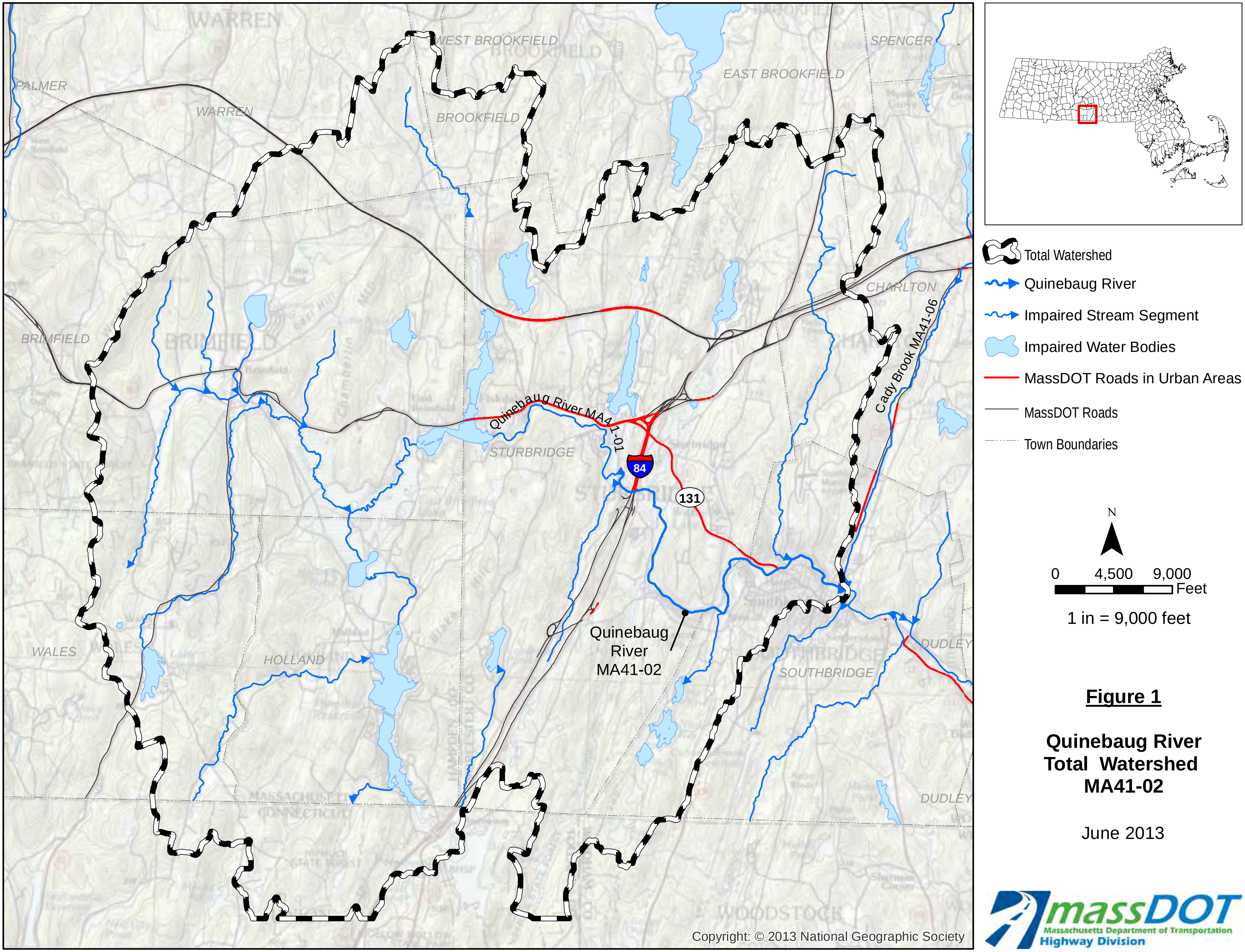

Figure 1

Quinebaug River Total Watershed MA41-02

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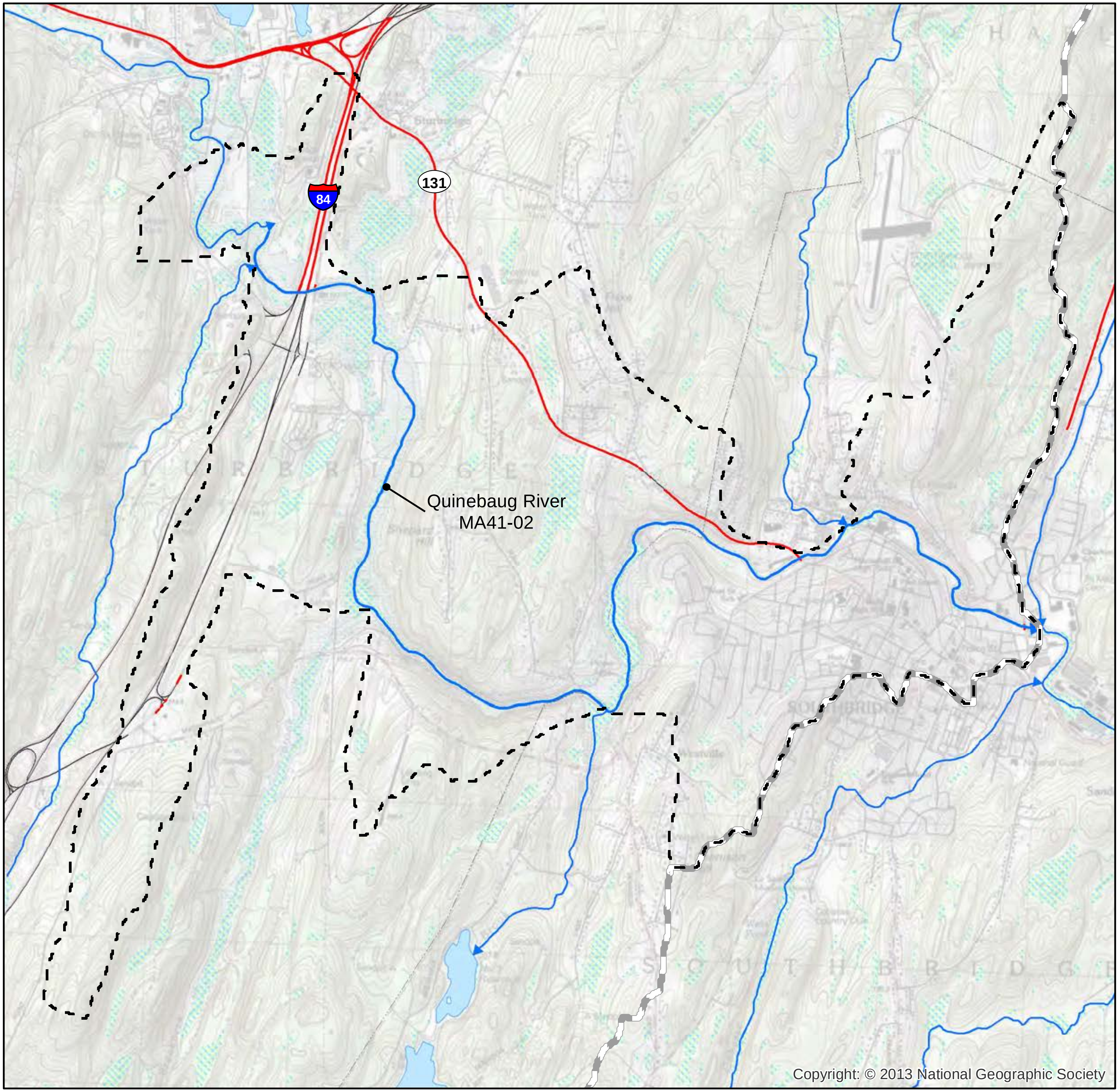

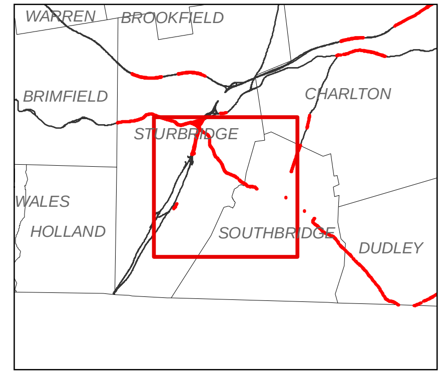

Subwatershed
Total Watershed
Quinebaug River
Impaired Stream Segment
Impaired Water Bodies
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 1,500 3,000 Feet

1 in = 3,000 feet

Figure 2

Quinebaug River Subwatershed MA41-02

June 2013

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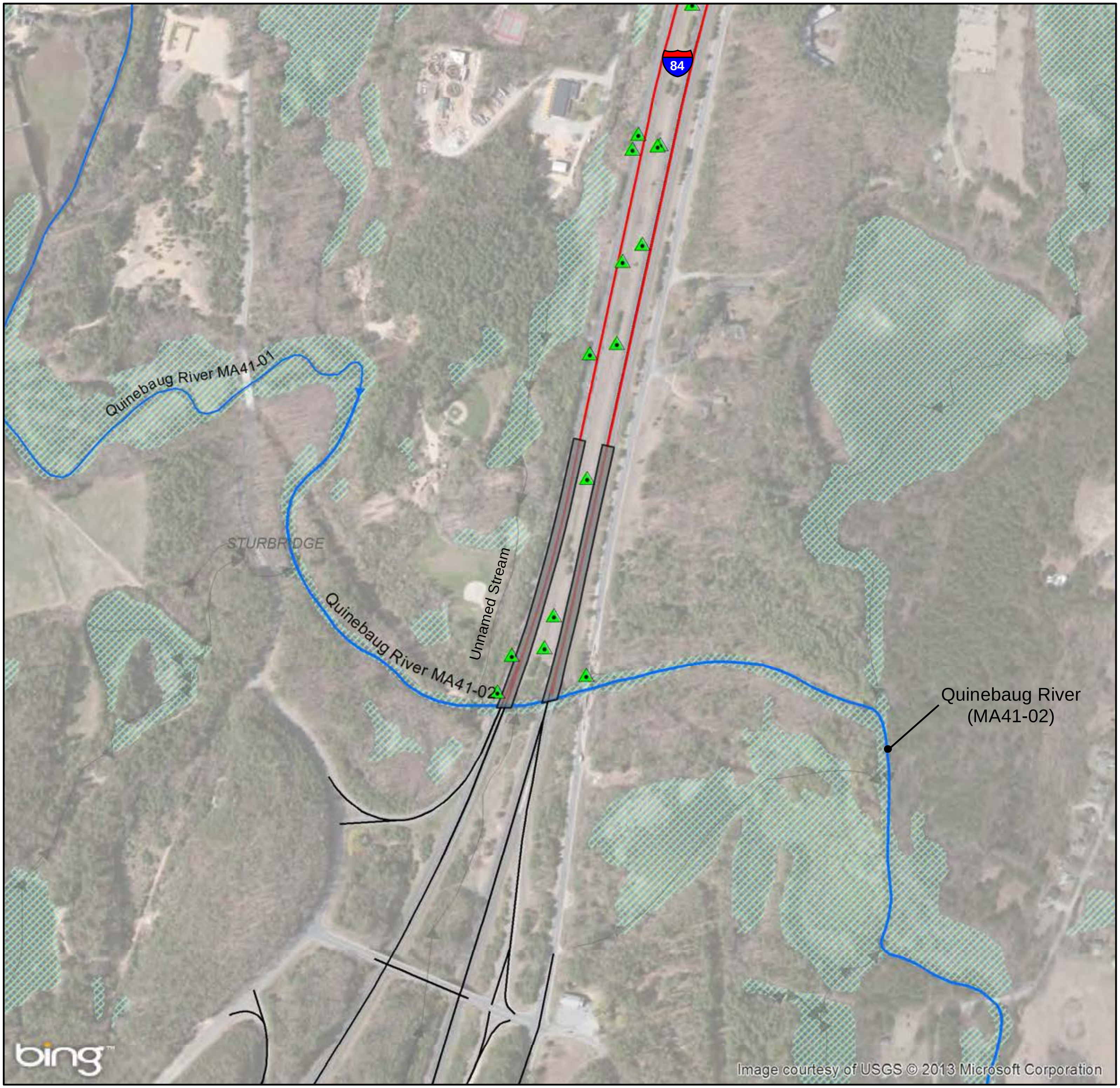
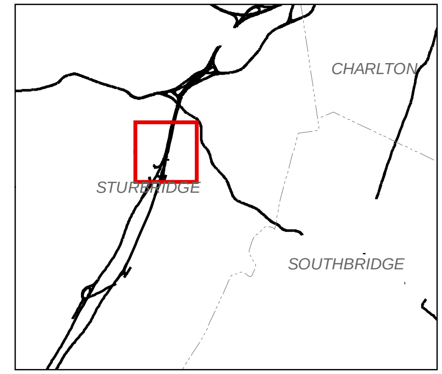
Massachusetts Department of Transportation
Highway Division





- DOT Direct Pervious Watershed
- DOT Direct IC Watershed
- Stormwater Outfalls
- Quinebaug River
- Impaired Stream Segment
- Impaired Water Bodies
- Non-Impaired Stream Segment
- NWI Wetland Areas
- MassDOT Roads in Urban Areas
- MassDOT Roads
- Town Boundaries

N

0 300 600 Feet

1 inch = 600 feet

Figure 3

Quinebaug River (MA41-02) MassDOT Directly Contributing Watershed

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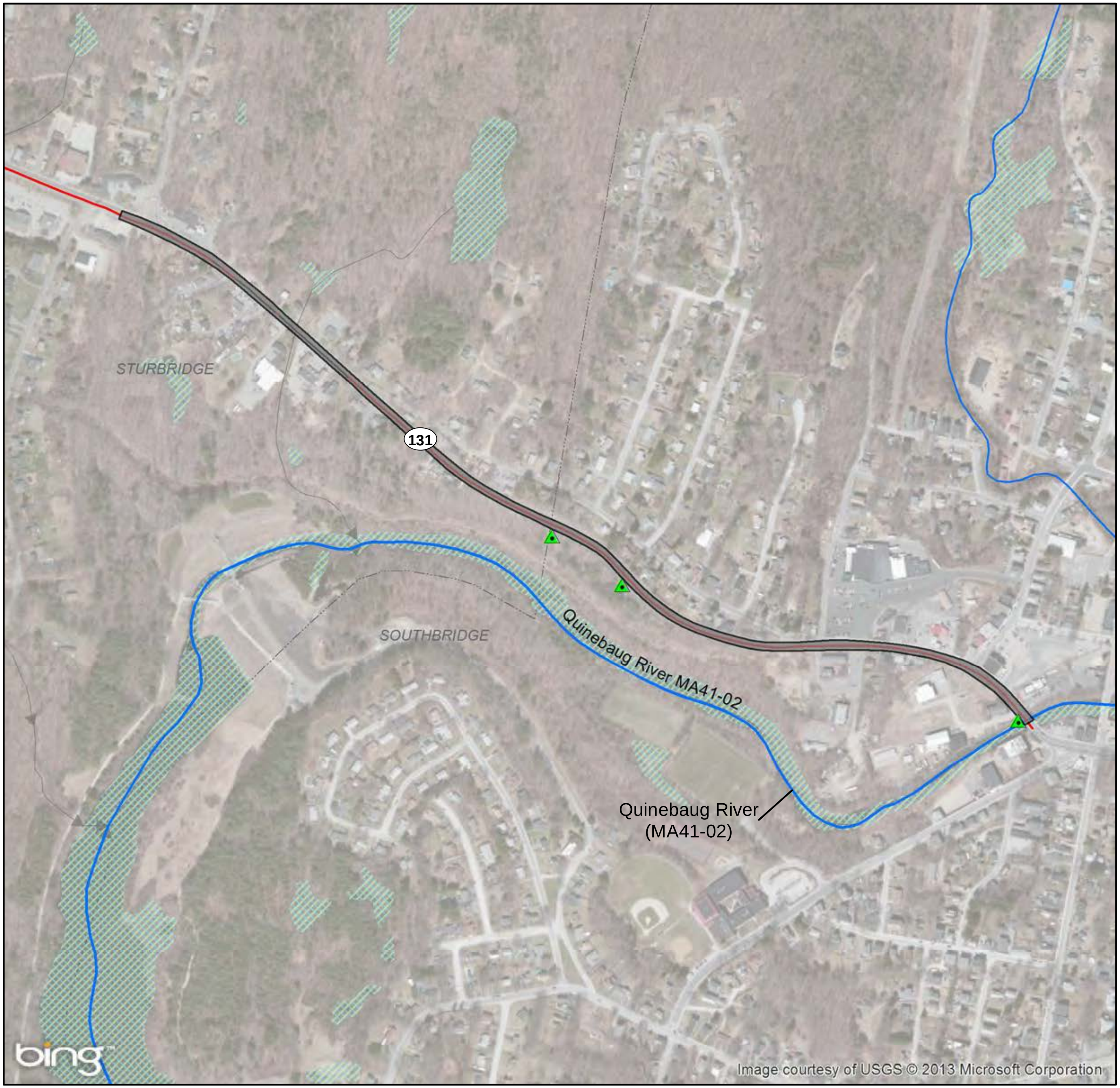

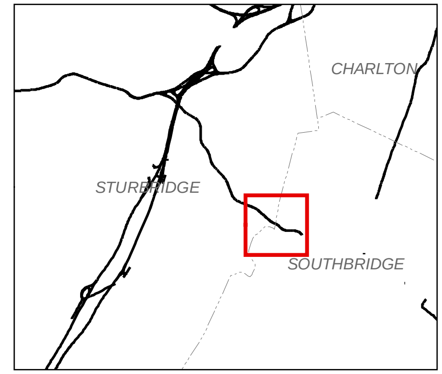

DOT Direct Pervious Watershed
DOT Direct IC Watershed
Stormwater Outfalls
Quinebaug River
Impaired Stream Segment
Impaired Water Bodies
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 300 600 Feet

1 inch = 600 feet

Figure 4

Quinebaug River (MA41-02) MassDOT Directly Contributing Watershed

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Impaired Waters Assessment for Aldrich Pond (MA51002) – Progress Report

Impaired Waterbody

Name: Aldrich Pond

Location: Sutton, MA

Water Body ID: MA51002

Impairments

Aldrich Pond (MA51002) is listed under Category 5, “Waters Requiring a TMDL”, on MassDEP’s final *Massachusetts Year 2010 Integrated List of Waters*. Aldrich Pond is impaired for the following:

- aquatic plants (macrophytes)
- (non-native aquatic plants*)

According to MassDEP’s *Blackstone River Watershed 2003-2007 Water Quality Assessment Report* (MassDEP, 2010), Aldrich Pond is impaired due to an infestation with the non-native aquatic plant species *Myriophyllum heterophyllum* and *Cabomba caroliniana*. These species were found present in Aldrich Pond during the 1994 Blackstone River Watershed synoptic lake surveys.

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *314 CMR 4.05 (5) (a) Aesthetics*. All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.
- *314 CMR 4.05 (5) (c) Nutrients*. Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established by the Department pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.

Site Description

Aldrich Pond is a water body of approximately 2 acres located in the Blackstone River Watershed in Sutton, MA. The lake is located approximately 600 feet downstream of Marble Pond (MA51093) and is fed by an unnamed stream which flows from the outlet of Marble Pond. Aldrich Pond is formed by a dam at the outlet on its southeast side. The pond is surrounded by forest on all sides.

The subwatershed and total contributing watershed to Aldrich Pond are the same and are approximately 632 acres. The watershed is shown in Figure 1. MassDOT's property directly contributing stormwater runoff to Aldrich Pond is comprised of approximately 500 feet of Route 146 (Worcester-Providence Turnpike), a four lane roadway with concrete median that runs northwest-southeast to the southwest of the pond. Route 146 is curbed and stormwater is collected in catch basins on the westbound side, and although there is no curb on the eastbound side, stormwater is collected in catch basins and piped to outfalls along the slope of the westbound shoulder. MassDOT's directly contributing watershed is shown in Figure 2.

Assessment under BMP 7U

None of the impairments for Aldrich Pond have been addressed by a TMDL. Therefore, MassDOT assessed the impairments using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of storm water on many impairments. For this water body, MassDOT used the IC method to assess the following impairments:

- aquatic plants (macrophytes)

According to MassDEP's final *Massachusetts Year 2010 Integrated List of Waters*, the impairment of non-native aquatic plants is not caused by pollutants (MassDEP, 2011). Therefore, this impairment was not considered further.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction necessary to attain the percent imperviousness in the watershed at which stormwater is not likely the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451 and were the same for Aldrich Pond. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. IC data were available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer.

In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for Aldrich Pond:

Table 1. Site Parameters for Aldrich Pond (MA51002)

Total Watershed		
Watershed Area	633	acres
Impervious Cover (IC) Area	77	acres
Percent Impervious	12.2	%
IC Area at 9% Goal	57	acres
Target Reduction % in IC	26	%
Subwatershed		
Subwatershed Area	633	acres
Impervious Cover (IC) Area	77	acres
Percent Impervious	12.2	%
IC Area at 9% Goal	57	acres
Target Reduction % in IC	26	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	0.9	acres
MassDOT's Target Reduction in Effective IC (26% of DOT Directly Contributing IC)	0.2	acres

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 26%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 0.2 acres.

Existing BMPs

There are no existing BMPs in the Aldrich Pond directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to the water body.

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 0.2 acres, MassDOT will consider the implementation of additional BMPs.

Conclusions

MassDOT used the IC Method to assess Aldrich Pond for the impairments identified in MassDEP's final *Massachusetts Year 2010 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed by 0.2 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Aldrich Pond to identify existing BMPs and found that no BMPs exist to reduce effective IC. This information is summarized in Table 2 below.

Table 2. Effective IC Reductions under Existing & Proposed Conditions

IC in Directly Contributing Watershed	0.9	acres
Target Reduction in Effective IC	0.2	acres
IC Effectively Reduced by Existing BMPs	0	acres
IC Remaining to Mitigate with Proposed BMPs	**0.2**	**acres**

MassDOT should reduce its effective IC within the directly contributing watershed by 0.2 acres to achieve the targeted reduction in IC. MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs to treat directly contributing IC as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide the target IC reduction or treatment to the maximum extent practicable.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of additional BMPs, and finalized assessments including reductions achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

References

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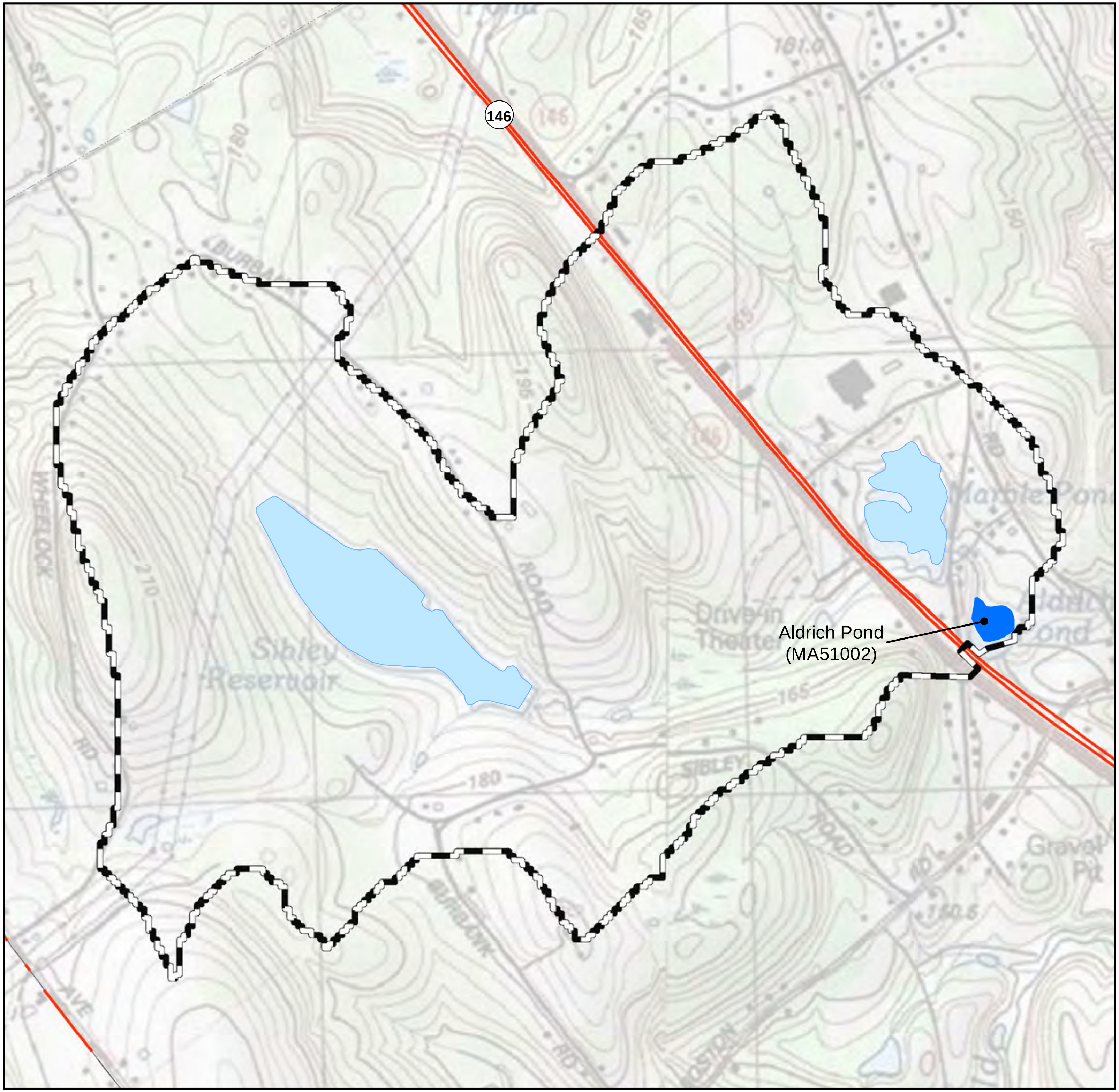

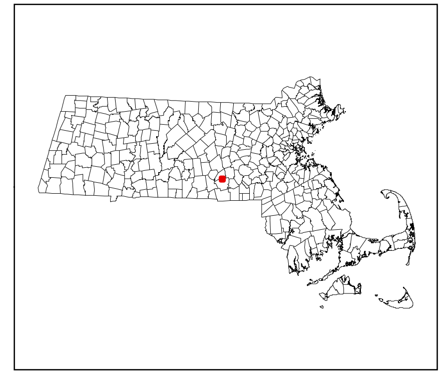

Impaired Stream Segment
Aldrich Pond
Impaired Water Bodies
Total Contributing Watershed
MassDOT Roads in Urban Area
MassDOT Roads
Town Boundaries

N

0 500 1,000 1,500 2,000 Feet

1 in = 1,000 feet

__Figure 1__

Aldrich Pond
Sub and Total Watershed
MA51002

February 2013

massDOT
Massachusetts Department of Transportation
Highway Division

Stormwater Outfalls
MassDOT Directly Contributing Watersheds
Impaired Stream Segment
Impaired Water Bodies
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 100 200 300 400 Feet

1 inch = 200 feet

Figure 2

Aldrich Pond (MA51002) Directly Contributing MassDOT Watershed

February 2013

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Impaired Waters Assessment for Middle River (MA51-02)

Impaired Waterbody

Name: Middle River

Location: Worcester, MA

Water Body ID: MA51-02

Impairments

The Middle River (MA51-02) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2010 Integrated List of Waters* (MassDEP, 2011). Middle River is impaired for the following:

- nutrient/eutrophication biological indicators
- other
- turbidity
- fecal coliform
- aquatic macroinvertebrate bioassessments
- (debris/floatables/trash*)
- (physical substrate habitat alterations*)

According to MassDEP's *Blackstone River Watershed 2003-2007 Water Quality Assessment Report* (MassDEP, 2010), the aquatic life use is impaired for physical substrate habitat alterations due to channelization and the primary and secondary contact as well as aesthetics are impaired for debris/floatables/trash due to unspecified urban stormwater. Middle River is also covered by a draft Total Maximum Daily Load (TMDL) for pathogens according to MassDEP's Draft Pathogen TMDL for the Blackstone River Watershed (MassDEP, no date).

Relevant Water Quality Standards

Water Body Classification: Class B, Warm Water Fishery

Applicable State Regulations:

- *314 CMR 4.05 (5) (c) Nutrients*. Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established by the Department pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.

- *314 CMR 4.05 (5) (b) Bottom Pollutants or Alterations.* All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.
- *301 CMR 4.05 (3)(b) 6 Color and Turbidity.* These waters shall be free from color and turbidity in concentrations or combinations that are aesthetically objectionable or would impair any use assigned to this Class.
- *314 CMR 4.05 (3)(b) 4 Bacteria*.
  - a. At bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: where E. coli is the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml; alternatively, where enterococci are the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no single sample taken during the bathing season shall exceed 61 colonies per 100 ml;
  - b. For other waters and, during the non bathing season, for waters at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: the geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml; alternatively, the geometric mean of all enterococci samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 61 colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department.
- *314 CMR 4.05 (3)(b) Solids*. These waters shall be free from floating, suspended and settleable solids in concentrations or combinations that would impair any use assigned to this class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.
- *314 CMR 4.05 (5) (a) Aesthetics*. All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.
- *314 CMR 4.05 (5)(e) Toxic Pollutants.* All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife. For pollutants not otherwise listed in 314 CMR 4.00, the National Recommended Water Quality Criteria: 2002, EPA 822R-02-047, November 2002 published by EPA pursuant to Section 304(a) of the Federal Water Pollution Control Act, are the allowable receiving water concentrations for the affected waters, unless the Department either establishes a site specific criterion or determines that naturally occurring background concentrations are higher. Where the Department determines that naturally occurring background concentrations are higher, those concentrations shall be the allowable receiving water concentrations. The Department shall use the water quality criteria for the protection of aquatic life expressed in terms of the dissolved fraction of metals when EPA's 304(a) recommended criteria provide for use of the dissolved fraction. The EPA recommended criteria based on total recoverable metals shall be converted to dissolved metals using EPA's published conversion factors. Permit limits will be written in terms of total recoverable metals. Translation from dissolved metals criteria to total recoverable metals permit limits will be based on EPA's conversion factors or other methods approved by the

Department. The Department may establish site specific criteria for toxic pollutants based on site specific considerations.

- *314 CMR 4.05 (3)(b) 1 Dissolved Oxygen*. Shall not be less than 6.0 mg/l in cold water fisheries and not less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.
- *314 CMR 4.05 (3)(b) 2 Temperature*.
    - a. Shall not exceed 68°F (20°C) based on the mean of the daily maximum temperature over a seven day period in cold water fisheries, unless naturally occurring. Where a reproducing cold water aquatic community exists at a naturally occurring higher temperature, the temperature necessary to protect the community shall not be exceeded and the natural daily and seasonal temperature fluctuations necessary to protect the community shall be maintained. Temperature shall not exceed 83°F (28.3°C) in warm water fisheries. The rise in temperature due to a discharge shall not exceed 3°F (1.7°0C) in rivers and streams designated as cold water fisheries nor 5°F (2.8°C) in rivers and streams designated as warm water fisheries (based on the minimum expected flow for the month); in lakes and ponds the rise shall not exceed 3°F (1.7°0C) in the epilimnion (based on the monthly average of maximum daily temperature);
    - b. natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained. There shall be no changes from natural background conditions that would impair any use assigned to this Class, including those conditions necessary to protect normal species diversity, successful migration, reproductive functions or growth of aquatic organisms;
- *314 CMR 4.05 (3)(b) 3 pH*. Shall be in the range of 6.5 through 8.3 standard units but not more than 0.5 units outside of the natural background range. There shall be no change from natural background conditions that would impair any use assigned to this Class.

Site Description

Middle River (MA51-02) flows for 3.1 miles from the outlet of Coes Pond to the confluence with the Blackstone River just downstream of the Tobias Boland Way Bridge in Worcester. The subwatershed and total watershed to Middle River are shown in **Figure 1**.

As shown in **Figure 2**, MassDOT-owned urban roadway within the Middle River subwatershed that potentially contributes stormwater runoff directly to Middle River include I-290 and Route 146, and five MassDOT-owned bridges: Cambridge Street Bridge, Exeter Street Bridge, Webster Street Bridge, Mill Street Bridge, and Park Street Bridge.

During a site visit on November 16, 2012, the directly contributing watershed from MassDOT roadway was determined to include approximately 1.3 miles of I-290 eastbound and westbound, portions of ramps to and from I-290 and three of the five bridges including Exeter Street Bridge, Webster Street Bridge, and Mill Street Bridge. The directly contributing watershed is shown in **Figure 3**. Brief descriptions of the drainage systems along each of the roadways in the subwatershed are given below.

<u>I-290</u>
Catch basins along I-290 and the ramps to and from Southbridge Street capture stormwater and discharge it directly to Middle River via pipe outlets. Northeast of the Southbridge Street ramp

system, more catch basin and pipe systems discharge stormwater runoff from I-290 directly to Middle River. Southwest of the Southbridge Street ramp system, catch basins along I-290 capture stormwater runoff and discharge it directly to the river via pipes and also discharge it to a ditch which conveys the water to the drainage system at the Southbridge Street ramps which also carries water directly to the river.

<u>Rte 146</u>
Catch basins along Route 146 capture stormwater runoff from the roadway. Some of the catch basins on Route 146 are piped directly to Middle River. Also, some of these catch basins are connected to a system which pipes the stormwater to an existing extended detention basin, described below. Stormwater that flows out of the detention basin flows directly into Middle River.

<u>Mill Street Bridge</u>
Stormwater runoff from the Mill Street bridge drains to a municipal drainage system which discharges to Middle River.

<u>Webster Street Bridge</u>
Stormwater runoff from the Webster Street Bridge directly enters Middle River via an outfall at the river.

<u>Exeter Street Bridge</u>
Stormwater runoff from the Exeter Street Bridge drains to a municipal drainage system which likely discharges to Middle River.

<u>Cambridge Street Bridge</u>
The Cambridge Street Bridge spans across Beaver Brook (MA51-07) which flows into Middle River. However, the road surface of the bridge is sloped away from Beaver Brook. Therefore, stormwater runoff from the bridge does not enter Beaver Brook and hence does not enter Middle River.

<u>Park Street Bridge</u>
The Park Street Bridge is surrounded by municipally-owned roadway. The bridge surface is sloped away from Middle River. Stormwater runoff from the bridge enters the municipal drainage system which likely does not drain to the river.

Assessment under BMP 7U

None of the impairments for Middle River (MA51-02) have been addressed by a final TMDL. Therefore, MassDOT assessed the impairments using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of stormwater on many impairments. For this water body, MassDOT used the IC method to assess the following impairments:

- nutrient/eutrophication biological indicators
- other
- turbidity
- fecal coliform
- aquatic macroinvertebrate bioassessments

According to MassDEP's final *Massachusetts Year 2010 Integrated List of Waters*, the impairments of debris/floatables/trash and physical substrate habitat alterations are not caused by pollutants (MassDEP, 2011). Therefore, these impairments are not considered further.

The impairment for pathogens is assessed separately in the section titled Assessment of Pathogen Impairment.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction necessary to attain the percent imperviousness in the watershed at which stormwater is not likely the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. IC data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer. In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for Middle River (MA51-02):

Table 1. Site Parameters for Middle River (MA51-02)

Total Watershed		
Watershed Area	40,200	acres
Impervious Cover (IC) Area	8,480	acres
Percent Impervious	21.1	%
IC Area at 9% Goal	3,610	acres
Target Reduction % in IC	57.4	%
Subwatershed		
Subwatershed Area	7,720	acres
Impervious Cover (IC) Area	2,280	acres
Percent Impervious	29.5	%
IC Area at 9% Goal	694	acres
Target Reduction % in IC	69.6	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	26.1	acres
MassDOT's Target Reduction in Effective IC (69.6% of DOT Directly Contributing IC)	18.1	acres

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 69.6%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 18.1 acres.

<u>Existing BMPs</u>

There is a stormwater basin located along Route 146 in between the mile marker 129 and 131 on the southbound side of the highway, adjacent to Middle River. This basin receives drainage from 3.5 acres of Route 146 before discharging to the river. The basin has a forebay to allow larger sediments to settle before overflowing into the main basin contoured to increase residence time and allow pollutants to settle before discharging into the Middle River. However, the outlet's invert is at the same elevation as the bottom of the basin and the drawdown time is less than 1 day; therefore, the IC Method does not provide any drawdown credit. Although the IC Method does not provide credit for the basin, this basin could easily gain credit from an outlet structure upgrade (i.e. reducing number of outlet pipes from two to one and installing an outlet pipe with a smaller diameter) to provide more attenuation. This basin should be considered for a stormwater improvement during retrofit design.

Mitigation Plan

Because there is no mitigation of impervious surface achieved by MassDOT BMPs to meet the reduction requirement of 15.5 acres, MassDOT will consider the implementation of BMPs.

Assessment of Pathogen Impairment

MassDOT assessed the pathogen impairment using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and*

Mitigation Plan), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by an order of magnitude within a given storm event at a single location (MassDEP, 2009b). Therefore, it is difficult to predict pathogen concentrations in stormwater with accuracy. Due to this difficulty, MassDOT generally will not conduct site specific assessments of loading at each location impaired for pathogens. Instead these sites will be assessed collectively based on available information on pathogen loading from highways, MassDOT actions, and information available from EPA and DEP. Based on this information MassDOT developed an approach to be consistent with relevant TMDL and permit condition requirements and an iterative adaptive management approach to stormwater management.

In addition, while there is a positive relationship between IC and pathogen loading, the relationship is not as direct as other impairments. According to the Center for Watershed Protection "…Other studies show that concentrations of bacteria are typically higher in urban areas than rural areas (USGS, 1999), but they are not always directly related to IC (CWP, 2003)." Therefore, DOT did not rely solely on the IC method to assess pathogen impairments. Instead, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

Pathogens in MassDOT Discharge

A study conducted on MassDOT's South East Expressway measured bacterial concentrations in stormwater runoff (Smith, 2002). This study found a geometric mean of 186 fecal coliforms/100 ml. Concentrations of pathogens in stormwater runoff from roadways can vary widely and pathogen concentrations in runoff across the state likely deviate significantly from this stretch of roadway's specific estimate. Event mean concentrations of fecal coliform bacteria in urban stormwater from other sources ranging between 14,000 and 17,000 fecal coliform organisms/100 mL have been reported (MassDEP, 2009b). These data suggest that pathogen loading from highways may be lower than other urban areas.

Consideration of the potential sources of pathogens supports the idea that pathogens are present in lower concentrations in highway runoff since potential pathogen sources are likely to be less prevalent in the highway environment than along other urban roadways:

- Illicit discharges: Due to the typical setback of highways from residential and commercial developments and the stand alone nature of the drainage system, the potential for illicit discharges (e.g. sewer connections, laundry tie-ins) is much lower than in other stormwater systems. This has been confirmed by MassDOT's illicit discharge detection on many miles of urban roadways within a broad range of areas across Massachusetts. After assessment of almost 140 miles, and investigation of more than 2,500 stormwater features, MassDOT's consultant performing the broad scope reviews has found no confirmed illicit discharges.
- Limited Sewer Utilities in Road Right of Ways: Since DOT does not provide sewer services, many MassDOT roads do not have sewer utilities within the road's right of way; thereby eliminating the chance of cross-connections or leaking pipes as a source of pathogens into the stormwater system.
- Pet waste: Pets are only present on highways in rare instances. In urban residential areas pets and their associated waste are much more common. MassDOT is aware that pet waste at road side rest stops may represent a potential source of pathogens to stormwater in certain situations.
- Wildlife: Highways are not generally an attractive place for wildlife. Wildlife generally avoids highways and only occasionally crosses them.

The dearth of pathogen sources on highways and the relatively low concentrations of pathogens measured in the South East Expressway study together suggest that pathogen loading from stormwater runoff from highways is lower than other urban sources.

Furthermore, in almost all cases the contribution of pathogens from MassDOT to a specific water body is likely to be very small relative to other sources of pathogens in the watershed. Since MassDOT urban roadways are linear and usually cross watersheds, they represent a small fraction of the receiving water body's watershed. The water quality within these water bodies is dependent on discharge from various sources, including discharges from other stormwater systems and a large number of other factors.

Assessment

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

TMDLs for pathogen impairments in Massachusetts recognize that pathogens are highly variable and difficult to address and emphasize the need for an iterative adaptive management approach to address pathogens. Examples of relevant language from these TMDLs are included below:

- "given the vast potential number of bacteria sources and the difficulty of identifying and removing them from some sources such as stormwater require an iterative process and will take some time to accomplish. While the stated goal in the TMDL is to meet the water quality standard at the point of discharge it also attempts to be clear that MassDEP's expectation is that for stormwater an iterative approach is needed…" (MassDEP, 2009a)
- "The NPDES permit does not, however, establish numeric effluent limitations for stormwater discharges. Maximum extent practicable (MEP) is the statutory standard that establishes the level of pollutant reductions that regulated municipalities must achieve. The MEP standard is a narrative effluent limitation that is satisfied through implementation of SWMPs and achievement of measurable goals."(MassDEP, 2009b)
- "Although the TMDL presents quantified WLAs for stormwater that are set equivalent to the criteria in the Massachusetts Water Quality Standards, the Phase II NPDES permits will not include numeric effluent limitations. Phase II permits are intended to be BMP based permits that will require communities to develop and implement comprehensive stormwater management programs involving the use of BMPs. Massachusetts and EPA believe that BMP based Phase II permits involving comprehensive stormwater management together with specific emphasis on pollutants contributing to existing water quality problems can be consistent with the intent of the quantitative WLAs for stormwater discharges in TMDLs." (MassDEP, no date).

This language clearly indicates that an iterative adaptive management approach is the appropriate way to address discharges to pathogen impaired waters. The recommendations in pathogen TMDLs for waters in Massachusetts generally require development and implementation of stormwater management programs, illicit discharge detection and elimination efforts, and in some cases installing BMPs to the maximum extent practicable

The draft North Coastal Watershed General MS4 permit and the draft Interstate, Merrimack, and South Coastal (IMS) watershed permits contain specific requirements for compliance with pathogen TMDLs (in Appendix G). While these permits are still in draft form, MassDOT believes they represent the best available guidance on what EPA believes is appropriate for addressing stormwater discharges to pathogen-impaired waters. Section 2.2.1(c) of the permit states "For any discharge from its MS4 to impaired waters with an approved TMDL, the permittee shall comply with the specific terms of Part 2.1 of this permit. In addition, where an approved TMDL establishes a

WLA that applies to its MS4 discharges, the permittee shall implement the specific BMPs and other permit requirements identified in Appendix G to achieve consistency with the WLA." Appendix G references a number of programmatic BMPs that are necessary to address pathogen loading. These cover the following general topics:

- Residential educational program
- Illicit connection identification, tracking and removal
- Pet waste management

Mitigation Plan

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Stormwater Management Plan (SWMP) including educational programs, illicit connection review and source control. The specific BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In
- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

In addition, the structural BMPs that will be considered to reduce the IC will also have the effect of reducing pathogen loads.

MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations. MassDOT's existing stormwater management plan outlines BMPs that include education and illicit discharge detection and elimination. MassDOT will be implementing a pet waste management program at its rest stops that have discharges to pathogen impaired waters.

Conclusions

MassDOT used the IC Method to assess the Middle River (MA51-02) for the impairments identified in MassDEP's final *Massachusetts Year 2010 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed by 18.1 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to the Middle River (MA51-02) to identify existing BMPs and found that no existing BMPs reduce effective IC. This information is summarized in Table 2 below.

Table 2. Effective IC Reductions under Existing & Proposed Conditions

IC in Directly Contributing Watershed	26.1	acres

Target Reduction in Effective IC	18.1	acres
IC Effectively Reduced by Existing BMPs	0.0	acres
IC Remaining to Mitigate with Proposed BMPs	**18.1**	**acres**

MassDOT should reduce its effective IC within the directly contributing watershed by 18.1 acres to achieve the targeted reduction in IC. MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs to treat directly contributing IC as part of MassDOT's Impaired Waters Retrofit Initiative. The stormwater basin along Route 146 should be considered for stormwater improvements. The design consultants will develop construction plans for BMPs that will aim to provide the target IC reduction or treatment to the maximum extent practicable.

Furthermore, MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of additional BMPs, and finalized assessments including reductions achieved by finalized BMP designs. MassDOT will also continue to implement non-structural BMPs that reduce the impacts of stormwater.

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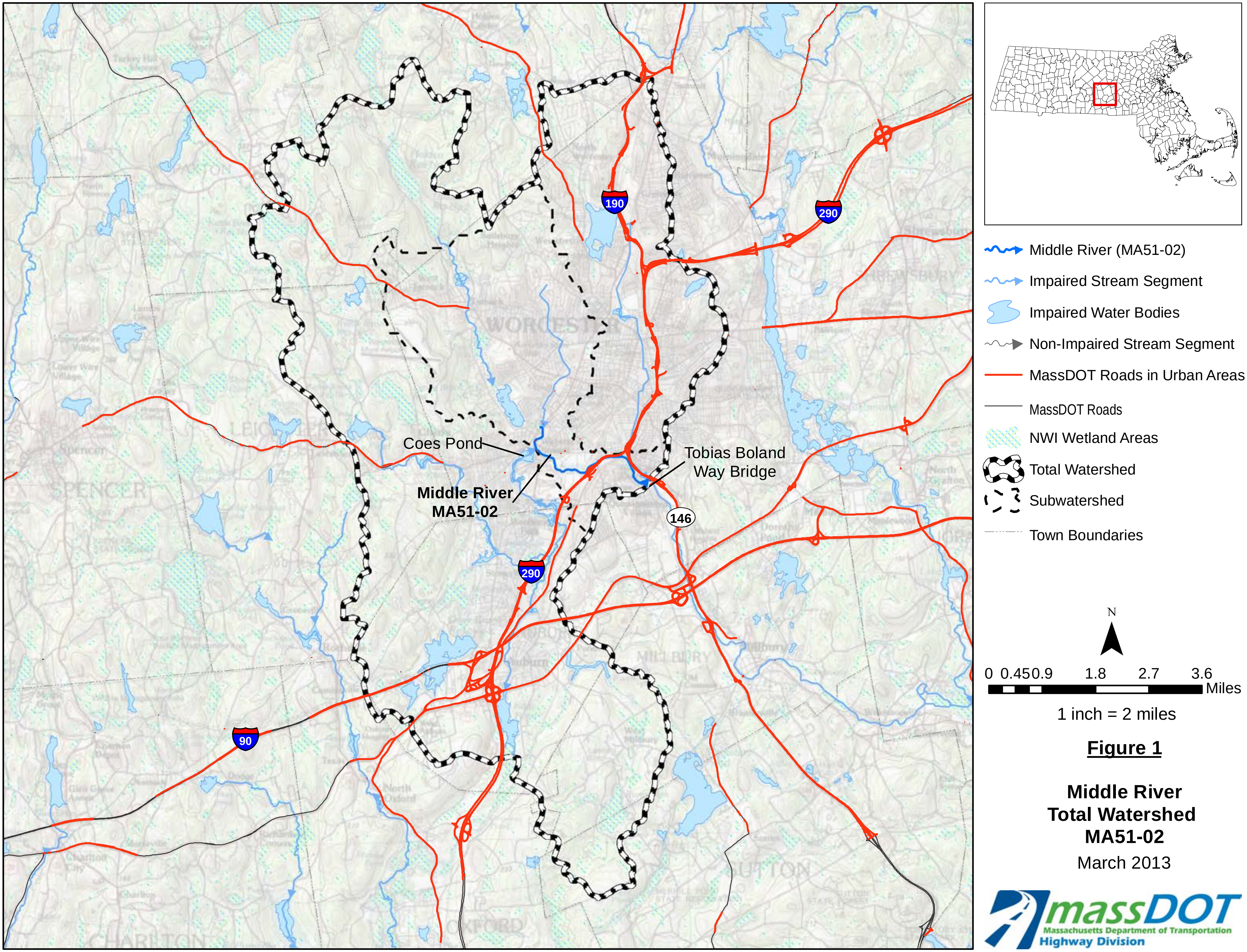


Figure 1

Middle River
Total Watershed
MA51-02
March 2013

massDOT
Massachusetts Department of Transportation
Highway Division

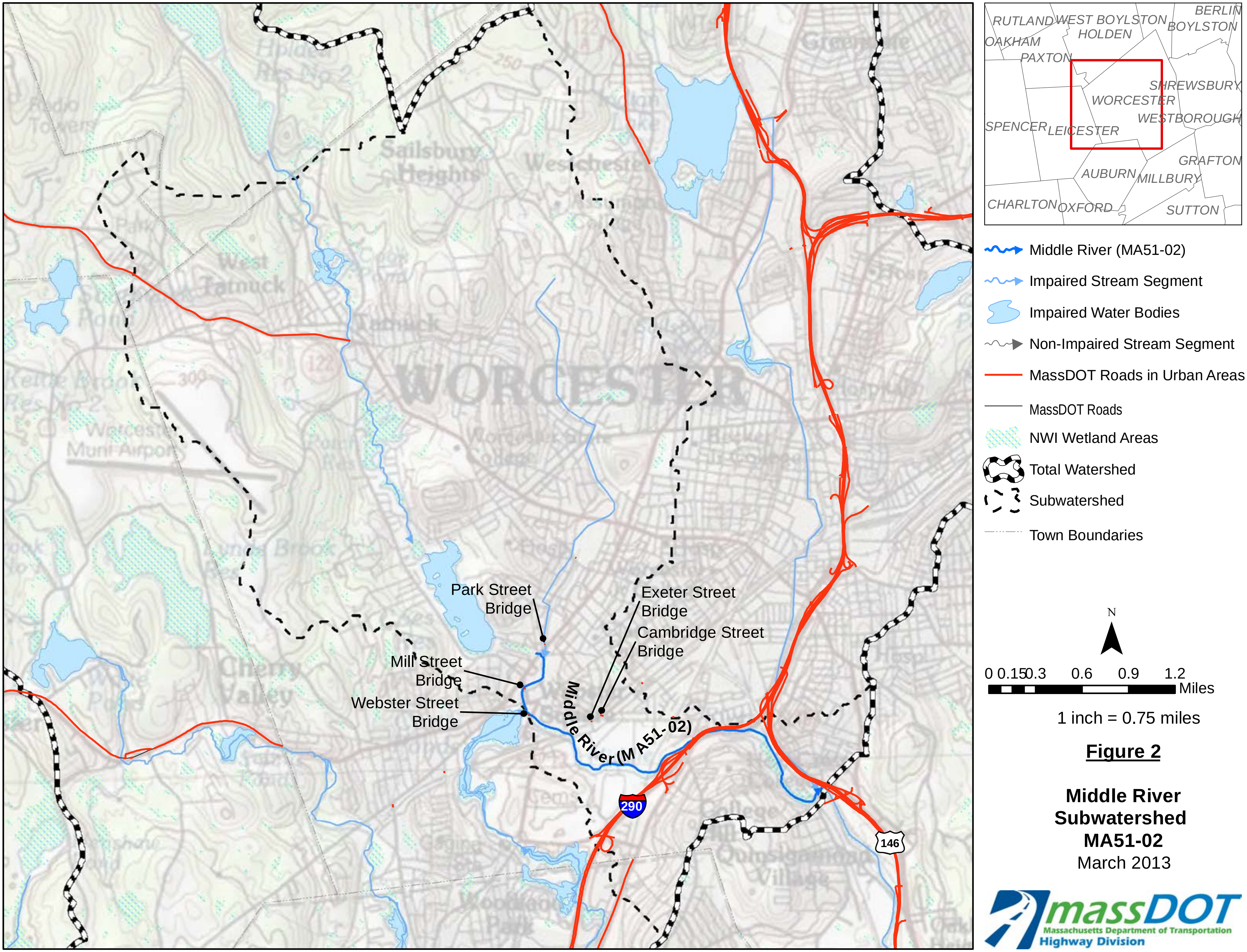


Figure 2

Middle River Subwatershed MA51-02

March 2013

massDOT Massachusetts Department of Transportation Highway Division

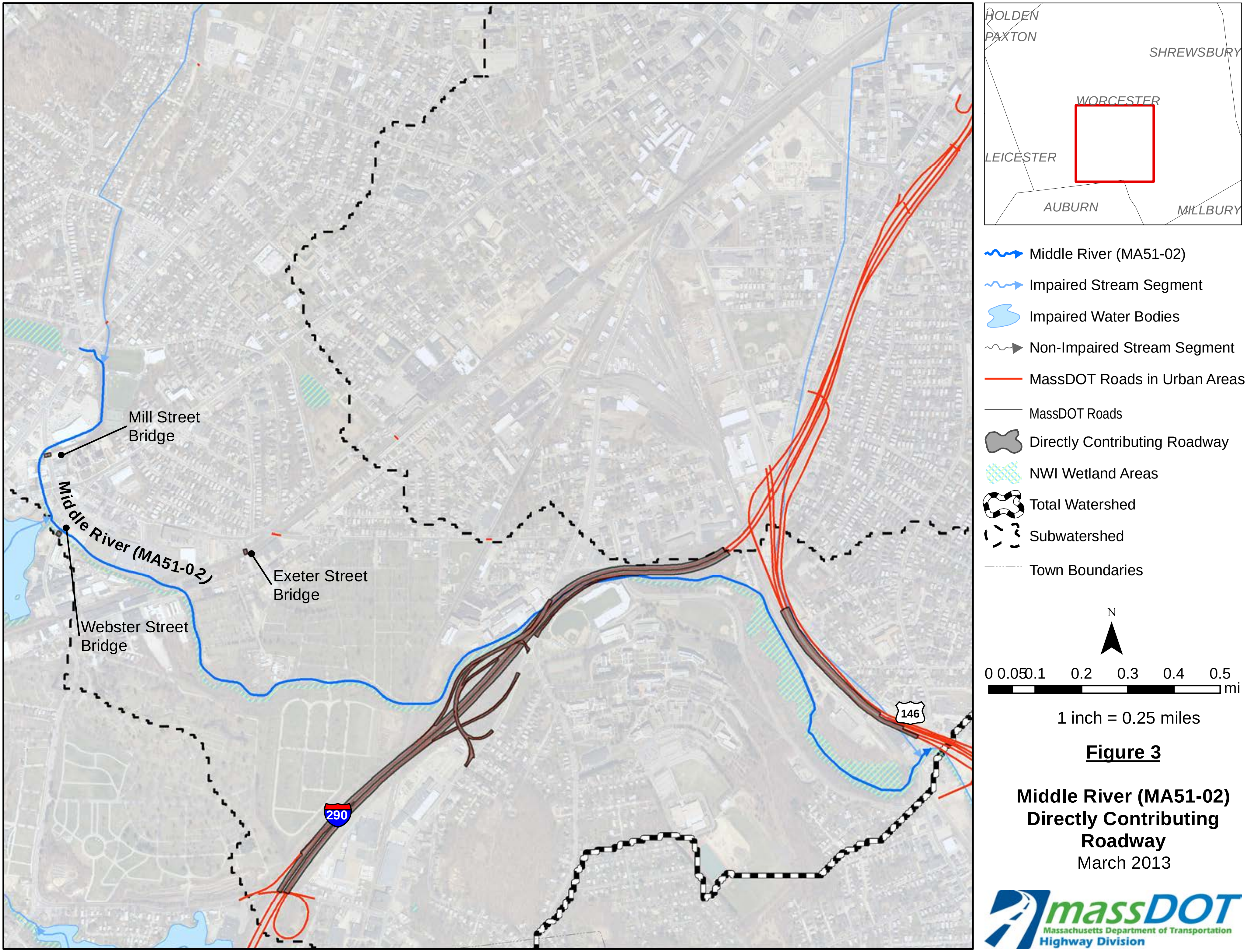
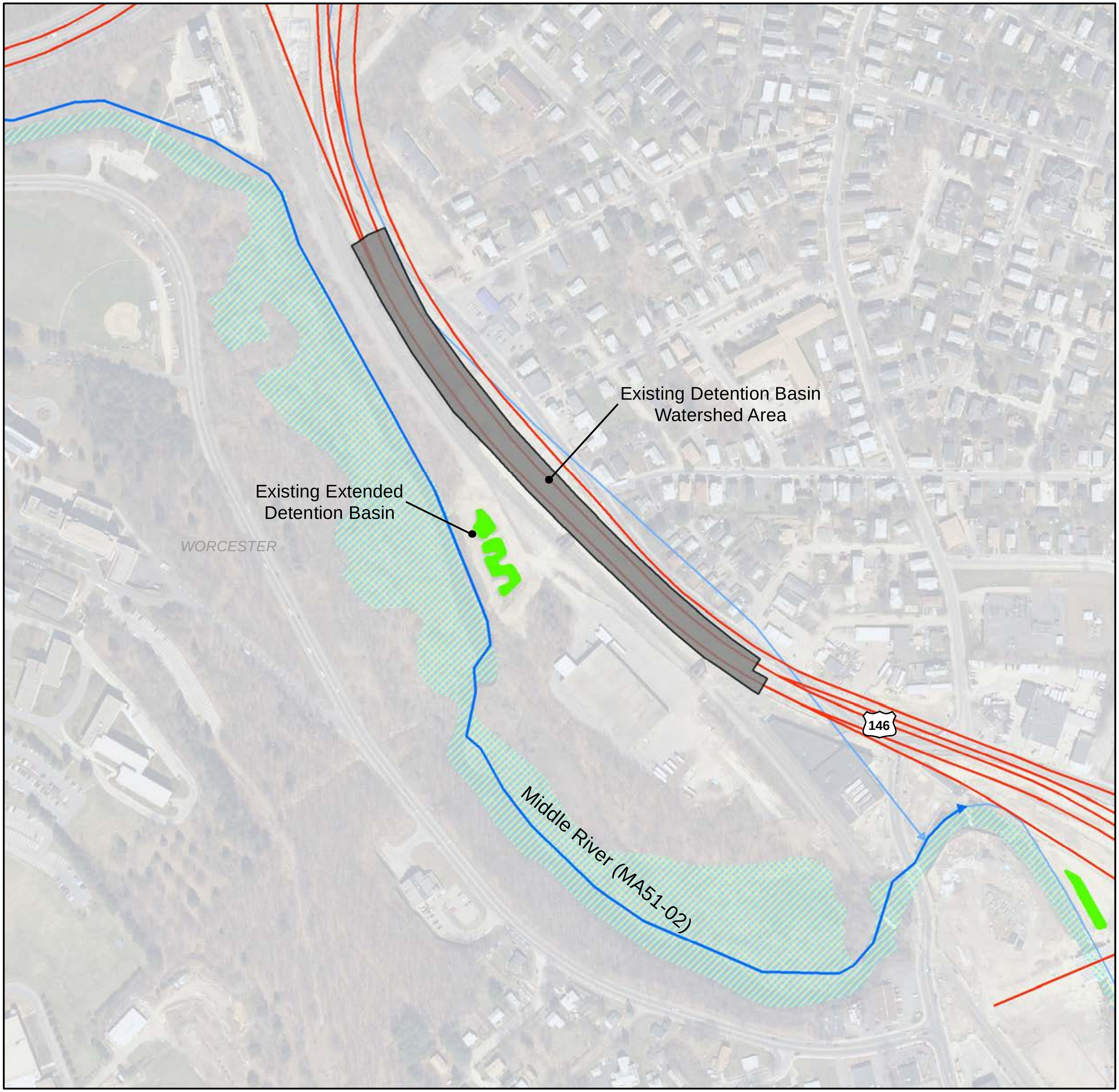
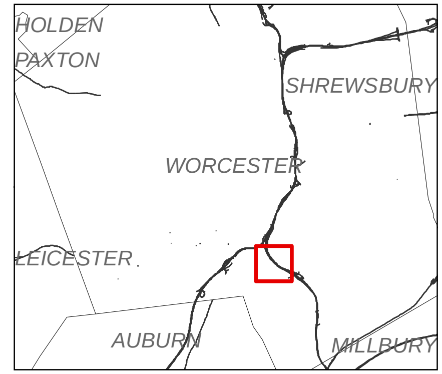


Figure 3

Middle River (MA51-02) Directly Contributing Roadway

March 2013





BMP Watershed
Existing BMP
Middle River (MA51-02)
Impaired Stream Segment
Impaired Water Bodies
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 70 140 280 420 560 700 Feet

1 inch = 375 feet

Figure 3

Middle River (MA51-02) BMP Watersheds

March 2013

massDOT Massachusetts Department of Transportation Highway Division

Impaired Waters Assessment for Blackstone River (MA51-04) Including Former Segments Rice City Pond (51131) and Riverdale Impoundment (51136) – Progress Report

Impaired Water Body

Name: Blackstone River including former segments Rice City Pond, and Riverdale Impoundment

Location: Grafton, Northbridge and Uxbridge, MA

Water Body IDs: MA51-04, MA51131, and MA51136

The final *Massachusetts Year 2010 Integrated List of Waters* (MassDEP, 2011) does not identify Rice City Pond (MA51131) and Riverdale Impoundment (MA51136) as water bodies that are separate from the Blackstone River (MA51-04). These water bodies were previously considered separately under the 303d listing. They are now considered run-of-river impoundments and are included with the impairments associated with the Blackstone River (MA51-04).

Impairments

The Blackstone River (MA51-04) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). The Blackstone River is impaired for the following designated uses: aesthetics, fish consumption, fish, other aquatic life and wildlife habitat, primary contact recreation, and secondary contact recreation. The causes of these designated use impairments are listed as the following chemical, physical, and biological characteristics:

- (Other flow regime alterations*)
- (physical substrate habitat alterations*)
- aquatic macroinvertebrate bioassessments
- cadmium
- copper
- DDT
- Escherichia coli
- excess algal growth
- fishes bioassessments
- lead
- nutrient/eutrophication biological indicators
- PCB(s) in fish tissue
- total phosphorus
- sedimentation/siltation
- taste and odor
- turbidity

The Blackstone River is also covered by a draft Total Maximum Daily Load (TMDL) for pathogens according to MassDEP's Draft Pathogen TMDL for the Blackstone River Watershed (MassDEP, no date).

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *314 CMR 4.05 (3)(b) 5 Solids*. These waters shall be free from floating, suspended and settleable solids in concentrations or combinations that would impair any use assigned to this class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.
- *314 CMR 4.05 (3)(b) 1 Dissolved Oxygen.* Shall not be less than 6.0 mg/l in cold water fisheries and not less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.
- *315 CMR 4.05 (3)(b) 2 Temperature*.

    a. Shall not exceed 68°F (20°C) based on the mean of the daily maximum temperature over a seven day period in cold water fisheries, unless naturally occurring. Where a reproducing cold water aquatic community exists at a naturally occurring higher temperature, the temperature necessary to protect the community shall not be exceeded and the natural daily and seasonal temperature fluctuations necessary to protect the community shall be maintained. Temperature shall not exceed 83°F (28.3°C) in warm water fisheries. The rise in temperature due to a discharge shall not exceed 3°F (1.7°0C) in rivers and streams designated as cold water fisheries nor 5°F (2.8°C) in rivers and streams designated as warm water fisheries (based on the minimum expected flow for the month); in lakes and ponds the rise shall not exceed 3°F (1.7°0C) in the epilimnion (based on the monthly average of maximum daily temperature);

    b. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained. There shall be no changes from natural background conditions that would impair any use assigned to this Class, including those conditions necessary to protect normal species diversity, successful migration, reproductive functions or growth of aquatic organisms;

- *314 CMR 5.04 (3)(b) 3 pH.* Shall be in the range of 6.5 through 8.3 standard units but not more than 0.5 units outside of the natural background range. There shall be no change from natural background conditions that would impair any use assigned to this Class.
- *314 CMR 4.05 (3)(b) 6 Color and Turbidity*. These waters shall be free from color and turbidity in concentrations or combinations that are aesthetically objectionable or would impair any use assigned to this class.
- *314 CMR 4.05 (3)(b) 4 Bacteria*.

    a. At bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: where E. coli is the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml; alternatively, where enterococci are the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no

single sample taken during the bathing season shall exceed 61 colonies per 100 ml;

b. For other waters and, during the non bathing season, for waters at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: the geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml; alternatively, the geometric mean of all enterococci samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 61 colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department

- *314 CMR 4.05 (5) (b) Bottom Pollutants or Alterations*. All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.
- *314 CMR 4*.05 (5)(c) *Nutrients*. Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established by the Department pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.
- *314 CMR 4.05 (5)(e) Toxic Pollutants.* All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife. For pollutants not otherwise listed in 314 CMR 4.00, the National Recommended Water Quality Criteria: 2002, EPA 822R-02-047, November 2002 published by EPA pursuant to Section 304(a) of the Federal Water Pollution Control Act, are the allowable receiving water concentrations for the affected waters, unless the Department either establishes a site specific criterion or determines that naturally occurring background concentrations are higher. Where the Department determines that naturally occurring background concentrations are higher, those concentrations shall be the allowable receiving water concentrations. The Department shall use the water quality criteria for the protection of aquatic life expressed in terms of the dissolved fraction of metals when EPA's 304(a) recommended criteria provide for use of the dissolved fraction. The EPA recommended criteria based on total recoverable metals shall be converted to dissolved metals using EPA's published conversion factors. Permit limits will be written in terms of total recoverable metals. Translation from dissolved metals criteria to total recoverable metals permit limits will be based on EPA's conversion factors or other methods approved by the Department. The Department may establish site specific criteria for toxic pollutants based on site specific considerations.

Site Description

The MA51-04 segment of the Blackstone River is 8.8 miles long and extends from the Fisherville Dam in Grafton to the outlet of Rice City Pond (MA51131) in Uxbridge (**Figure 1**). Rice City Pond

(MA51131) and Riverdale Impoundment (MA51136) are considered run-of-river impoundments along the Blackstone River since their estimated retention times are less than one day (MassDEP, 2010). Water quality assessments prior to 2010 listed these water bodies separately.

State Route 122 is situated along the Blackstone River (MA51-04) throughout this reach of the river (**Figure 2**). There are many areas of Route 122 with stormwater sewers that discharge directly to tributary streams that are in close proximity to the Blackstone River. There are also many sections of roadway that discharge to low-lying areas that do not appear to have established outlets. The soils along Route 122 in the Blackstone River (MA51-04) subwatershed are primarily classified as hydrologic soil group (HSG) type A or B, so infiltration of stormwater runoff from Route 122 is likely occurring at many outfall locations. As a result, there are many sections of Route 122 that are not considered to be directly discharging to the Blackstone River because roadway runoff appears to be naturally infiltrating near the outfalls.

MassDOT's property that directly contributes stormwater runoff to the Blackstone River (MA51-04) consists of approximately 2.27 miles (7.8 acres) of Route 122 and approximately 2,870 square feet of the Route 122A/Main Street bridge over the Blackstone River (**Figures 3a – 3e)**. The northernmost segment of Route 122 that directly discharges to the Blackstone River extends from approximately 0.44 miles north to approximately 0.16 miles south of the Route 122 and Route 122A/Main Street intersection in Grafton (**Figure 3a**). The northern 0.37 miles of this road segment drains via catch basins and storm drains that discharge directly to a channelized tributary stream that flows into the Blackstone River within 0.27 miles of this point. The southern 0.23 miles of this road segment drains via catch basins and storm drains to three outfalls that are assumed to daylight adjacent to the Blackstone River, though due to private property access and lack of drainage plans for this area, this assumption could not be confirmed.

A 0.48-mile segment of Route 122 that directly contributes runoff to the Blackstone River is situated between approximately 325 feet northwest of the King Street intersection and 380 feet southeast of the Milford Road intersection with Route 122 (**Figure 3b).** This road area drains via catch basins and storm drains that discharge directly into a tributary stream that flows approximately 0.25 miles from Route 122 to the Blackstone River.

Approximately 0.62 miles of Route 122 from Mahoney Lane to approximately 500 feet southeast of Wards Lane in Northbridge drain via catch basins and storm drains to three outfalls (**Figure 3c**). The northwestern 0.40 mile portion of this Route 122 segment is assumed to drain into the culvert that conveys a tributary stream under the road. The tributary stream flows into the Blackstone River approximately 450 feet from Route 122. The two outfalls on the southeastern portion of this segment of Route 122 discharge to forested areas within 40 feet of the Blackstone River. Some points of concentrated overbank flow also exist along this road segment.

MassDOT property in Northbridge includes the Route 122 bridge over the Blackstone River that is approximately 0.32 miles south of the center of Northbridge (**Figure 3d**). This bridge is in the process of being rebuilt. It is assumed that drainage from this bridge will be a direct discharge to the Blackstone River. MassDOT does not own the 0.77 mile portion of Route 122 within the center of the village of Northbridge.

Approximately 0.45 miles of Route 122 from Dudley Avenue to the intersection with Church Street is drained by catch basins and storm drains (**Figure 3e**). Details of this storm drainage system could not be derived from available drawings. Observations of pipe inverts indicate the 1.5-acre area of this road segment drains north to an outfall pipe that discharges to a highly eroded drainage channel. This channel appears to lead to the Blackstone River within 0.25 miles of Route 122.

Drainage from other segments of Route 122 within the Blackstone River (MA51-04) watershed were identified and evaluated for their potential direct contribution to the Blackstone River. Road segments not described above were considered not directly contributing stormwater runoff to the Blackstone River, thus were not included in the calculations of MassDOT property subject to pollutant load reduction.

Assessment under BMP 7U

None of the following impairments for the Blackstone River have been addressed by a TMDL. Therefore, MassDOT assessed the impairments using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of stormwater on many impairments. For this water body, MassDOT used the IC method to assess the following impairments:

- nutrient/eutrophication biological indicators
- sedimentation/siltation
- turbidity
- metals (cadmium, copper, and lead)
- aquatic macroinvertebrate bioassessments
- PCB(s) in fish tissue
- taste and odor

According to MassDEP's final *Massachusetts Year 2010 Integrated List of Waters*, the impairment of physical substrate habitat alterations and other flow regime alterations are not caused by pollutants (MassDEP, 2011). Therefore, this impairment is not considered further.

MassDOT concluded that the impairment for PCB in fish tissue is unrelated to stormwater runoff. The Nationwide Urban Runoff Program (NURP) conducted by the EPA found that PCB was detected in less than 1% of stormwater samples collected (EPA, 1983). Therefore, MassDOT concluded that stormwater runoff from its roadways does not contribute to the impairments of PCB in fish tissue.

The impairment for fecal coliform is assessed separately in the section titled, Assessment of Pathogen Impairment.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction necessary to attain the percent imperviousness in the watershed at which stormwater is not likely the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. IC data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer. In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for the Blackstone River (MA51-04):

Table 1. Site Parameters for Blackstone River (MA51-04)

Subwatershed		
Watershed Area	7,690	acres
Impervious Cover (IC) Area	827	acres
Percent Impervious	10.8	%
IC Area at 9% Goal	692	acres
Target Reduction % in IC	16.3	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	7.8	acres
MassDOT's Target Reduction in Effective IC (16.3% of DOT Directly Contributing IC)	1.3	acres

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 16.3%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 1.3 acres.

Existing BMPs

There are no existing BMPs in the Blackstone River (MA51-04) directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to the Blackstone River.

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 1.3 acres, MassDOT will consider the implementation of additional BMPs.

Assessment of Pathogen Impairment

MassDOT assessed the pathogen impairment using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by an order of magnitude within a given storm event at a single location (MassDEP, 2009b). Therefore, it is difficult to predict pathogen concentrations in stormwater with accuracy. Due to this difficulty, MassDOT generally will not conduct site specific assessments of loading at each location impaired for pathogens. Instead these sites will be assessed collectively based on available information on pathogen loading from highways, MassDOT actions, and information available from EPA and DEP. Based on this information MassDOT developed an approach to be consistent with relevant TMDL and permit condition requirements and an iterative adaptive management approach to stormwater management.

In addition, while there is a positive relationship between IC and pathogen loading, the relationship is not as direct as other impairments. According to the Center for Watershed Protection "…Other studies show that concentrations of bacteria are typically higher in urban areas than rural areas (USGS, 1999), but they are not always directly related to IC (CWP, 2003)." Therefore, DOT did not rely solely on the IC method to assess pathogen impairments. Instead, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

Pathogens in MassDOT Discharge

A study conducted on MassDOT's South East Expressway measured bacterial concentrations in stormwater runoff (Smith, 2002). This study found a geometric mean of 186 fecal coliforms/100 ml. Concentrations of pathogens in stormwater runoff from roadways can vary widely and pathogen concentrations in runoff across the state likely deviate significantly from this stretch of roadway's specific estimate. Event mean concentrations of fecal coliform bacteria in urban stormwater from other sources ranging between 14,000 and 17,000 fecal coliform organisms/100 mL have been reported (MassDEP, 2009b). These data suggest that pathogen loading from highways may be lower than other urban areas.

Consideration of the potential sources of pathogens supports the idea that pathogens are present in lower concentrations in highway runoff since potential pathogen sources are likely to be less prevalent in the highway environment than along other urban roadways:

- <u>Illicit discharges:</u> Due to the typical setback of highways from residential and commercial developments and the stand alone nature of the drainage system, the potential for illicit discharges (e.g. sewer connections, laundry tie-ins) is much lower than in other stormwater systems. This has been confirmed by MassDOT's illicit discharge detection on many miles of urban roadways within a broad range of areas across Massachusetts. After assessment of almost 140 miles, and investigation of more than 2,500 stormwater features, MassDOT's consultant performing the broad scope reviews has found no confirmed illicit discharges.

- Limited Sewer Utilities in Road Right of Ways: Since DOT does not provide sewer services, many MassDOT roads do not have sewer utilities within the road's right of way; thereby eliminating the chance of cross-connections or leaking pipes as a source of pathogens into the stormwater system.
- Pet waste: Pets are only present on highways in rare instances. In urban residential areas pets and their associated waste are much more common. MassDOT is aware that pet waste at road side rest stops may represent a potential source of pathogens to stormwater in certain situations.
- Wildlife: Highways are not generally an attractive place for wildlife. Wildlife generally avoids highways and only occasionally crosses them.

The dearth of pathogen sources on highways and the relatively low concentrations of pathogens measured in the South East Expressway study together suggest that pathogen loading from stormwater runoff from highways is lower than other urban sources.

Furthermore, in almost all cases the contribution of pathogens from MassDOT to a specific water body is likely to be very small relative to other sources of pathogens in the watershed. Since MassDOT urban roadways are linear and usually cross watersheds, they represent a small fraction of the receiving water body's watershed. The water quality within these water bodies is dependent on discharge from various sources, including discharges from other stormwater systems and a large number of other factors.

Assessment

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

TMDLs for pathogen impairments in Massachusetts recognize that pathogens are highly variable and difficult to address and emphasize the need for an iterative adaptive management approach to address pathogens. Examples of relevant language from these TMDLs are included below:

- "given the vast potential number of bacteria sources and the difficulty of identifying and removing them from some sources such as stormwater require an iterative process and will take some time to accomplish. While the stated goal in the TMDL is to meet the water quality standard at the point of discharge it also attempts to be clear that MassDEP's expectation is that for stormwater an iterative approach is needed…" (MassDEP, 2009a)
- "The NPDES permit does not, however, establish numeric effluent limitations for stormwater discharges. Maximum extent practicable (MEP) is the statutory standard that establishes the level of pollutant reductions that regulated municipalities must achieve. The MEP standard is a narrative effluent limitation that is satisfied through implementation of SWMPs and achievement of measurable goals."(MassDEP, 2009b)
- "Although the TMDL presents quantified WLAs for stormwater that are set equivalent to the criteria in the Massachusetts Water Quality Standards, the Phase II NPDES permits will not include numeric effluent limitations. Phase II permits are intended to be BMP based permits that will require communities to develop and implement comprehensive stormwater management programs involving the use of BMPs. Massachusetts and EPA believe that BMP based Phase II permits involving comprehensive stormwater management together with specific emphasis on pollutants contributing to existing water quality problems can be consistent with the intent of the quantitative WLAs for stormwater discharges in TMDLs." (MassDEP, 2002).

This language clearly indicates that an iterative adaptive management approach is the appropriate way to address discharges to pathogen impaired waters. The recommendations in pathogen TMDLs for waters in Massachusetts generally require development and implementation of stormwater management programs, illicit discharge detection and elimination efforts, and in some cases installing BMPs to the maximum extent practicable.

The draft North Coastal Watershed General MS4 permit and the draft Interstate, Merrimack, and South Coastal (IMS) watershed permits contain specific requirements for compliance with pathogen TMDLs (in Appendix G). While these permits are still in draft form, MassDOT believes they represent the best available guidance on what EPA believes is appropriate for addressing stormwater discharges to pathogen-impaired waters. Section 2.2.1(c) of the permit states "For any discharge from its MS4 to impaired waters with an approved TMDL, the permittee shall comply with the specific terms of Part 2.1 of this permit. In addition, where an approved TMDL establishes a WLA that applies to its MS4 discharges, the permittee shall implement the specific BMPs and other permit requirements identified in Appendix G to achieve consistency with the WLA." Appendix G references a number of programmatic BMPs that are necessary to address pathogen loading. These cover the following general topics:

- Residential educational program
- Illicit connection identification, tracking and removal
- Pet waste management

Mitigation Plan

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Stormwater Management Plan (SWMP) including educational programs, illicit connection review and source control. The specific BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In
- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

In addition, the structural BMPs that will be considered to reduce the IC will also have the effect of reducing pathogen loads.

MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations. MassDOT's existing stormwater management plan outlines BMPs that include education and illicit discharge detection and elimination. MassDOT will be implementing a pet waste management program at its rest stops that have discharges to pathogen impaired waters.

Conclusions

MassDOT used the IC Method to assess the Blackstone River (MA51-04) for the impairments identified in MassDEP's final *Massachusetts Year 2010 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed by 1.3 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to the Blackstone River to identify existing BMPs and found that no BMPs exist to reduce effective IC. This information is summarized in Table 2 below.

Table 2. Effective IC Reductions under Existing & Proposed Conditions

IC in Directly Contributing Watershed	7.8	acres
Target Reduction in Effective IC	1.3	acres
IC Effectively Reduced by Existing BMPs	0	acres
IC Remaining to Mitigate with Proposed BMPs	**1.3**	**acres**

MassDOT should reduce its effective IC within the directly contributing watershed by an additional 1.3 acres to achieve the targeted reduction in IC. MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs to treat directly contributing IC as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide the target IC reduction or treatment to the maximum extent practicable.

Furthermore, MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of additional BMPs, and finalized assessments including reductions achieved by finalized BMP designs. MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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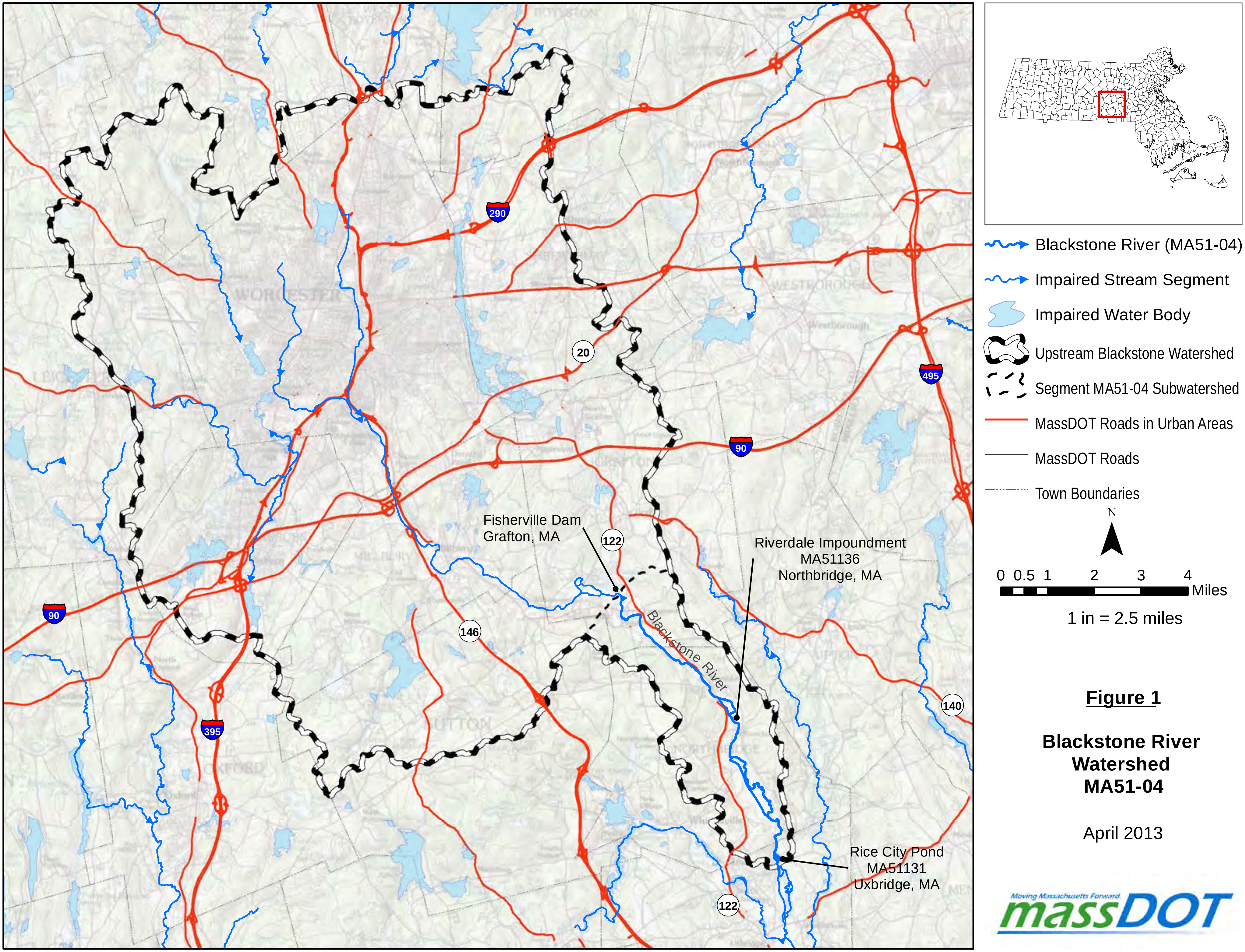

Figure 1

Blackstone River Watershed MA51-04

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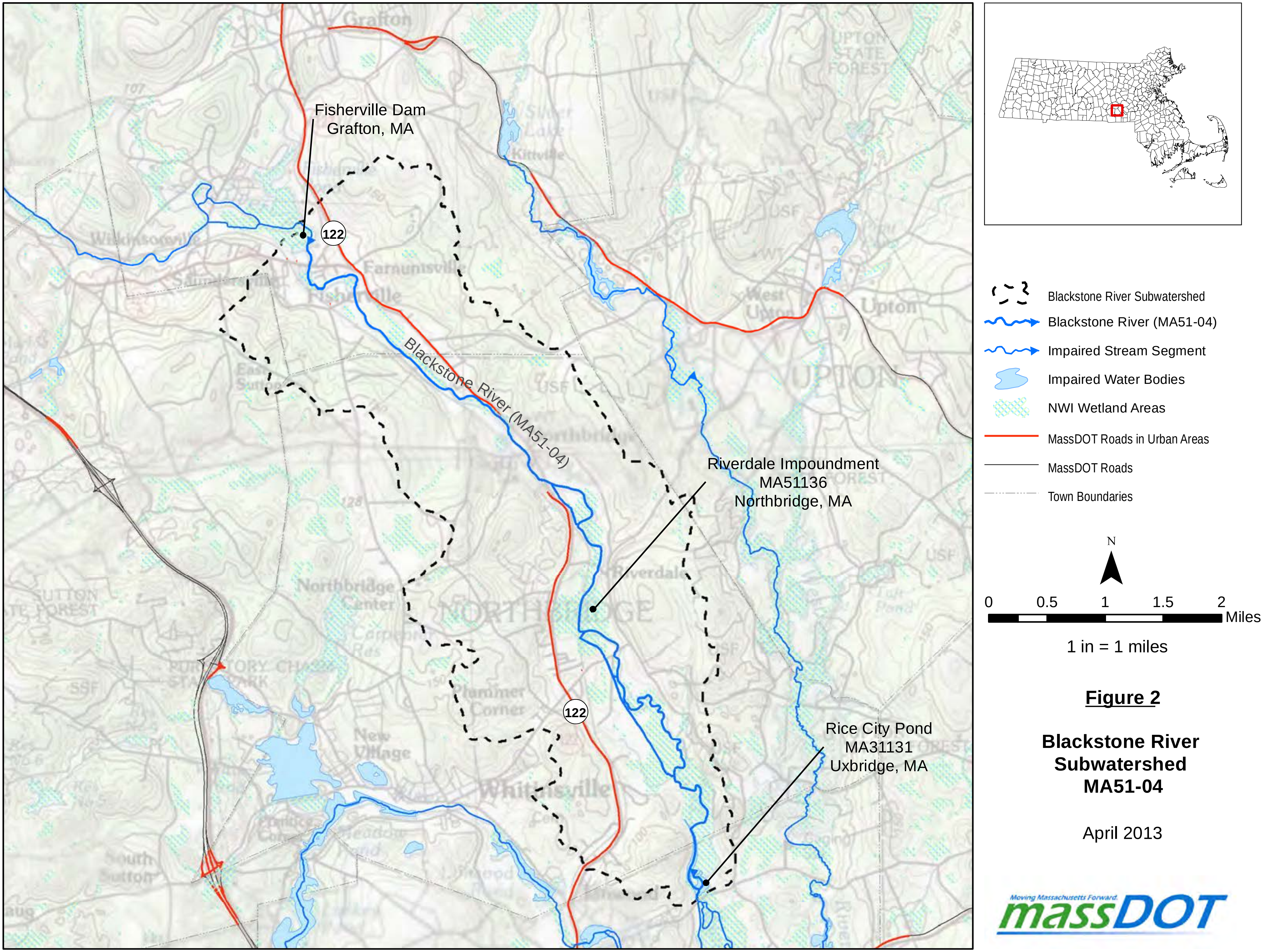

Figure 2

Blackstone River Subwatershed MA51-04

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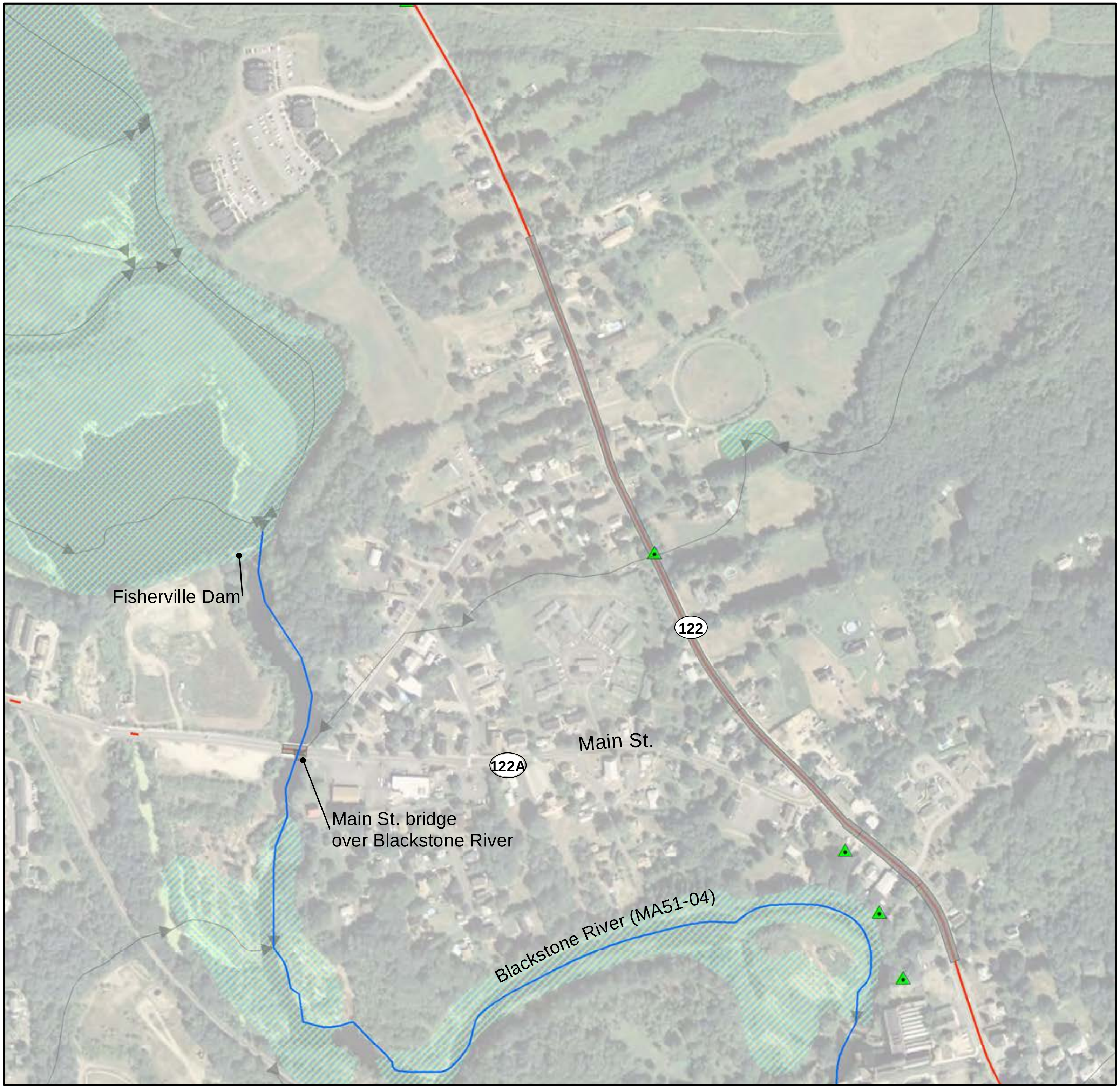

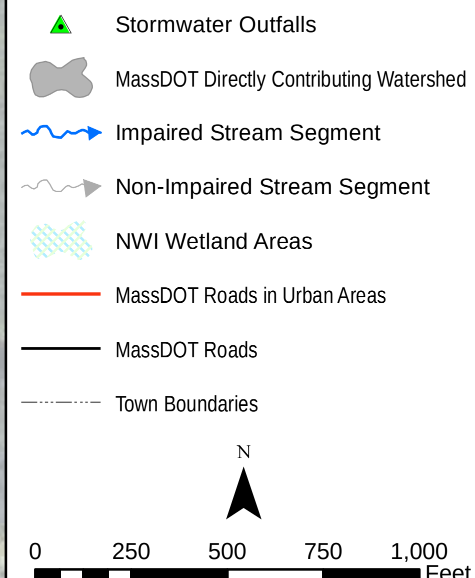

Figure 3a

Blackstone River MA51-04 Directly Contributing MassDOT Watershed

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Stormwater Outfalls

MassDOT Directly Contributing Watershed

Impaired Stream Segment

Non-Impaired Stream Segment

NWI Wetland Areas

MassDOT Roads in Urban Areas

MassDOT Roads

Town Boundaries

N

0 250 500 750 1,000 Feet

1 inch = 500 feet

Figure 3b

Blackstone River
MA51-04
Directly Contributing
MassDOT Watershed

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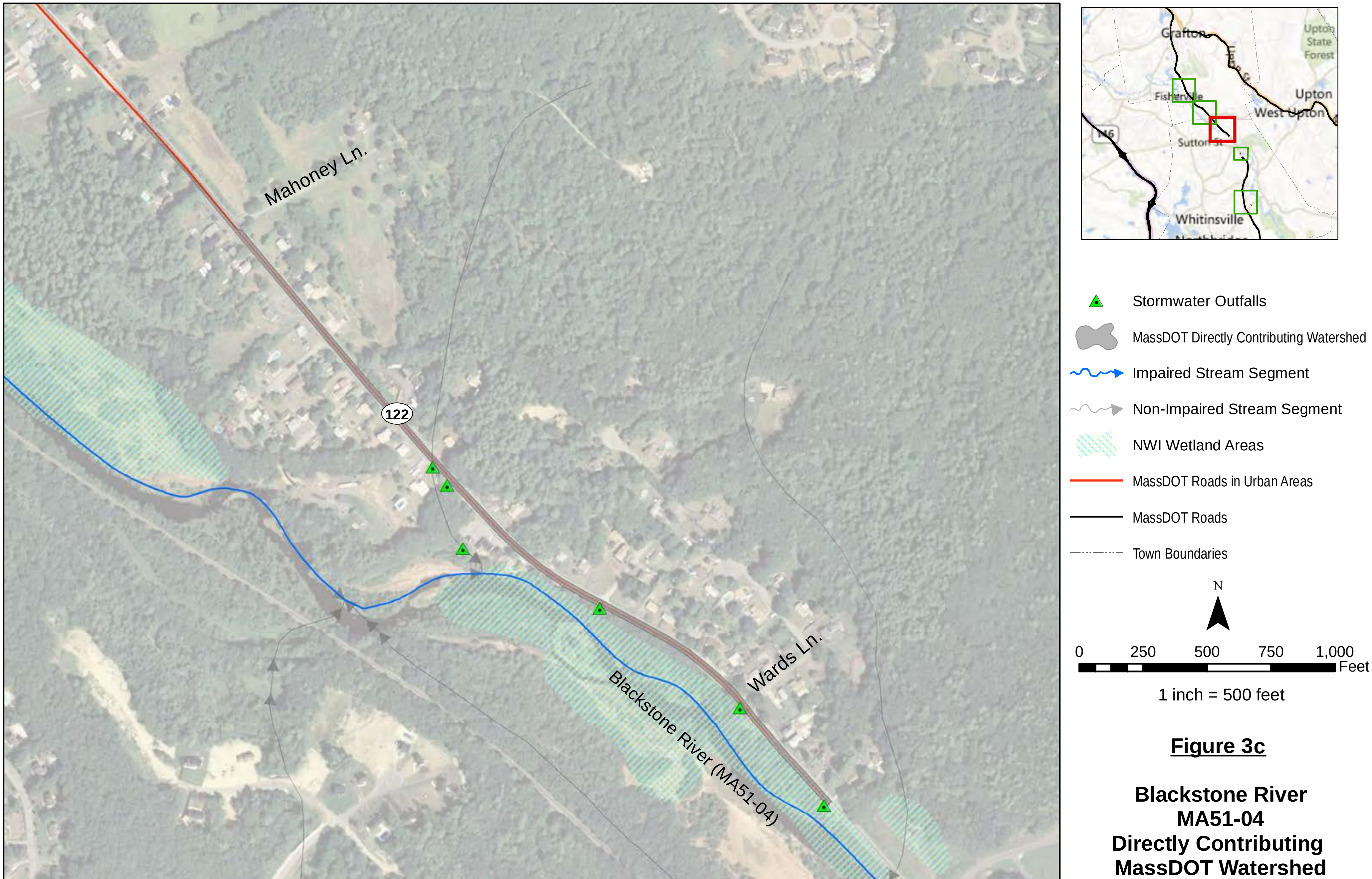

Figure 3c

Blackstone River MA51-04 Directly Contributing MassDOT Watershed

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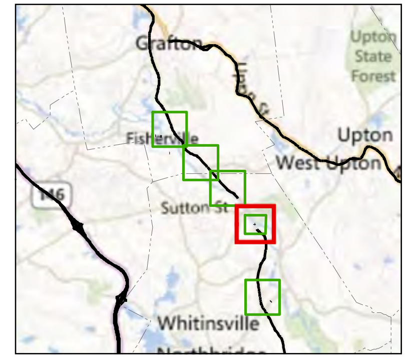

Stormwater Outfalls

MassDOT Directly Contributing Watershed

Impaired Stream Segment

Non-Impaired Stream Segment

NWI Wetland Areas

MassDOT Roads in Urban Areas

MassDOT Roads

Town Boundaries

N

0 250 500 750 1,000 Feet

1 inch = 500 feet

Figure 3d

Blackstone River MA51-04 Directly Contributing MassDOT Watershed

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April 2013

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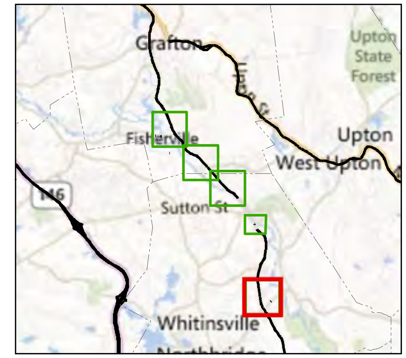

Stormwater Outfalls

MassDOT Directly Contributing Watershed

Impaired Stream Segment

Non-Impaired Stream Segment

NWI Wetland Areas

MassDOT Roads in Urban Areas

MassDOT Roads

Town Boundaries

N

0 250 500 750 1,000 Feet

1 inch = 500 feet

Figure 3e

Blackstone River MA51-04 Directly Contributing MassDOT Watershed

5 of 5

April 2013

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Impaired Waters Assessment for Poor Farm Brook (MA51-17) Including Former Segment City Farm Pond (MA51020) – Progress Report

Impaired Waterbody

Name: Poor Farm Brook

Location: West Boylston, Worcester and Shrewsbury, MA

Water Body ID: MA51-17

Impairments

Poor Farm Brook (MA51-17) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2010 Integrated List of Waters* (MassDEP, 2011). Poor Farm Brook is impaired for the following:

- sedimentation/siltation
- (aquatic plants (macrophytes)*).

The *Blackstone River Watershed 2003-2007 Water Quality Assessment Report* (MassDEP, 2010) identifies Poor Farm Brook as impaired due to low flow alterations which may be due to flow alterations from water diversions and potentially due to habitat modification other than hydromodification, discharges from municipal separate storm sewer systems (MS4), channelization, or baseflow depletion from groundwater withdrawals.

City Farm Pond (formerly MA51020) was listed separately in the final *Massachusetts Year 2008 Integrated List of Waters* (MassDEP, 2008); however, it is considered part of Poor Farm Brook in the final *Massachusetts Year 2010 Integrated List of Waters* and final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013).

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *314 CMR 4.05 (5) (b) Bottom Pollutants or Alterations*. All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.
- *314 CMR 4.05 (5) (a) Aesthetics*. All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.

Site Description

Poor Farm Brook begins in West Boylston and flows approximately 3.6 miles before discharging into Shirley Street Pond (MA51196). The subwatershed of Poor Farm Brook has an area of approximate 3.9 square miles. The total watershed and subwatershed are the same for Poor Farm Brook and are shown in Figure 1.

The only MassDOT-owned urban roadways within the subwatershed are Route 70 and ramps to and from Interstate I-190. The I-190 ramps are over a mile away from Poor Farm Brook, and therefore, discharge from these roadways does not directly discharge to the brook. An approximate 80,330-square foot area of Route 70 roadway surface discharges stormwater directly to Poor Farm Brook and is considered direct discharge in this assessment. The drainage system along this portion of Route 70 is comprised of a system of catch basins which drains stormwater to a trunkline which then drains stormwater to an outfall which discharges directly into Poor Farm Brook. There is approximately 6 feet of MassDOT right-of-way along the side of Route 70 where this outfall is located. This space constraint limits the potential for implementing a BMP at this location. The directly contributing MassDOT impervious cover area is shown in Figure 2.

Assessment under BMP 7U

A TMDL has not been developed to address the impairments of sedimentation/siltation and aquatic plants (macrophytes) for Poor Farm Brook. Therefore, MassDOT assessed the impairments using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of stormwater on many impairments. For this water body, MassDOT used the IC method to assess the impairment of sedimentation/siltation.

According to MassDEP's final *Massachusetts Year 2010 Integrated List of Waters*, the impairment of aquatic plants (macrophytes) is not caused by pollutants (MassDEP, 2011). Therefore, this impairment is not considered further in this assessment.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction necessary to attain the percent imperviousness in the watershed at which stormwater is not likely the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater is the potential cause to the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. Where needed, the USGS Data Series watersheds were modified to add specificity based on USGS topography. IC data were available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer.

In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines (EPA, 2006).

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for Poor Farm Brook (MA51-17):

Table 1. Site Parameters for Poor Farm Brook (MA51-17)

Total Watershed and Subwatershed		
Watershed Area	2,520	acres
Impervious Cover (IC) Area	614	acres
Percent Impervious	24.3*	%
IC Area at 9% Goal	227	acres
Target Reduction % in IC	63.0	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	1.8	acres
MassDOT's Target Reduction in Effective IC (63.0% of DOT Directly Contributing IC)	1.2	acres

*Rounding accounts for differences calculations.

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 63.0%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 1.2 acres.

Existing BMPs

No existing BMPs were observed in the Poor Farm Brook subwatershed that are mitigating stormwater runoff impacts prior to discharge to the brook.

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 1.2 acres, MassDOT will consider the implementation of additional BMPs.

Conclusions

MassDOT used the IC Method to assess Poor Farm Brook for the impairments identified in MassDEP's final *Massachusetts Year 2010 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed by 1.2 acres to achieve the targeted reduction in effective IC. MassDOT performed an assessment within the directly contributing watershed to Poor Farm Brook and found no BMPs exist to reduce effective IC. This information is summarized in Table 2 below.

Table 2. Effective IC Reductions under Existing & Proposed Conditions

IC in Directly Contributing Watershed	1.8	acres
Target Reduction in Effective IC	1.2	acres
IC Effectively Reduced by Existing BMPs	0	acres
IC Remaining to Mitigate with Proposed BMPs	**1.2**	**acres**

MassDOT should reduce its effective IC within the directly contributing watershed by an additional 1.2 acres to achieve the targeted reduction in IC. MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs to treat directly contributing IC as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to achieve the target IC reduction or treatment to the maximum extent practicable.

Furthermore, MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of additional BMPs, and finalized assessments including reductions achieved by finalized BMP designs. Additionally, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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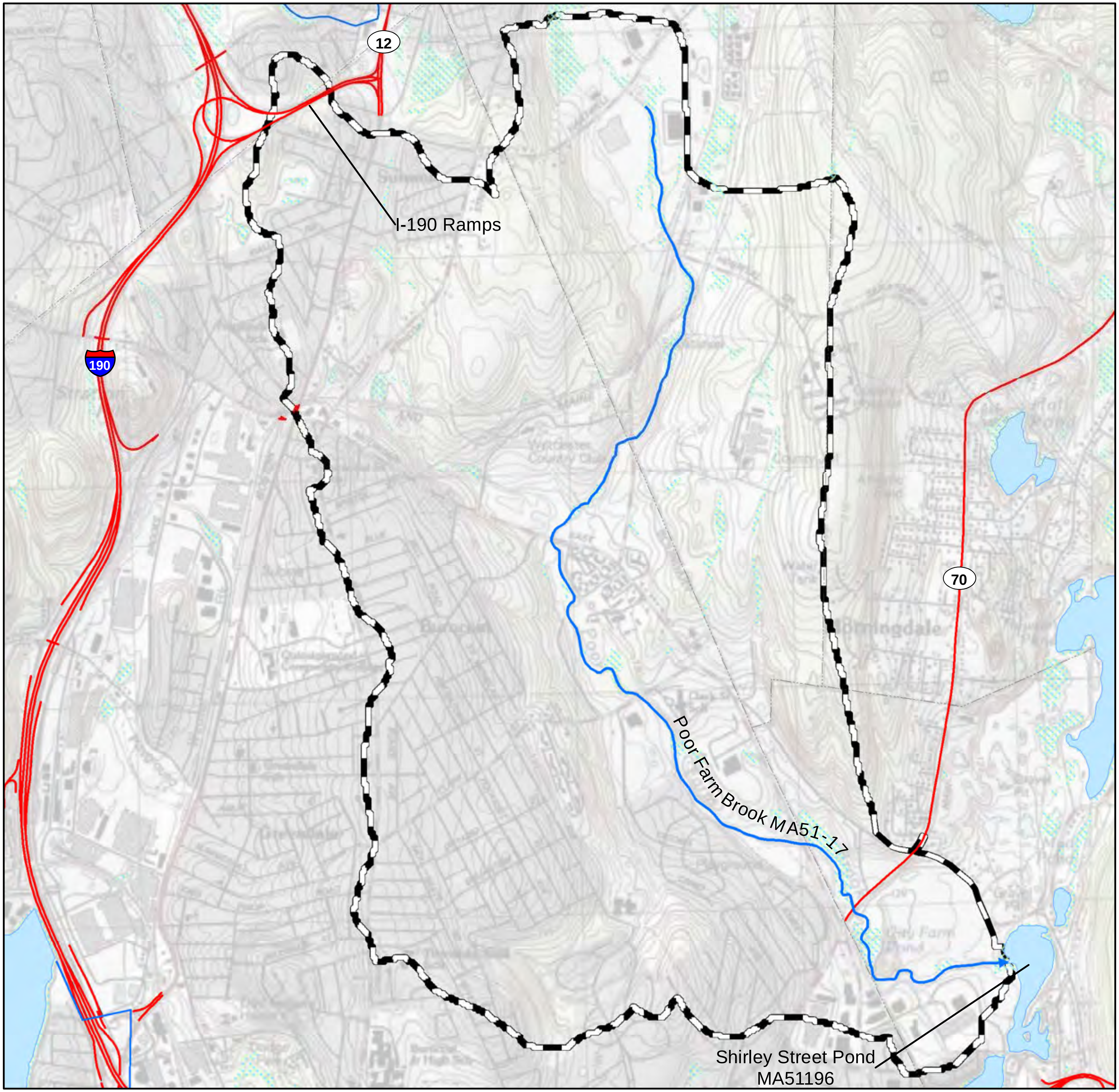

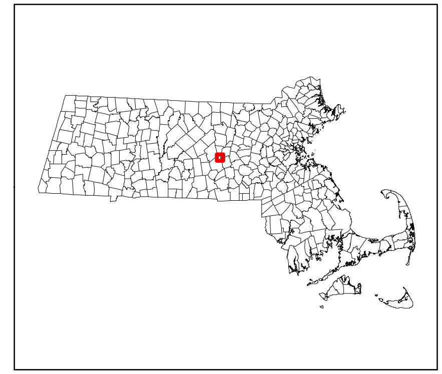

Poor Farm Brook
Impaired Stream Segment
Impaired Water Bodies
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries
Total Watershed and Subwatershed

N

0 0.1 0.2 0.3 0.4 Miles

1 in = 2,000 feet

Figure 1

Poor Farm Brook Subwatershed MA51-17

February 2013

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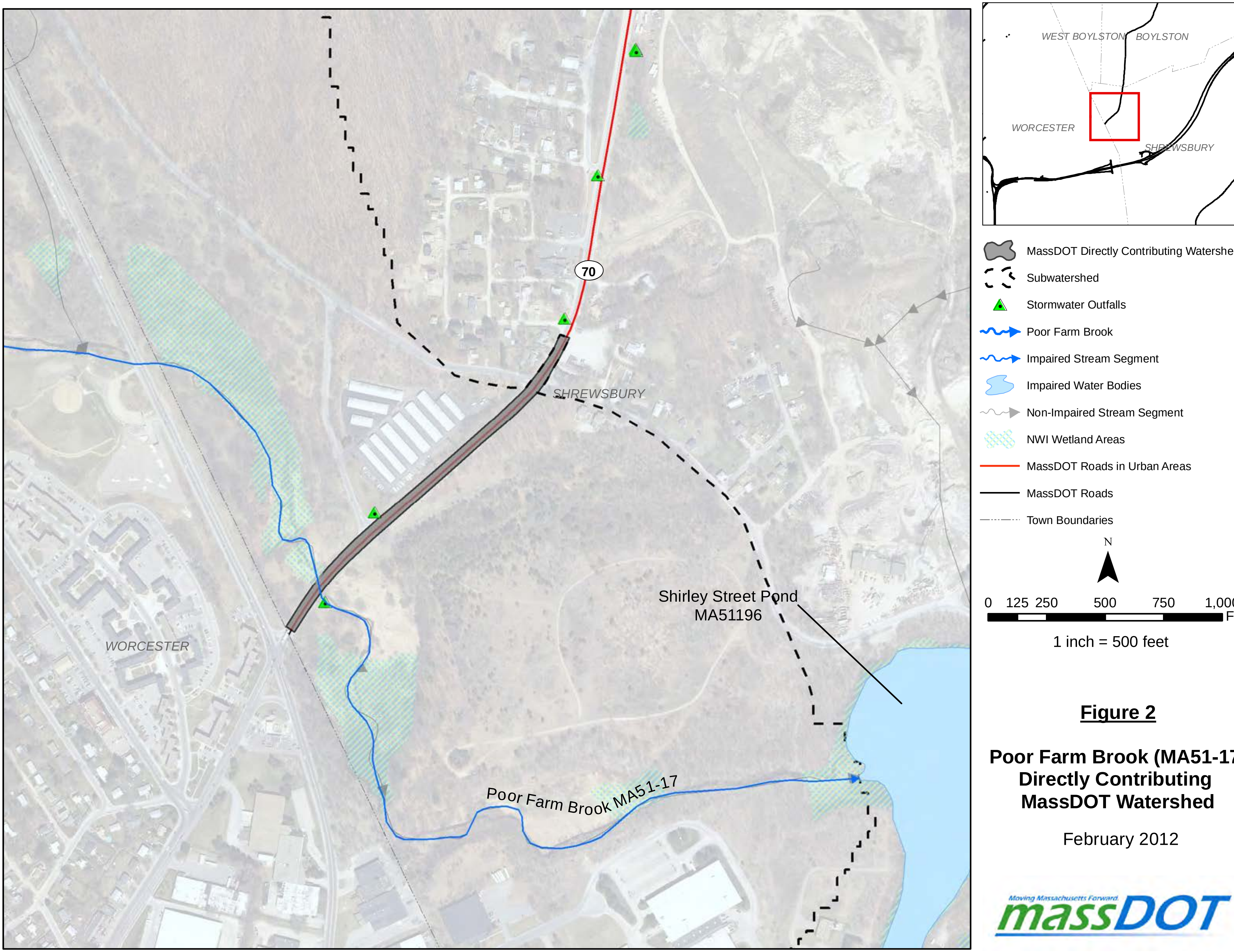

MassDOT Directly Contributing Watershed
Subwatershed
Stormwater Outfalls
Poor Farm Brook
Impaired Stream Segment
Impaired Water Bodies
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 125 250 500 750 1,000 Feet

1 inch = 500 feet

Figure 2

Poor Farm Brook (MA51-17) Directly Contributing MassDOT Watershed

February 2012

Moving Massachusetts Forward. massDOT

Impaired Waters Assessment for Flint Pond (MA51050) – Progress Report

Impaired Waterbody

Name: Flint Pond

Location: Shrewsbury, MA

Water Body ID: MA51050

Impairments

Flint Pond (MA51050) is listed under Category 4a, "TMDL is Completed", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). Flint Pond is impaired for the following:

- (Eurasian water milfoil, myriophyllum spicatum*)
- (non-native aquatic plants*)
- aquatic plants (macrophytes)
- turbidity.

Flint Pond (MA51050) is covered in MassDEP's *Total Maximum Daily Loads (TMDL) of Phosphorus for Selected Northern Blackstone Lakes* [CN 70.1] (MassDEP, 2002b) as well as MassDEP's *Blackstone River Watershed 2003-2007 Water Quality Assessment Report* (MassDEP, 2010). The water quality assessment report states that segment MA51050 of Flint Pond is impaired due to non-native aquatic macrophyte infestations, Eurasian Water Milfoil (Myriophyllum spicatum). The TMDL states:

"The lakes"…(including Flint Pond)…"were listed on the state '303d' list for a variety of pollutant and stressors including low dissolved oxygen, turbidity, nutrients, and over-abundance of nuisance aquatic plants. All of the pollutants and stressors are indicators of nutrient enriched systems, better known as the process of eutrophication. In freshwater systems the primary nutrient known to accelerate eutrophication is phosphorus. Therefore, in order to prevent further degradation in water quality and to ensure that each lake meets state water quality standards the TMDL establishes a phosphorus limit for each lake and outlines corrective actions to achieve that goal." (MassDEP, 2002b)

Therefore, MassDOT used this TMDL to assess MassDOT's potential contribution to the impairments of turbidity and the aquatic plants (macrophytes) for Flint Pond.

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *314 CMR 4.05 (5) (b) Bottom Pollutants or Alterations*. All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.

- *314 CMR 4.05 (5) (a) Aesthetics*. All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.
- *314 CMR 4.05 (3)(b) 6 Color and Turbidity*. These waters shall be free from color and turbidity in concentrations or combinations that are aesthetically objectionable or would impair any use assigned to this class.
- *314 CMR 4.05 (5) (c) Nutrients*. Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established by the Department pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.

Site Description

Flint Pond is comprised of two segments, segment MA51050 and segment MA51188. Segment MA51050 is assessed in this report. Segment MA51050 of Flint Pond is located in Shrewsbury, Massachusetts, and lays upstream of Segment MA51188 of Flint Pond. It has a surface area of approximately 92 acres. The total watershed draining to segment MA51050 is approximately 23 square miles and the subwatershed is approximately 11 square miles. The total watershed is shown in Figure 1 and the subwatershed is shown in Figure 2.

There are several MassDOT-owned urban roadways within the subwatershed of Segment MA51050 of Flint Pond. These include Interstate 290, Route 9, Maple Avenue, Route 20 and Route 122. The drainage along each of these roadways is briefly described below:

<u>Interstate 290</u>
The portion of I-290 within the subwatershed discharges stormwater runoff to Lake Quinsigamond and Shirley Street Pond, which are upstream of Flint Pond. Therefore, I-290 does not discharge directly to Flint Pond.

<u>Route 9</u>
The portion of Route 9 within the subwatershed discharges to wetland areas and to Lake Quinsigamond, upstream of Flint Pond. Therefore, Route 9 does not discharge directly to Flint Pond.

<u>Maple Avenue</u>
Stormwater runoff from Maple Ave discharges to wetland areas over 1.4 miles away from Segment MA51050 of Flint Pond and therefore is indirect.

<u>Route 20</u>
The portion of Route 20 within the subwatershed of Segment MA51188 of Flint Pond is curbed and is generally crowned in the center of the roadway. Both Segments 51188 and 51050 of Flint

Pond abut this portion of Route 20, as well as Lake Quinsigamond (MA51125). Although the road is curbed on both sides, there are only a few stormwater drainage features along this stretch of Route 20. There are, however, various outfalls along the sides of the road as observed during field investigation. There is one outfall draining to Segment MA51050. Based on the locations of these outfalls and the topography of the roadway, the portion of Route 20 shown in Figure 3 is considered direct in this assessment.

Route 122

Route 122 is over 1.2 miles away from Segment MA51050 of Flint Pond. As shown in Figure 2, Segment MA51050 and Route 122 are separated by several roads, a railroad track, and commercial and residential area. Therefore, Route 122 is considered indirect in this assessment.

Assessment under BMP 7R

The TMDL for phosphorus for Flint Pond addresses the impairment of aquatic plants (macrophytes) and turbidity. Therefore, MassDOT assessed the contribution of phosphorus from MassDOT property directly draining to this water body to address this impairment. The assessment was completed using the approach described in BMP 7R (TMDL Watershed Review).

According to the final *Massachusetts Year 2012 Integrated List of Waters*, non-native aquatic plants and Eurasian water milfoil, myriophyllum spicatum, are non-pollutant stressors which indicates that restoration will require measures other than TMDL development and implementation. As a result, MassDOT has concluded that storm water runoff from its roadways does not contribute to these impairments found in Flint Pond.

TMDL

The Massachusetts Department of Environmental Protection's (MassDEP) TMDL report titled *Total Maximum Daily Loads of Phosphorus for Lake Quinsigamond and Flint Pond* [CN 115] (MassDEP, 2002a) does not specify the breakdown of land use within the watershed. However, the report does provide a figure of the watershed on Page 33. The subbasin with UniqID 23031 in USGS's Massachusetts DS-451 nested subbasins layer is approximately the same as the watershed shown in the TMDL except it includes area downstream of the lower segment of Flint Pond. Therefore, MassDOT redelineated this subbasin to eliminate this area, and used the resulting basin and MassGIS's Land Use layer to determine the breakdown of land use areas within the watershed. The land uses of commercial, industrial, residential, and transportation (an area of approximately 6,735 acres) were used in the calculations described below. The TMDL report does not list the current phosphorus loading and target phosphorus loading based on land use. Instead, it lists loadings for five sources including Atmosphere, Base Flow, Storm Flow, and two NPDES-permitted point sources (see page 16 of the TMDL report). The current and target phosphorus loadings reported for Storm Flow were used for the calculations in this assessment. The TMDL calculations are summarized as follows:

- Pollutant of Concern: Phosphorus
- Impairment for Segment MA51050 of Flint Pond Addressed in MassDEP TMDL Report: aquatic plants (macrophytes) and turbidity
- Applicable Waste Load Allocation (WLA): See Tables 1 (page 16) and page 33 of TMDL Report.
  - Description of Associated Land Use: No land use breakdown was provided by the MassDEP TMDL report so a GIS analysis was performed to determine land use breakdown in the watershed. The land uses of commercial, industrial, residential, and transportation were chosen to be applied to the source "Storm Flow", as all of these land uses typically generate stormwater runoff.

– Land Use Current Load (TP): 1,123 kg/yr (2,476 lbs/yr) based on Storm Flow source
– Land Use Target WLA (TP): 538 kg/yr (1,186 lbs/yr) based on Storm Flow source
– Area in Watershed: 2,726 ha (6,735 acres) identified in GIS analysis
– Land Use Target Areal WLA (TP): 0.20 kg/ha/yr (0.18 lb/acre/yr)

Estimated Loading from MassDOT

The loading of total phosphorus (TP) from MassDOT property directly contributing stormwater runoff to Segment MA51050 of Flint Pond was estimated using the following assumptions and calculations:

- MassDOT estimates the TP loading from its impervious areas as 1.60 lb/acre/yr. This loading rate is based on data collected in a study of storm water runoff conducted by the United States Geological Survey (USGS) (Smith and Granato, 2010). The study analyzed storm water samples from 12 sites located on highways operated by MassDOT across Massachusetts between September 2005 and September 2007. Samples were taken under a variety of weather conditions during this period.
- MassDOT estimates the TP loading from its pervious areas as 0.6 lb/acre/yr. This loading rate is based on the loading rate for hayland provided in the United States Environmental Protection Agency's (EPA) document EPA 440/5-80-011, "Modeling phosphorus loading and Pond response under uncertainty: a manual and compilation of export coefficients" (Reckhow, 1980). Hayland was chosen to represent the pervious right-of-way areas which are typically cleared areas that are mowed only once per year.
- MassDOT calculated its total estimated TP loading rate using the estimated loading rates listed above. MassDOT property contributing storm water directly to Segment MA51050 of Flint Pond is 2.0 acres of impervious area and 0.4 acres of pervious area. The TP loading is 3.4 lb/yr without accounting for existing BMPs or treatment throughout the watershed.
- MassDOT calculated its target TP WLA using the TMDL target areal WLA of 0.18 lb/ac/yr and the total area of MassDOT property within the TMDL watershed directly draining to Segment MA51050 of Flint Pond (2.4 acres). The target TP WLA for MassDOT runoff is 0.4 lb/yr.

Assessment

MassDOT calculated its current TP loading rate (3.4 lb/yr) and its target TP WLA (0.4 lb/yr) using values provided in MassDEP's TMDL report and USGS and MassGIS datalayers. The difference between these two values represents the target reduction in TP that MassDOT will aim to achieve to comply with the WLA. For the watershed directly contributing to Flint Pond, this target reduction is 3.0 lb/yr, or 88%. As explained in BMP 7R, MassDOT's pollutant loading analysis provides only a preliminary estimate of the level of pollutant reductions that may be recommended. In light of the variability of data on stormwater discharges, MassDOT will rely on a variety of other factors apart from numeric guidelines, including site constraints, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines (EPA, 2006).

There were no existing BMPs identified in the DOT direct watershed to Flint Pond. Thus, there is currently no TP reduction being provided.

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 3.0 lb/yr, MassDOT will consider the implementation of additional BMPs.

Conclusions

MassDOT evaluated its property within the directly contributing watershed to Segment MA51050 of Flint Pond to identify existing BMPs. This assessment of Flint Pond has shown that MassDOT has no existing BMPs in place, and therefore, discharges stormwater directly to Flint Pond without providing treatment.

To meet the TMDL for aquatic plants (macrophytes) and turbidity, MassDOT should reduce its TP loading within the directly contributing watershed by 3.0 lb/yr to achieve the targeted reduction. MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide the target load reduction or treatment to the maximum extent practicable. Once the design of proposed BMPs is finalized, MassDOT will develop a final assessment of this water body under the Impaired Waters program.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding the design progress made towards meeting the load reduction, plans for construction of the BMPs and finalized assessments. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater discharge.

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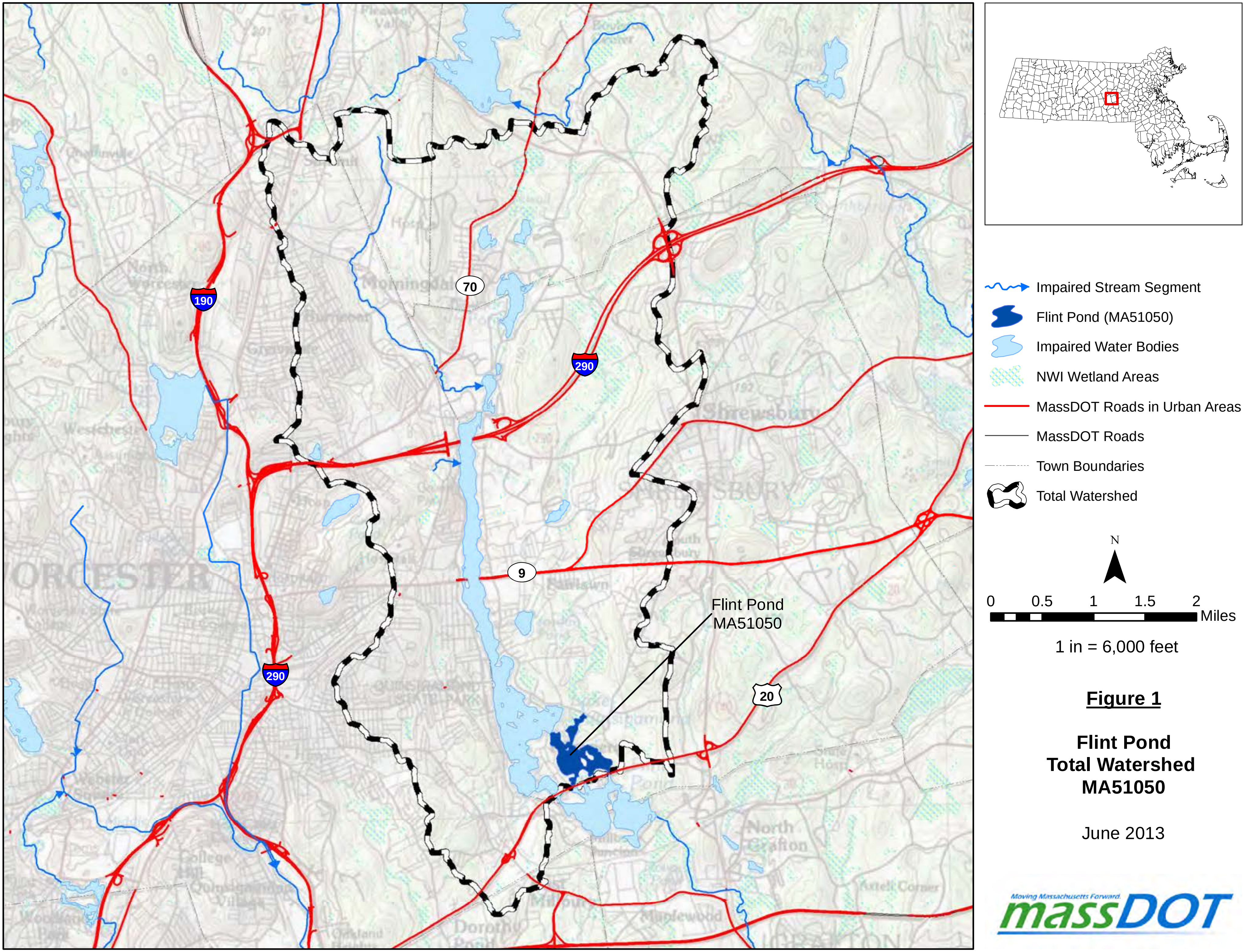

Figure 1

Flint Pond
Total Watershed
MA51050

June 2013

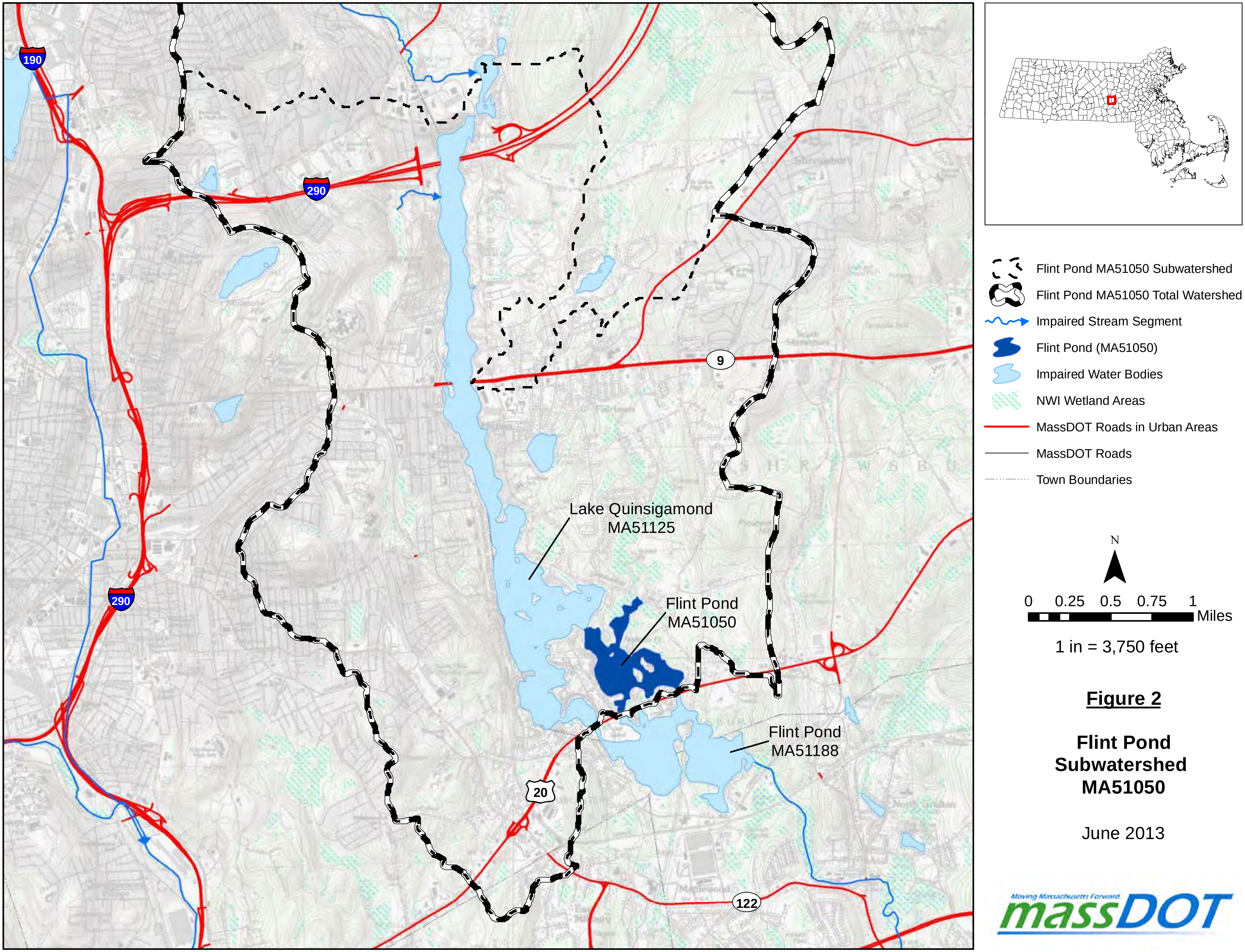

Figure 2

Flint Pond Subwatershed MA51050

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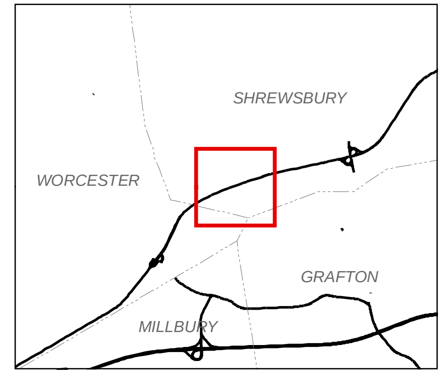

MassDOT Direct Watershed (Impervious)
MassDOT Direct Watershed (Pervious)
Subwatershed
Stormwater Outfalls
Impaired Stream Segment
Flint Pond (MA51050)
Impaired Water Bodies
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 250 500 750 1,000 ft

1 inch = 500 feet

Figure 3

Flint Pond (MA51050) Directly Contributing MassDOT Watershed

June 2013

Moving Massachusetts Forward. massDOT

Impaired Waters Assessment for Marble Pond (MA51093) – Progress Report

Impaired Waterbody

Name: Marble Pond

Location: Sutton, MA

Water Body ID: MA51093

Impairments

Marble Pond (MA51093) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2010 Integrated List of Waters* (MassDEP, 2011). Marble Pond is impaired for the following:

- aquatic plants (macrophytes)
- (non-native aquatic plants*)

According to MassDEP's *Blackstone River Watershed 2003-2007 Water Quality Assessment Report* (MassDEP, 2010), Marble Pond is impaired due to an infestation with the non-native aquatic plant species *Myriophyllum heterophyllum*. This species was found present in Marble Pond during the 1994 Blackstone River Watershed synoptic lake surveys.

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *314 CMR 4.05 (5) (a) Aesthetics*. All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.
- *314 CMR 4.05 (5) (c) Nutrients*. Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established by the Department pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.

Site Description

Marble Pond is a water body of approximately 8 acres located in the Blackstone River Watershed in Sutton, MA. The lake is located approximately 600 feet upstream of Aldrich Pond (MA51002) and is fed by two unnamed streams which flow from upstream wetlands to the north and to the west. Marble Pond lies between Marble Rd and Route 146 (Worcester-Providence Turnpike). Adjacent land use types include forest, residential, commercial and industrial.

The subwatershed and total contributing watershed to Marble Pond are the same and are approximately 607 acres. The watershed is shown in Figure 1. MassDOT's property directly contributing stormwater runoff to Marble Pond is comprised of approximately 0.7 miles of Route 146, a four lane roadway with concrete median that runs northwest-southeast to the southwest of the pond. It is conservatively assumed that MassDOT's directly contributing watershed extends to the portion of Route 146 just north of Sonia's Auto Sales. During a field visit on November 13, 2012 field engineers could not locate an outfall south of Sonia's Auto Sales and assumed drainage from this portion of the roadway drains south to the piped system which discharges upstream of Marble Pond. MassDOT's directly contributing watershed is shown in Figure 2.

Assessment under BMP 7U

None of the impairments for Marble Pond have been addressed by a TMDL. Therefore, MassDOT assessed the impairments using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of storm water on many impairments. For this water body, MassDOT used the IC method to assess the following impairments:

- aquatic plants (macrophytes)

According to MassDEP's final *Massachusetts Year 2010 Integrated List of Waters*, the impairment of non-native aquatic plants is not caused by pollutants (MassDEP, 2011). Therefore, this impairment was not considered further.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction necessary to attain the percent imperviousness in the watershed at which stormwater is not likely the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451 and were the same for Marble Pond. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. IC data were available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer.

In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for Marble Pond:

Table 1. Site Parameters for Marble Pond (MA51093)

Total Watershed		
Watershed Area	607	acres
Impervious Cover (IC) Area	72	acres
Percent Impervious	11.9	%
IC Area at 9% Goal	55	acres
Target Reduction % in IC	24	%
Subwatershed		
Subwatershed Area	607	acres
Impervious Cover (IC) Area	72	acres
Percent Impervious	11.9	%
IC Area at 9% Goal	55	acres
Target Reduction % in IC	24	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	6.6	acres
MassDOT's Target Reduction in Effective IC (24% of DOT Directly Contributing IC)	1.6	acres

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 24%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 1.6 acres.

Existing BMPs

There are no existing BMPs in the Marble Pond directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to the water body.

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 1.6 acres, MassDOT will consider the implementation of additional BMPs.

Conclusions

MassDOT used the IC Method to assess Marble Pond for the impairments identified in MassDEP's final *Massachusetts Year 2010 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed by 1.6 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Marble Pond to identify existing BMPs and found that no BMPs exist to reduce effective IC. This information is summarized in Table 2 below.

Table 2. Effective IC Reductions under Existing & Proposed Conditions

IC in Directly Contributing Watershed	6.6	acres
Target Reduction in Effective IC	1.6	acres
IC Effectively Reduced by Existing BMPs	0	acres
IC Remaining to Mitigate with Proposed BMPs	**1.6**	**acres**

MassDOT should reduce its effective IC within the directly contributing watershed by 1.6 acres to achieve the targeted reduction in IC. MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs to treat directly contributing IC as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide the target IC reduction or treatment to the maximum extent practicable.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of additional BMPs, and finalized assessments including reductions achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

References

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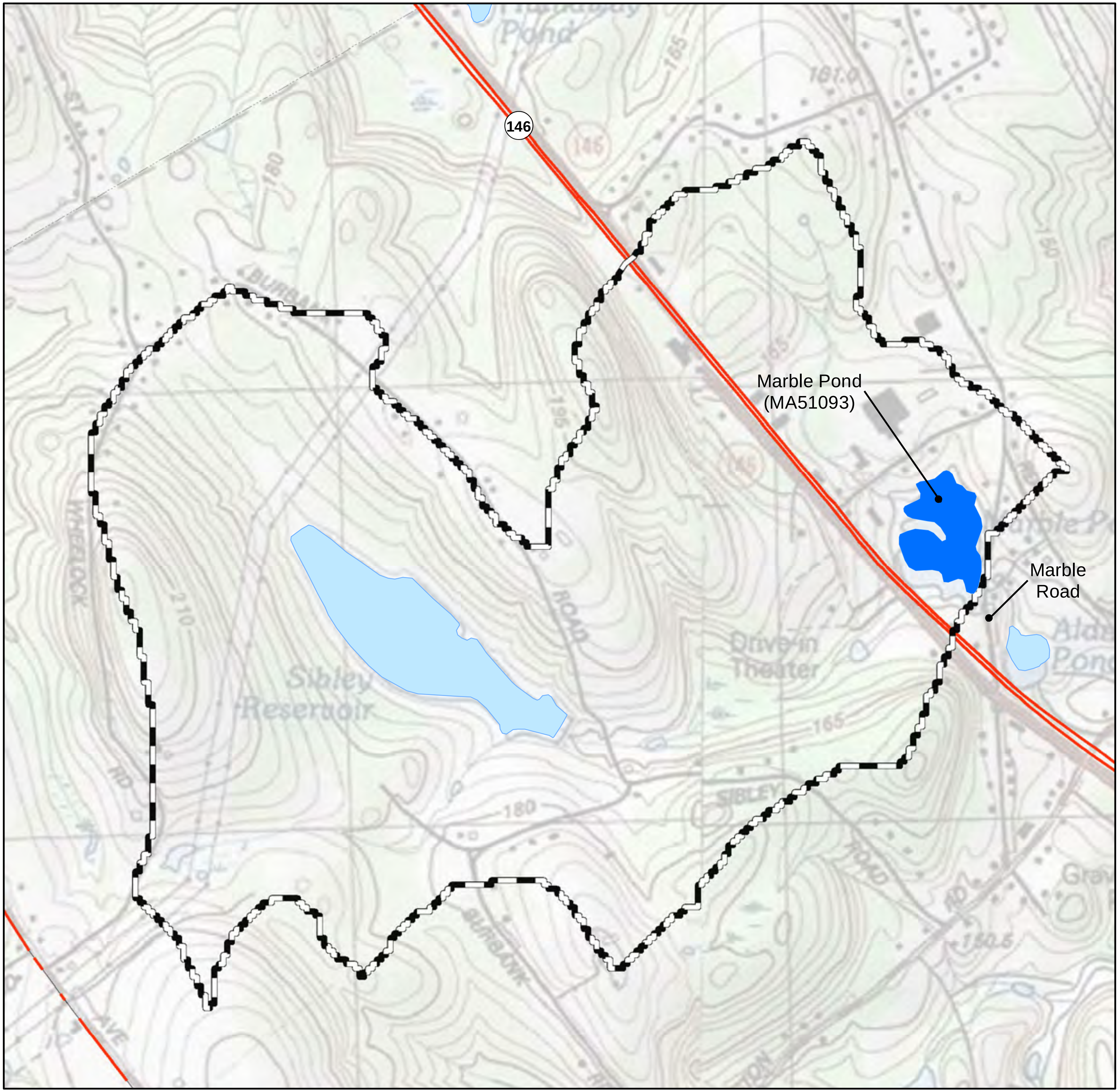

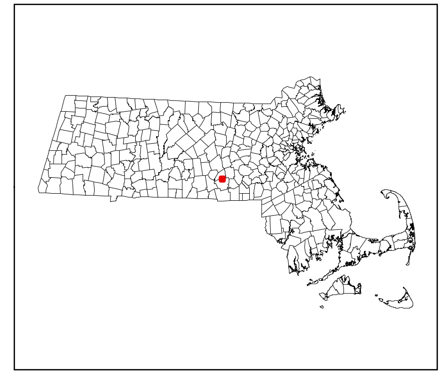

Impaired Stream Segment

Marble Pond

Impaired Water Bodies

Total Contributing Watershed

MassDOT Roads in Urban Area

MassDOT Roads

Town Boundaries

N

0 500 1,000 1,500 2,000 Feet

1 in = 1,000 feet

Figure 1

Marble Pond
Sub and Total Watershed
MA51093

February 2013

massDOT
Massachusetts Department of Transportation
Highway Division

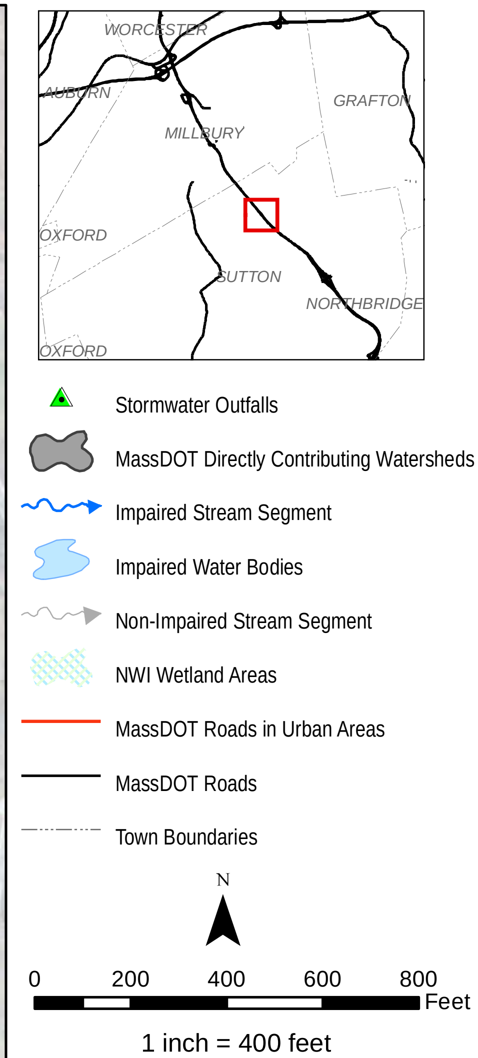

Figure 2

Marble Pond (MA51093) Directly Contributing MassDOT Watershed

February 2013

massDOT Moving Massachusetts Forward.

Impaired Waters Assessment for Pondville Pond (MA51120) – Progress Report

Impaired Waterbody

Name: Pondville Pond

Location: Auburn and Millbury, MA

Water Body ID: MA51120

Impairments

Pondville Pond (MA51120) is listed as a Category 4a water body on MassDEP's final *Massachusetts Year 2010 Integrated List of Waters* (MassDEP, 2011). Pondville Pond is impaired for the following:

- excess algal growth
- (non-native aquatic plants*)

Pondville Pond is covered by a Total Maximum Daily Load (TMDL) for phosphorus according to MassDEP's *Total Maximum Daily Loads of Phosphorus for Selected Northern Blackstone Lakes* [CN 70.1] (MassDEP, 2002).

According to MassDEP's *Blackstone River Watershed 2003-2007 Water Quality Assessment Report* (MassDEP, 2010), Pondville Pond is impaired due to an infestation with the non-native aquatic plant species *Cabomba caroliniana*. A second potentially non-native aquatic plant species (*Myriophyllum heterophyllum*) has also been reported to infest the pond although its presence was not confirmed at the time of the latest assessment.

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *314 CMR 4.05 (5) (a) Aesthetics*. All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.
- *314 CMR 4.05 (5) (c) Nutrients*. Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established by the Department pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing

and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.

Site Description

Pondville Pond is a water body of approximately 41 acres located in the Blackstone River Watershed in Auburn and Millbury, MA. The lake bisects Ramshorn Brook which flows south-north through the water body and is impounded by the Pondville Pond Dam at its northwest boundary on the downstream side of Route 20 (Washington Street). In addition to Ramshorn Brook, Pondville Pond receives inflow from Stone Brook. Pondville Pond's watershed land uses consist of the following: 62% forested, 27% rural, 6% water and wetlands and 5% urban (MassDEP, 2010).

Pondville Pond's subwatershed and total contributing watershed are the same and cover approximately 4,780 acres. The watershed is shown in Figure 1. MassDOT's property directly contributing stormwater runoff to Pondville Pond is comprised of approximately 0.5 miles of Route 20 (Washington Street), a two-lane roadway that runs southeast-northwest to the northwest of the pond. Runoff from Route 20 is collected in piped stormwater systems which discharge to outfalls along the side of the road and, in some cases, directly to Pondville Pond. MassDOT's directly contributing watershed is shown in Figure 2.

Assessment under BMP 7R

The TMDL for phosphorus for Pondville Pond addresses the impairment of excess algal growth. Therefore, MassDOT assessed the contribution of phosphorus from MassDOT property directly draining to this water body to address the impairment. The assessment was completed using the approach described in BMP 7R (MassDOT, 2012).

According to the final *Massachusetts Year 2010 Integrated List of Waters*, the impairment of non-native aquatic plants is not caused by pollutants (MassDEP, 2011). Therefore, this impairment is not considered further.

TMDL

The Massachusetts Department of Environmental Protection's (MassDEP) TMDL report titled *Total Maximum Daily Loads of Phosphorus for Selected Northern Blackstone Lakes* [CN70.1] (MassDEP, 2002) can be summarized as follows:

- Pollutant of Concern: Phosphorus
- Impairment for Pondville Pond Addressed in TMDL: excess algal growth
- Applicable Waste Load Allocation (WLA): See Tables 2l (p. 50), and 4l (p. 61) of TMDL Report.
  - Description of Associated Land Use: Commercial/Industrial
  - Commercial/Industrial Land Use Current Load (TP): 52 kg/yr (115 lbs/yr)
  - Commercial/ Industrial Land Use Target WLA (TP): 43 kg/yr (95 lbs/yr)
  - Commercial/Industrial Area in Watershed: 35.8 ha (88.5 acres)
  - Commercial/Industrial Land Use Target Areal WLA (TP): 1.2 kg/ha/yr (1.1 lb/acre/yr)

Estimated Loading from MassDOT

The loading of total phosphorus (TP) from MassDOT property directly contributing storm water runoff to Pondville Pond was estimated using the following assumptions and calculations:

- MassDOT estimates the TP loading from its impervious areas as 1.6 lb/acre/yr. This loading rate is based on data collected in a study of storm water runoff conducted by the United States Geological Survey (USGS) (Smith and Granato, 2010). The study analyzed storm water samples from 12 sites located on highways operated by MassDOT across Massachusetts between September 2005 and September 2007. Samples were taken under a variety of weather conditions during this period.
- MassDOT estimates the TP loading from its pervious areas as 0.6 lb/acre/yr. This loading rate is based on the loading rate for hayland provided in the United States Environmental Protection Agency's (EPA) document EPA 440/5-80-011, "Modeling phosphorus loading and Pond response under uncertainty: a manual and compilation of export coefficients" (Reckhow, 1980). Hayland was chosen to represent the pervious right-of-way areas which are typically cleared areas that are mowed only once per year.
- MassDOT calculated its total estimated TP loading rate using the estimated loading rates listed above. MassDOT property contributing storm water directly to Pondville Pond is 2.1 acres of impervious area and 0.5 acres of pervious area. The TP loading is 3.8 lb/yr without accounting for existing BMPs or treatment throughout the watershed.
- MassDOT calculated its target TP WLA using the TMDL target areal WLA of 1.1 lb/ac/yr and the total area of MassDOT property within the TMDL watershed directly draining to Pondville Pond (2.7 acres). The target TP WLA for MassDOT runoff is 2.9 lb/yr.

Assessment

MassDOT calculated its current TP loading rate (3.8 lb/yr) and its target TP WLA (2.9 lb/yr) using values provided in MassDEP's TMDL report. The difference between these two values represents the target reduction in TP that MassDOT will aim to achieve to comply with the WLA. For the watershed directly contributing to Pondville Pond, this target reduction is 0.9 lb/yr, or 23%. As explained in BMP 7R, MassDOT's pollutant loading analysis provides only a preliminary estimate of the level of pollutant reductions that may be recommended. In light of the variability of data on stormwater discharges, MassDOT will rely on a variety of other factors apart from numeric guidelines, including site constraints, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

During a site visit on November 13, 2012, no existing BMPs were identified in the DOT direct watershed to Pondville Pond. Thus, there is currently no TP reduction being provided.

Table 1. Loading from MassDOT's Directly Contributing Property Relative to TMDL WLA

Total Area	2.7	ac
Target Areal WLA	1.1	lb/ac/yr
Total Estimated Load	3.8	lb/yr
Target Load for MassDOT's Directly Contributing Property	2.9	lb/yr
MassDOT's Required Load Reduction	0.9	lb/yr

Mitigation Plan

Because the total mitigation achieved by MassDOT's existing BMPs is less than the target reduction of 0.9 lb/yr, the implementation of additional BMPs will be considered by MassDOT.

Conclusions

MassDOT used the TMDL Method to assess Pondville Pond for the impairments identified in MassDEP's final *Massachusetts Year 2010 Integrated List of Waters*. Results indicate that MassDOT should reduce its current TP loading rate by 0.9 lb/yr to meet the TMDL for TP. MassDOT evaluated its property within the directly contributing watershed to Pondville Pond to identify existing BMPs and found that no BMPs exist to reduce the total phosphorus loading. This information is summarized in Table 2 below.

Table 2. TP Load Reductions under Existing & Proposed Conditions

Current Estimated TP Load	3.8	lb/yr
Target Reduction in TP Load	0.9	lb/yr
TP Load Reduction provided by Existing BMPs	0	lb/yr
TP Load Remaining to Mitigate with Proposed BMPs	**0.9**	**acres**

To meet the TMDL for phosphorus, MassDOT should reduce its TP loading within the directly contributing watershed by 0.9 lb/yr to achieve the targeted reduction. MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide the target load reduction or treatment to the maximum extent practicable. Once the design of proposed BMPs is finalized, MassDOT will develop a final assessment of this water body under the Impaired Waters program.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding the design progress made towards meeting the load reduction, plans for construction of the BMPs and finalized assessments. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of storm water.

References

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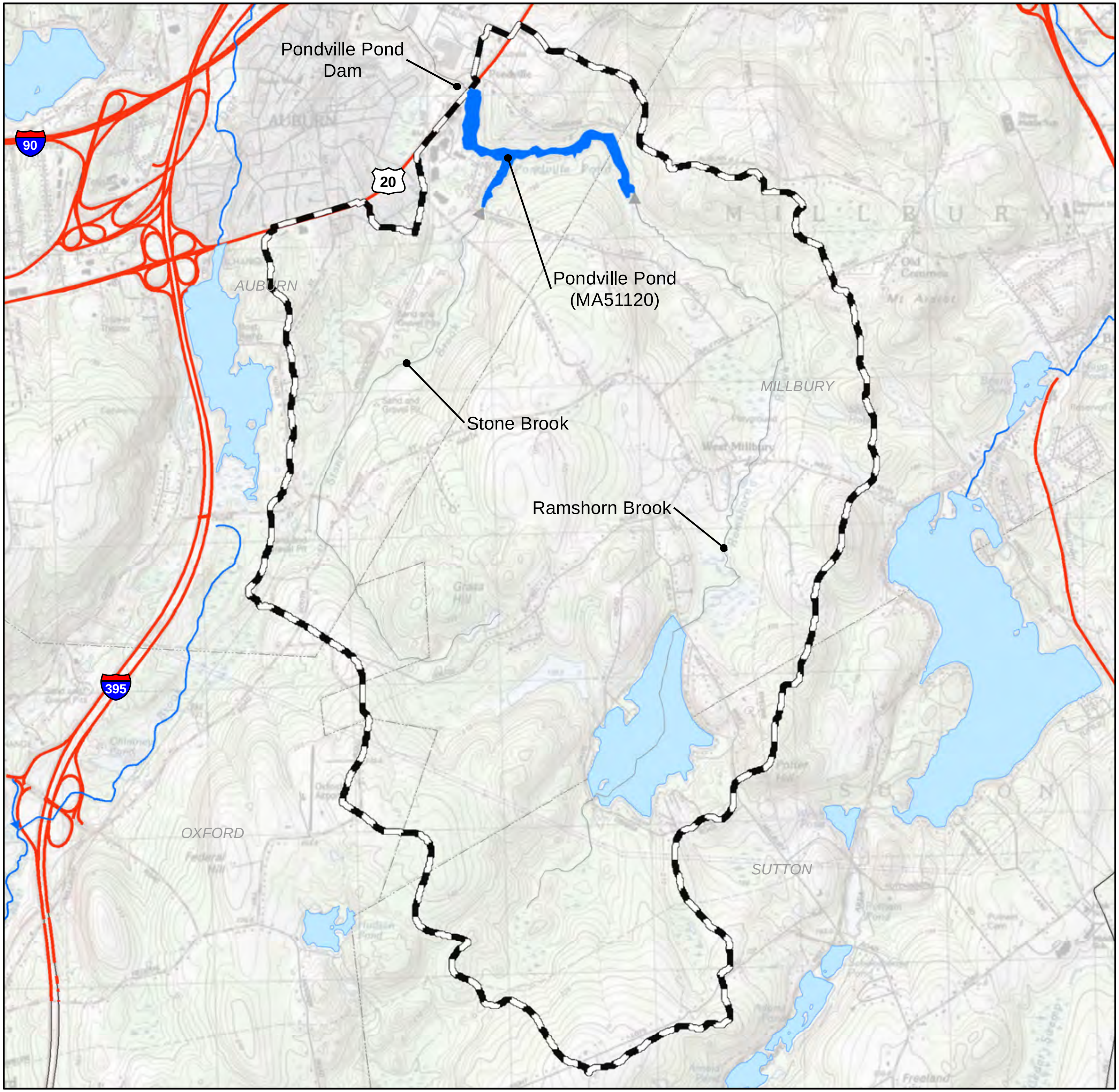
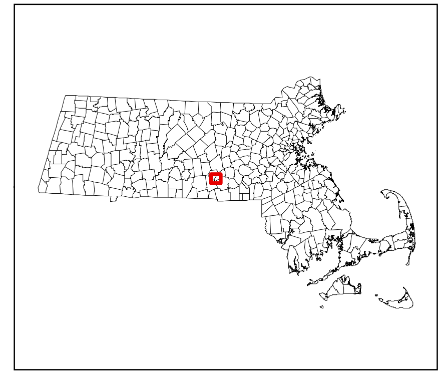




Impaired Stream Segment

Pondville Pond

Impaired Water Bodies

Sub and Total Contributing Watershed

MassDOT Roads in Urban Area

MassDOT Roads

Town Boundaries

N

0 1,500 3,000 4,500 6,000 Feet

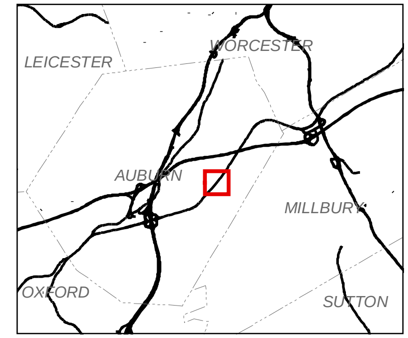
1 in = 3,000 feet

<u>Figure 1</u>

Pondville Pond
Sub and Total Watershed
MA51120

February 2013

massDOT
Massachusetts Department of Transportation
Highway Division



Stormwater Outfalls

MassDOT Direct Watershed (Impervious)

MassDOT Direct Watershed (Pervious)

Impaired Stream Segment

Impaired Water Bodies

Non-Impaired Stream Segment

NWI Wetland Areas

MassDOT Roads in Urban Areas

MassDOT Roads

Town Boundaries

N

0 150 300 450 600 Feet

1 inch = 300 feet

Figure 2

Pondville Pond (MA51120) Directly Contributing MassDOT Watershed

February 2013

Impaired Waters Assessment for Lake Quinsigamond (MA51125) – Progress Report

Impaired Waterbody

Name: Lake Quinsigamond

Location: Worcester and Shrewsbury, MA

Water Body ID: MA51125

Impairments

Lake Quinsigamond (MA51125) is listed under Category 4a, "TMDL is Completed", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). Lake Quinsigamond is covered by the phosphrous TMDL, *Total Maximum Daily Loads of Phosphorus for Lake Quinsigamond and Flint Pond* [CN 115] (MassDEP, 2002) and is impaired for the following:

- (eurasian water milfoil, myriophyllum spicatum*)
- (non-native aquatic plants*)
- excess algal growth
- dissolved oxygen

The *Blackstone River Watershed 2003-2007 Water Quality Assessment Report* (MassDEP, 2010) states that Lake Quinsigamond is impaired due to non-native aquatic macrophyte infestation, Eurasian Water Milfoil (Myriophyllum spicatum) and low dissolved oxygen. The report states that the sources of the impairments are the introduction of a non-native organism and other unknown reasons.

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *314 CMR 4.05 (3)(b) 1 Dissolved Oxygen*. Shall not be less than 6.0 mg/l in cold water fisheries and not less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.
- *314 CMR 4.05 (5)(a) Aesthetics*. All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.
- *314 CMR 4.05 (5)(c) Nutrients*. Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established by the Department pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to

> cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.

Site Description

Lake Quinsigamond (MA51125) is located in the towns of Worcester and Shrewsbury, MA and has a surface area of approximately 471 acres. The total watershed of the lake has an area of approximately 20 square miles and the subwatershed covers approximately 8 square miles. The total watershed is shown in Figure 1 and the subwatershed is shown in Figure 2.

MassDOT owns several urban roadways within the subwatershed of segment MA51125, including Interstate 290, the Marsh Avenue bridge, Plantation Street, ramps to and from Interstate 290, Route 9, and Route 20. The drainage along each roadway is briefly described below. The directly contributing MassDOT watershed areas are shown in Figures 3 and 4.

<u>Route 9 (Figure 3)</u>

The drainage system on Route 9 is comprised of catch basins connected to a trunkline which drains stormwater runoff to the Route 9 bridge over Lake Quinsigamond, where the trunkline outfalls directly into the lake. There are scuppers along the bridge to capture stormwater which then drops directly into the lake.

<u>Plantation Street (Figure 4)</u>

Stormwater runoff from Plantation Street is captured by catch basins that are connected to the Rte 290 drainage system which discharges directly to Lake Quinsigamond. Figure 4 illustrates the sections of Plantation Street that provide direct contribution.

<u>Interstate 290 and Ramps (Figure 4)</u>

Approximately 4,000 feet of I-290 contributes stormwater directly to Lake Quinsigamond. Catch basins along I-290 capture stormwater runoff and direct it to a drainage system that discharges to the Lake. Stormwater runoff from the I-290 ramps to Plantation Street flows down the ramps and into the drainage system on Plantation Street. As described above, the Plantation Street drainage system in the vicinity of Rte 290 ultimately discharges directly to Lake Quinsigamond. The outfalls on Route 290 that are west of the Plantation Street off ramps connect directly to Coal Mine Brook, which is covered under a separate assessment.

<u>Marsh Avenue Bridge (Figure 4)</u>

There are no drainage features on Marsh Avenue bridge. The bridge has high curbs and the entire bridge is sloped down toward Lincoln Street. Stormwater runoff from the bridge flows past the bridge and down Marsh Avenue, and is collected by the catch basins on Marsh Avenue and potentially on Lincoln Street.

<u>Route 20</u>

There are no outfalls to Lake Quinsigamond from Route 20. Therefore, Route 20 is not considered direct in this assessment.

Assessment under BMP 7R

The TMDL for phosphorus for Lake Quinsigamond addresses the impairment of excess algal growth. Therefore, to address this impairment, MassDOT assessed the contribution of phosphorus from MassDOT property directly draining to this water body. The assessment was completed using the approach described in BMP 7R (TMDL Watershed Review).

According to the final *Massachusetts Year 2012 Integrated List of Waters*, the impairment of non-native aquatic plants is not caused by pollutants (MassDEP, 2013). Therefore, this impairment is not considered further in this assessment.

TMDL

The Massachusetts Department of Environmental Protection's (MassDEP) TMDL report titled *Total Maximum Daily Loads of Phosphorus for Lake Quinsigamond and Flint Pond* [CN 115] (MassDEP, 2002) does not specify the breakdown of land use within the watershed. However, the report does provide a figure of the watershed on Page 33. The subbasin with UniqID 23031 in USGS's Massachusetts DS-451 nested subbasins layer is approximately the same as the watershed shown in the TMDL except it includes area downstream of the lower segment of Flint Pond. Therefore, MassDOT redelineated this subbasin to eliminate this area, and used the resulting basin and MassGIS's Land Use layer to determine the breakdown of land use areas within the watershed. The land uses of commercial, industrial, residential, and transportation (an area of approximately 6,735 acres) were used in the calculations described below. The TMDL report does not list the current phosphorus loading and target phosphorus loading based on land use. Instead, it lists loadings for five sources including Atmosphere, Base Flow, Storm Flow, and two NPDES-permitted point sources (see page 16 of the TMDL report). The current and target phosphorus loadings reported for Storm Flow were used for the calculations in this assessment. The TMDL calculations are summarized as follows:

- Pollutant of Concern: Phosphorus
- Impairment for Lake Quinsigamond Addressed in MassDEP TMDL Report: excess algal growth
- Applicable Waste Load Allocation (WLA): See Tables 1 (page 16) and page 33 of TMDL Report.
  - Description of Associated Land Use: No land use breakdown was provided by the MassDEP TMDL report so a GIS analysis was performed to determine land use breakdown in the watershed. The land uses of commercial, industrial, residential, and transportation were chosen to be applied to the source "Storm Flow", as all of these land uses typically generate stormwater runoff.
  - Land Use Current Load (TP): 1,123 kg/yr (2,476 lbs/yr) based on Storm Flow source
  - Land Use Target WLA (TP): 538 kg/yr (1,186 lbs/yr) based on Storm Flow source
  - Area in Watershed: 2,726 ha (6,735 acres) identified in GIS analysis
  - Land Use Target Areal WLA (TP): 0.20 kg/ha/yr (0.18 lb/acre/yr)

Estimated Loading from MassDOT

The loading of total phosphorus (TP) from MassDOT property directly contributing stormwater runoff to Lake Quinsigamond was estimated using the following assumptions and calculations:

- MassDOT estimates the TP loading from its impervious areas as 1.60 lb/acre/yr. This loading rate is based on data collected in a study of stormwater runoff conducted by the United States Geological Survey (USGS) (Smith and Granato, 2010). The study analyzed stormwater samples from 12 sites located on highways operated by MassDOT across Massachusetts between September 2005 and September 2007. Samples were taken under a variety of weather conditions during this period.
- MassDOT estimates the TP loading from the pervious areas of its property as 0.6 lb/acre/yr. This loading rate is based on the loading rate for hayland provided in the United States Environmental Protection Agency's (EPA) document EPA 440/5-80-011, "Modeling phosphorus loading and Pond response under uncertainty: a manual and compilation of export coefficients" (Reckhow, 1980). Hayland was chosen to represent the pervious right-of-way areas which are typically cleared areas that are mowed only once per year.
- MassDOT calculated its total estimated TP loading rate using the estimated loading rates listed above. MassDOT property contributing stormwater directly to Lake Quinsigamond is 26.3 acres of impervious area and 24.9 acres of pervious area. The TP loading is 57 lb/yr without accounting for existing BMPs or treatment throughout the watershed.
- MassDOT calculated its target TP WLA using the TMDL target areal WLA of 0.18 lb/ac/yr and the total area of MassDOT property within the TMDL watershed directly draining to Lake Quinsigamond (51.3 acres). The target TP WLA for MassDOT runoff is 9 lb/yr.

Assessment

MassDOT calculated its current TP loading rate (57 lb/yr) and its target TP WLA (9 lb/yr) using values provided in MassDEP's TMDL report and USGS and MassGIS datalayers. The difference between these two values represents the target reduction in TP that MassDOT will aim to achieve to comply with the WLA. For the watershed directly contributing to Lake Quinsigamond, this target reduction is 48 lb/yr, or 84%. As explained in BMP 7R, MassDOT's pollutant loading analysis provides only a preliminary estimate of the level of pollutant reductions that may be recommended. In light of the variability of data on stormwater discharges, MassDOT will rely on a variety of other factors apart from numeric guidelines, including site constraints, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines (EPA, 2006).

<u>Existing BMPs</u>
There are two BMPs currently under construction in the DOT direct drainage areas to Lake Quinsigamond. The Route 9 Bridge spanning the Lake is currently under construction and infiltration BMPs are located near the west abutment in Worcester (ex-BMP-1) and the east abutment in Shrewsbury (Ex-BMP-2). The BMPs are described in the Burns Memorial Bridge Replacement Drainage Report (FS&T, 2012) and are shown on Figure 3. Ex-BMP-1 provides a TP pollutant load reduction of 2.04 lbs/yr and Ex-BMP-1 provides 1.62 lbs/yr.

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 48 lb/yr, MassDOT will consider the implementation of additional BMPs.

Conclusions

MassDOT evaluated its property within the directly contributing watershed to Lake Quinsigamond to identify existing BMPs. This assessment of Lake Quinsigamond has shown that MassDOT has two BMPs under construction, but will require additional load reduction from additional BMPs.

To meet the TMDL for excess algal growth, MassDOT should target a TP load reduction from its directly contributing drainage area by 44.3 lb/yr to achieve the targeted reduction, as summarized in Table 1 below. MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide the target load reduction or treatment to the maximum extent practicable. Once the design of proposed BMPs is finalized, MassDOT will develop a final assessment of this water body under the Impaired Waters program.

Table 1: TP Load Reduction Summary

MassDOT's Required Load Reduction	48	lb/yr
Reduction provided by existing BMPs under construction	3.7	lb/yr
Reduction provided by proposed BMPs	0.0	lb/yr
MassDOT's Targeted Load Reduction	**44.3**	**lb/yr**

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding the design progress made towards meeting the load reduction, plans for construction of the BMPs and finalized assessments. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater runoff from its roadways and easement areas.

References

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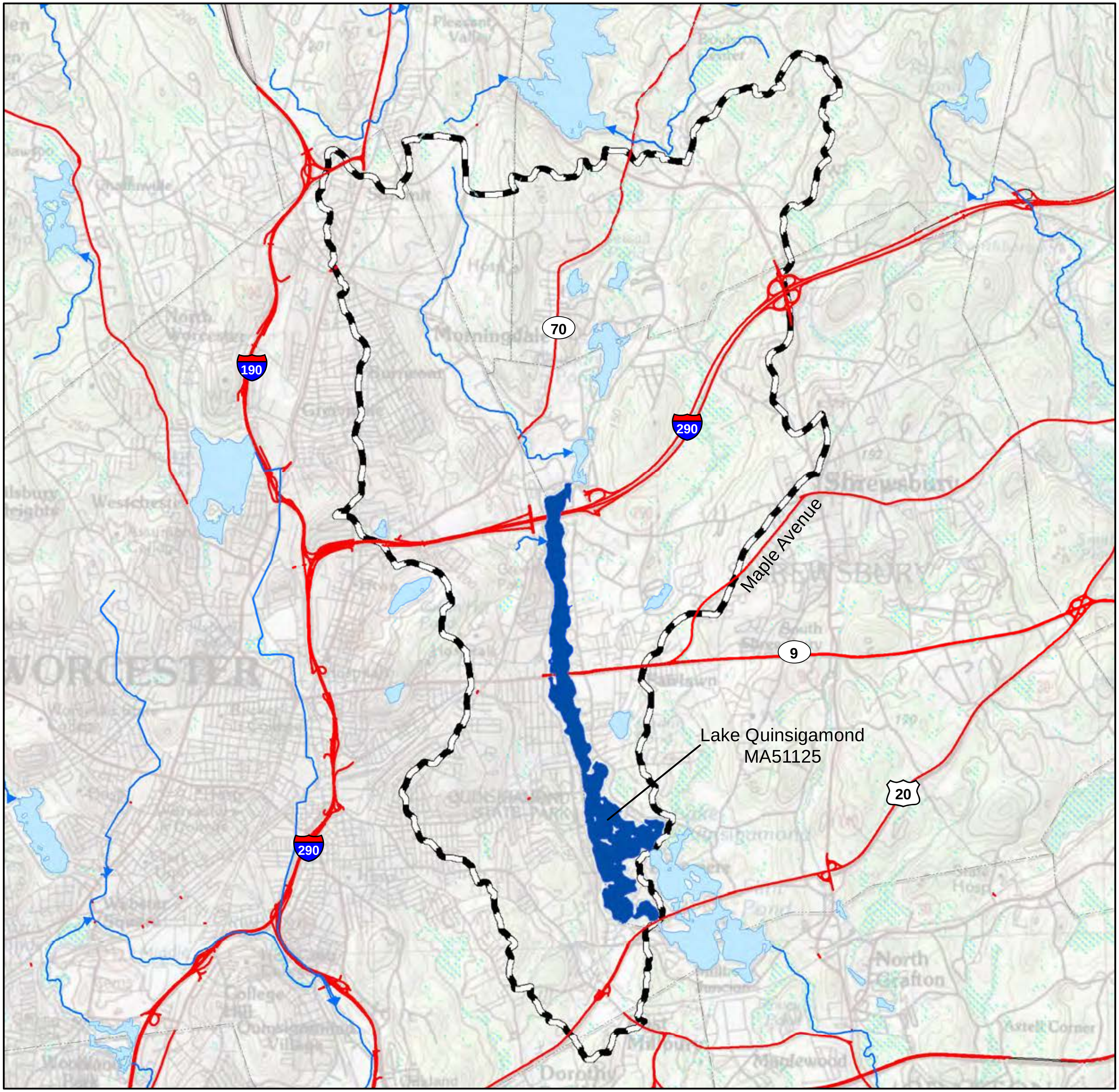
Smith, K.P., & Granato, G.E. (2010). Quality of storm water runoff discharged from Massachusetts highways, 2005-07: U.S. Geological Survey Scientific Investigations Report 2009-5269, 198 p.



Impaired Stream Segment
Lake Quinsigamond
Impaired Water Bodies
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries
Total Watershed

N

0 0.5 1 1.5 2 Miles

1 in = 6,000 feet

Figure 1

Lake Quinsigamond Total Watershed MA51125

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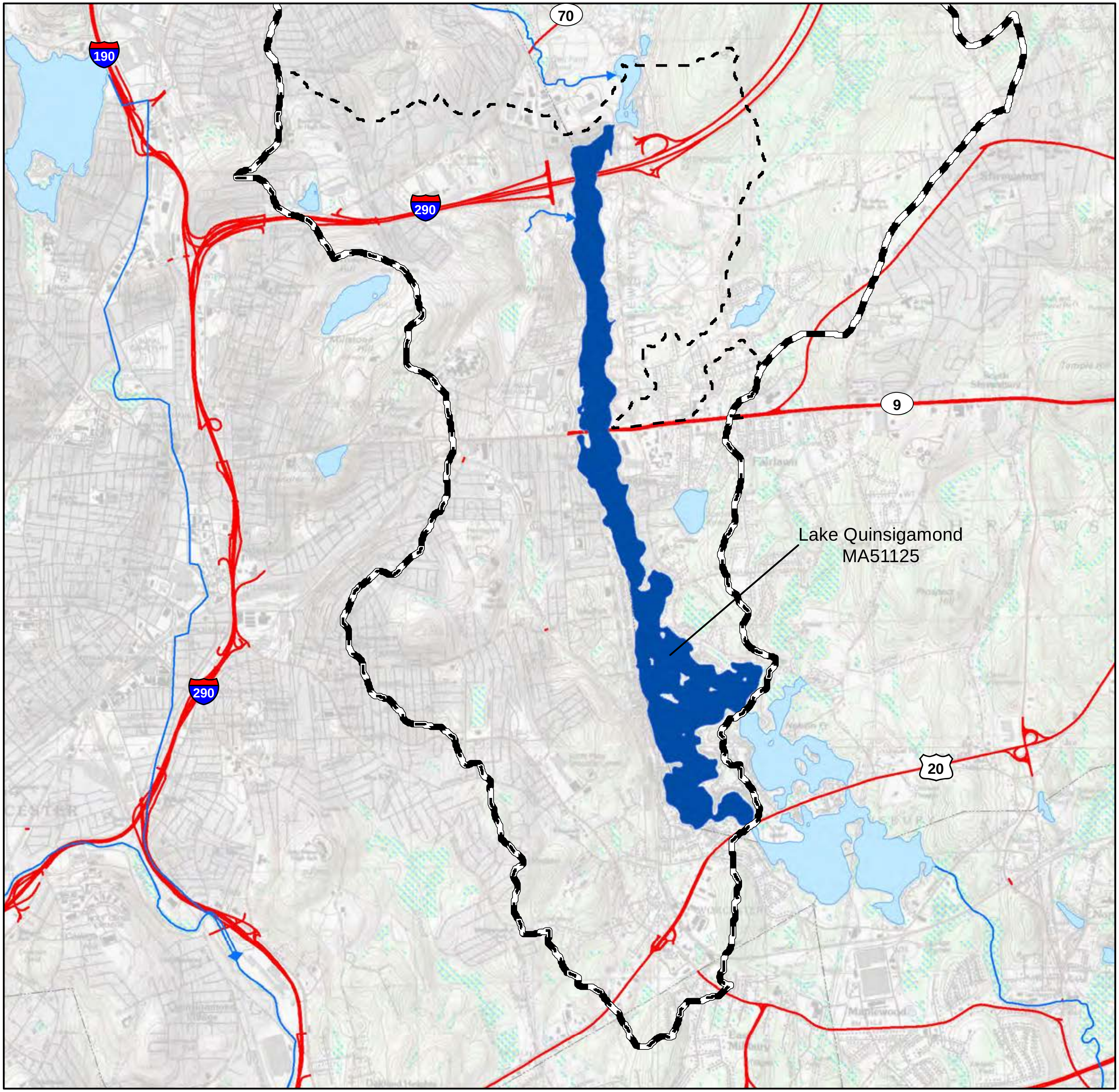

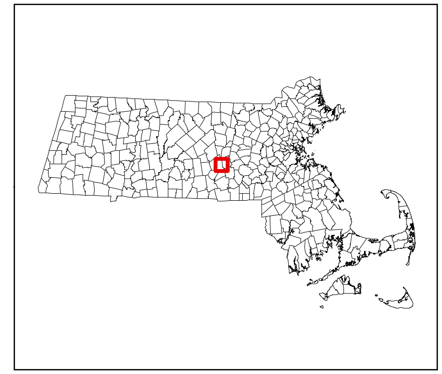

Lake Quinsigamond Subwatershed

Lake Quinsigamond Total Watershed

Impaired Stream Segment

Lake Quinsigamond

Impaired Water Bodies

NWI Wetland Areas

MassDOT Roads in Urban Areas

MassDOT Roads

Town Boundaries

N

0 0.25 0.5 0.75 1 Miles

1 in = 3,750 feet

Figure 2

Lake Quinsigamond Subwatershed MA51125

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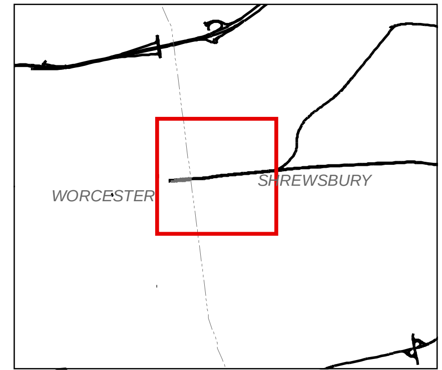

MassDOT Direct Watershed (Impervious)
MassDOT Direct Watershed (Pervious)
Subwatershed
Stormwater Outfalls
Poor Farm Brook
Impaired Stream Segment
Impaired Water Bodies
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 250 500 750 1,000 Feet

1 inch = 750 feet

Figure 3

Lake Quinsigamond (MA51125) Directly Contributing MassDOT Watershed

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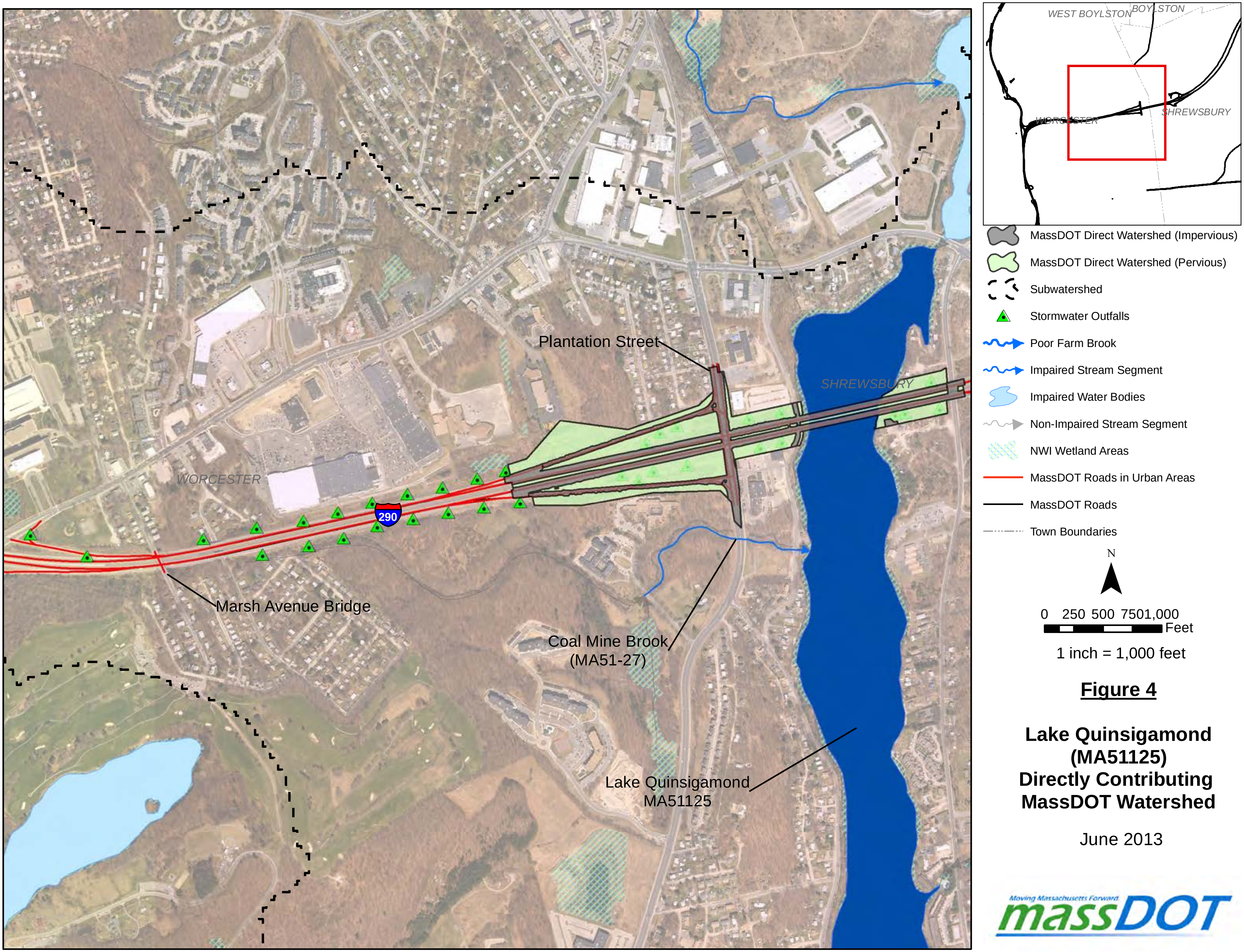

Figure 4

Lake Quinsigamond (MA51125) Directly Contributing MassDOT Watershed

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Impaired Waters Assessment for Flint Pond (MA51188) – Progress Report

Impaired Waterbody

Name: Flint Pond

Location: Shrewsbury, Worcester and Grafton, MA

Water Body ID: MA51188

Impairments

Flint Pond (MA51188) is listed under Category 4a, "TMDL is Completed", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* MassDEP, 2013). Flint Pond is impaired for the following:

- aquatic plants (macrophytes)
- (Eurasian water milfoil, myriophyllum spicatum*)
- (non-native aquatic plants*)

Flint Pond (MA51188) is covered in MassDEP's *Total Maximum Daily Loads (TMDL) of Phosphorus for Selected Northern Blackstone Lakes* [CN 70.1] (MassDEP, 2002b) as well as MassDEP's *Blackstone River Watershed 2003-2007 Water Quality Assessment Report* (MassDEP, 2010). The water quality assessment report states that segment MA51188 of Flint Pond is impaired due to non-native aquatic macrophyte infestations, Eurasian Water Milfoil (Myriophyllum spicatum). The TMDL states:

"The lakes"…(including Flint Pond)…"were listed on the state '303d' list for a variety of pollutant and stressors including low dissolved oxygen, turbidity, nutrients, and over-abundance of nuisance aquatic plants. All of the pollutants and stressors are indicators of nutrient enriched systems, better known as the process of eutrophication. In freshwater systems the primary nutrient known to accelerate eutrophication is phosphorus. Therefore, in order to prevent further degradation in water quality and to ensure that each lake meets state water quality standards the TMDL establishes a phosphorus limit for each lake and outlines corrective actions to achieve that goal." (MassDEP, 2002b)

Because segment MA51188 of Flint Pond is covered by a phosphorus TMDL, MassDOT used this TMDL to assess MassDOT's potential contribution to the impairment of aquatic plants (macrophytes) for Flint Pond.

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *314 CMR 4.05 (5) (b) Bottom Pollutants or Alterations*. All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.

- *314 CMR 4.05 (5) (a) Aesthetics*. All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.
- *314 CMR 4.05 (5) (c) Nutrients.* Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established by the Department pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.

Site Description

Flint Pond is comprised of two segments, segment MA51050 and segment MA51188. Segment MA51188 is assessed in this report. Segment MA51188 of Flint Pond is located in Shrewsbury, Worcester and Grafton, Massachusetts, and lays downstream of Segment MA51050. It has a surface area of approximately 173 acres. The total watershed of segment MA51188 is approximately 24 square miles and the subwatershed is approximately 2 square miles. The total watershed is shown in Figure 1 and the subwatershed is shown in Figure 2.

There are several MassDOT-owned urban roadways in the subwatershed of Segment MA51188. These include Route 20, Route 122, and ramps from Route 122 to Interstate 90. The drainage along each of these roadways is briefly described below.

<u>Route 122</u>
Route 122 is over 1.2 miles away from Segment MA51188 of Flint Pond. As shown in Figure 2, Segment MA51188 and Route 122 are separated by several town roads, a railroad track, and commercial and residential area. Therefore, Route 122 is considered indirect in this assessment.

<u>Ramps to Interstate 90</u>
These ramps are located farther from Segment MA51188 that Route 122. Similarly to Route 122, Segment MA51188 and these ramps are separated by several roads, a railroad track, and commercial and residential area as shown in Figure 2. Therefore, these ramps are considered indirect in this assessment.

<u>Route 20</u>

The portion of Route 20 within the subwatershed of Segment MA51188 of Flint Pond is curbed and is generally crowned in the center of the roadway. Both Segments 51188 and 51050 of Flint Pond lay adjacent to this portion of Route 20, as well as Lake Quinsigamond (MA51125). An evaluation of drainage plans indicated that two sections of Route 20 discharge directly to Flint Pond, as illustrated on Figure 3. A piped drainage system conveys stormwater directly to five outfalls that discharge to Flint Pond (MA51188).

Assessment under BMP 7R

The TMDL for phosphorus for Flint Pond addresses the impairment of aquatic plants (macrophytes). Therefore, MassDOT assessed the contribution of phosphorus from MassDOT property directly draining to this water body to address this impairment. The assessment was completed using the approach described in BMP 7R (TMDL Watershed Review).

According to the final *Massachusetts Year 2012 Integrated List of Waters*, non-native aquatic plants and Eurasian water milfoil, myriophyllum spicatum are non-pollutant stressors which indicate that restoration will require measures other than TMDL development and implementation. As a result, MassDOT has concluded that storm water runoff from its roadways does not contribute to these impairments found in Flint Pond.

TMDL

The Massachusetts Department of Environmental Protection's (MassDEP) TMDL report titled *Total Maximum Daily Loads of Phosphorus for Lake Quinsigamond and Flint Pond* [CN 115] (MassDEP, 2002a) does not specify the breakdown of land use within the watershed. However, the report does provide a figure of the watershed on Page 33. The subbasin with UniqID 23031 in USGS's Massachusetts DS-451 nested subbasins layer is approximately the same as the watershed shown in the TMDL except it includes area downstream of the lower segment of Flint Pond. Therefore, MassDOT redelineated this subbasin to eliminate this area, and used the resulting basin and MassGIS's Land Use layer to determine the breakdown of land use areas within the watershed. The land uses of commercial, industrial, residential, and transportation (an area of approximately 6,735 acres) were used in the calculations described below. The TMDL report does not list the current phosphorus loading and target phosphorus loading based on land use. Instead, it lists loadings for five sources including Atmosphere, Base Flow, Storm Flow, and two NPDES-permitted point sources (see page 16 of the TMDL report). The current and target phosphorus loadings reported for Storm Flow were used for the calculations in this assessment. The TMDL calculations are summarized as follows:

- Pollutant of Concern: Phosphorus
- Impairment for Segment MA51050 of Flint Pond Addressed in MassDEP TMDL Report: aquatic plants (macrophytes)
- Applicable Waste Load Allocation (WLA): See Tables 1 (page 16) and page 33 of TMDL Report.
  - Description of Associated Land Use: No land use breakdown was provided by the MassDEP TMDL report so a GIS analysis was performed to determine land use breakdown in the watershed. The land uses of commercial, industrial, residential, and transportation were chosen to be applied to the source "Storm Flow", as all of these land uses typically generate stormwater runoff.
  - Land Use Current Load (TP): 1,123 kg/yr (2,476 lbs/yr) based on Storm Flow source
  - Land Use Target WLA (TP): 538 kg/yr (1,186 lbs/yr) based on Storm Flow source
  - Area in Watershed: 2,726 ha (6,735 acres) identified in GIS analysis
  - Land Use Target Areal WLA (TP): 0.20 kg/ha/yr (0.18 lb/acre/yr)

Estimated Loading from MassDOT

The loading of total phosphorus (TP) from MassDOT property directly contributing storm water runoff to segment MA51188 of Flint Pond was estimated using the following assumptions and calculations:

- MassDOT estimates the TP loading from its impervious areas as 1.60 lb/acre/yr. This loading rate is based on data collected in a study of storm water runoff conducted by the United States Geological Survey (USGS) (Smith and Granato, 2010). The study analyzed storm water samples from 12 sites located on highways operated by MassDOT across Massachusetts between September 2005 and September 2007. Samples were taken under a variety of weather conditions during this period.
- MassDOT estimates the TP loading from its pervious areas as 0.6 lb/acre/yr. This loading rate is based on the loading rate for hayland provided in the United States Environmental Protection Agency's (EPA) document EPA 440/5-80-011, "Modeling phosphorus loading and Pond response under uncertainty: a manual and compilation of export coefficients" (Reckhow, 1980). Hayland was chosen to represent the pervious right-of-way areas which are typically cleared areas that are mowed only once per year.
- MassDOT calculated its total estimated TP loading rate using the estimated loading rates listed above. MassDOT property contributing storm water directly to Segment MA51188 of Flint Pond is 16.1 acres of impervious area and 3.2 acres of pervious area. The TP loading is 27.7 lb/yr without accounting for existing BMPs or treatment throughout the watershed.
- MassDOT calculated its target TP WLA using the TMDL target areal WLA of 0.18 lb/ac/yr and the total area of MassDOT property within the TMDL watershed directly draining to Segment MA51188 of Flint Pond (19.3 acres). The target TP WLA for MassDOT runoff is 3.4 lb/yr.

Assessment

MassDOT calculated its current TP loading rate (27.7 lb/yr) and its target TP WLA (3.4 lb/yr) using values provided in MassDEP's TMDL report and USGS and MassGIS datalayers. The difference between these two values represents the target reduction in TP that MassDOT will aim to achieve to comply with the WLA. For the watershed directly contributing to Segment MA51188 of Flint Pond, this target reduction is 24.3 lb/yr, or 88%. As explained in BMP 7R, MassDOT's pollutant loading analysis provides only a preliminary estimate of the level of pollutant reductions that may be recommended. In light of the variability of data on stormwater discharges, MassDOT will rely on a variety of other factors apart from numeric guidelines, including site constraints, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines (EPA, 2006).

Existing BMPs

There are no existing BMPs within MassDOT's directly contributing watershed to Flint Pond that are mitigating potential storm water quality impacts. Therefore, no phosphorus loading reduction is provided by existing MassDOT BMPs.

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 24.3 lb/yr, MassDOT will consider the implementation of additional BMPs.

Conclusions

MassDOT evaluated its property within the directly contributing watershed to Segment MA51188 of Flint Pond to identify existing BMPs. This assessment of Flint Pond has shown that MassDOT has no existing BMPs in place, and therefore, stormwater runoff is discharged directly to Flint Pond without treatment.

To meet the TMDL for aquatic plants (macrophytes), MassDOT should reduce its TP loading within the directly contributing watershed by 24.3 lb/yr to achieve the targeted reduction. MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide the target load reduction or treatment to the maximum extent practicable. Once the design of proposed BMPs is finalized, MassDOT will develop a final assessment of this water body under the Impaired Waters program.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT''s programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding the design progress made towards meeting the load reduction, plans for construction of the BMPs and finalized assessments. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater discharge.

References

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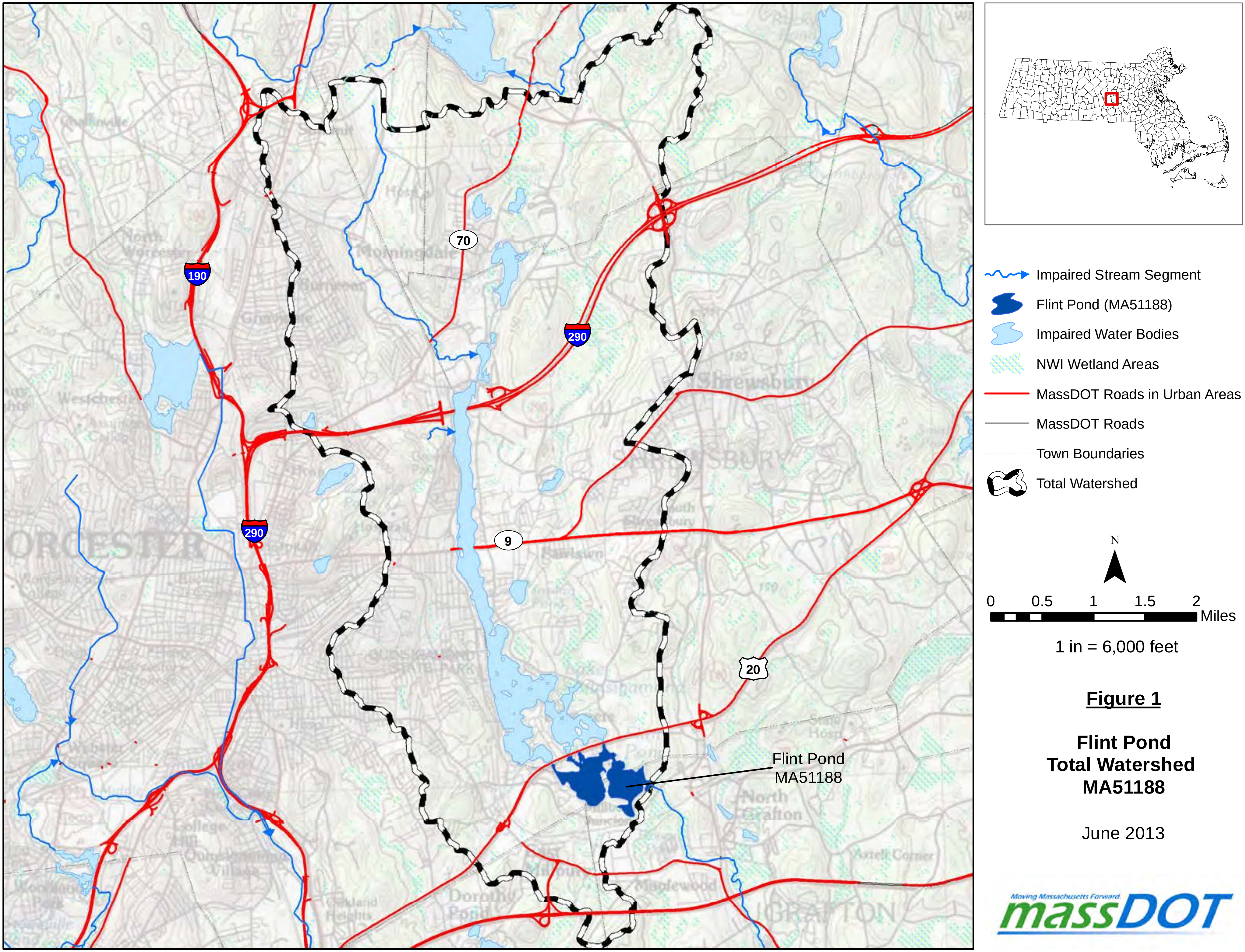

Figure 1

Flint Pond Total Watershed MA51188

June 2013

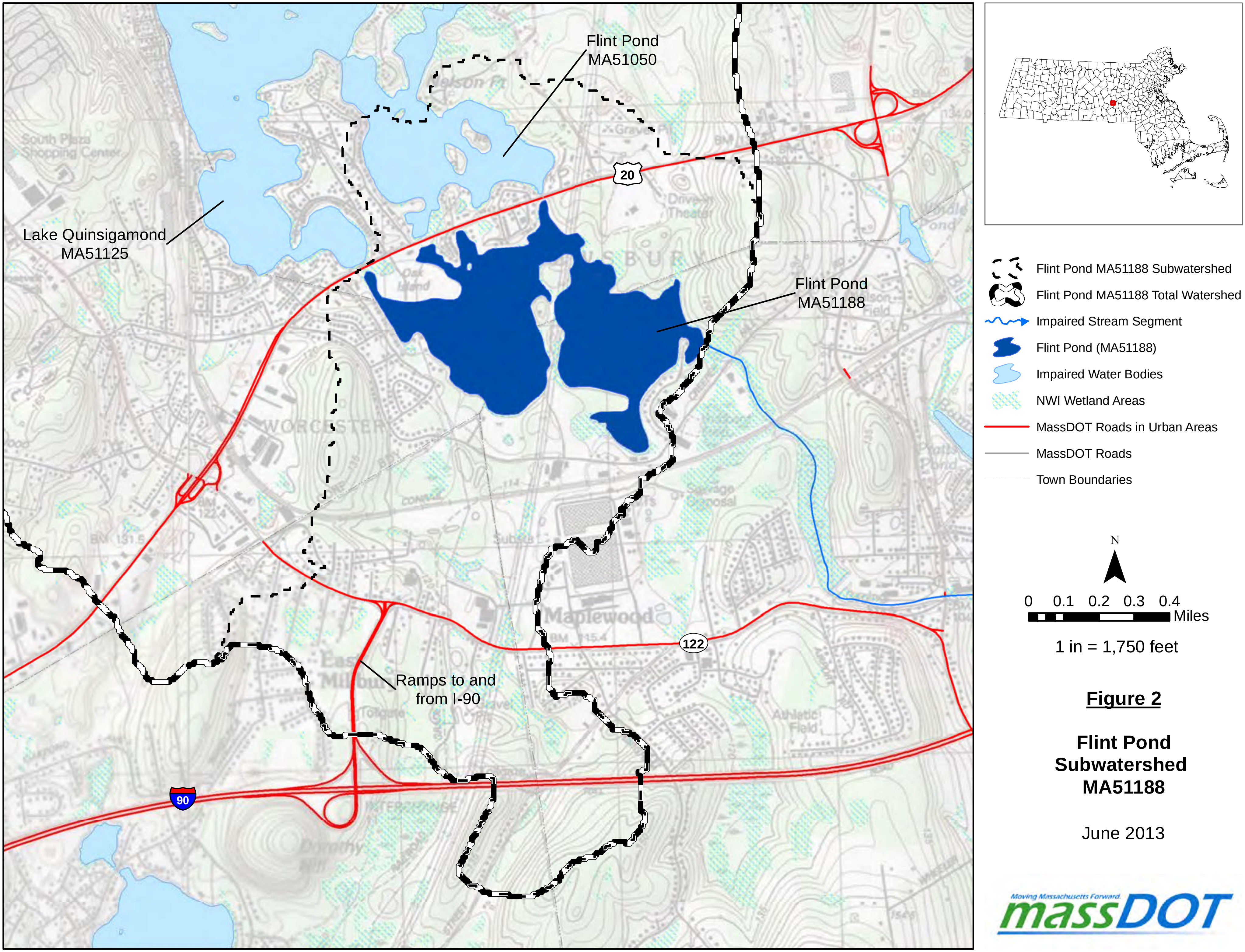

Figure 2

Flint Pond Subwatershed MA51188

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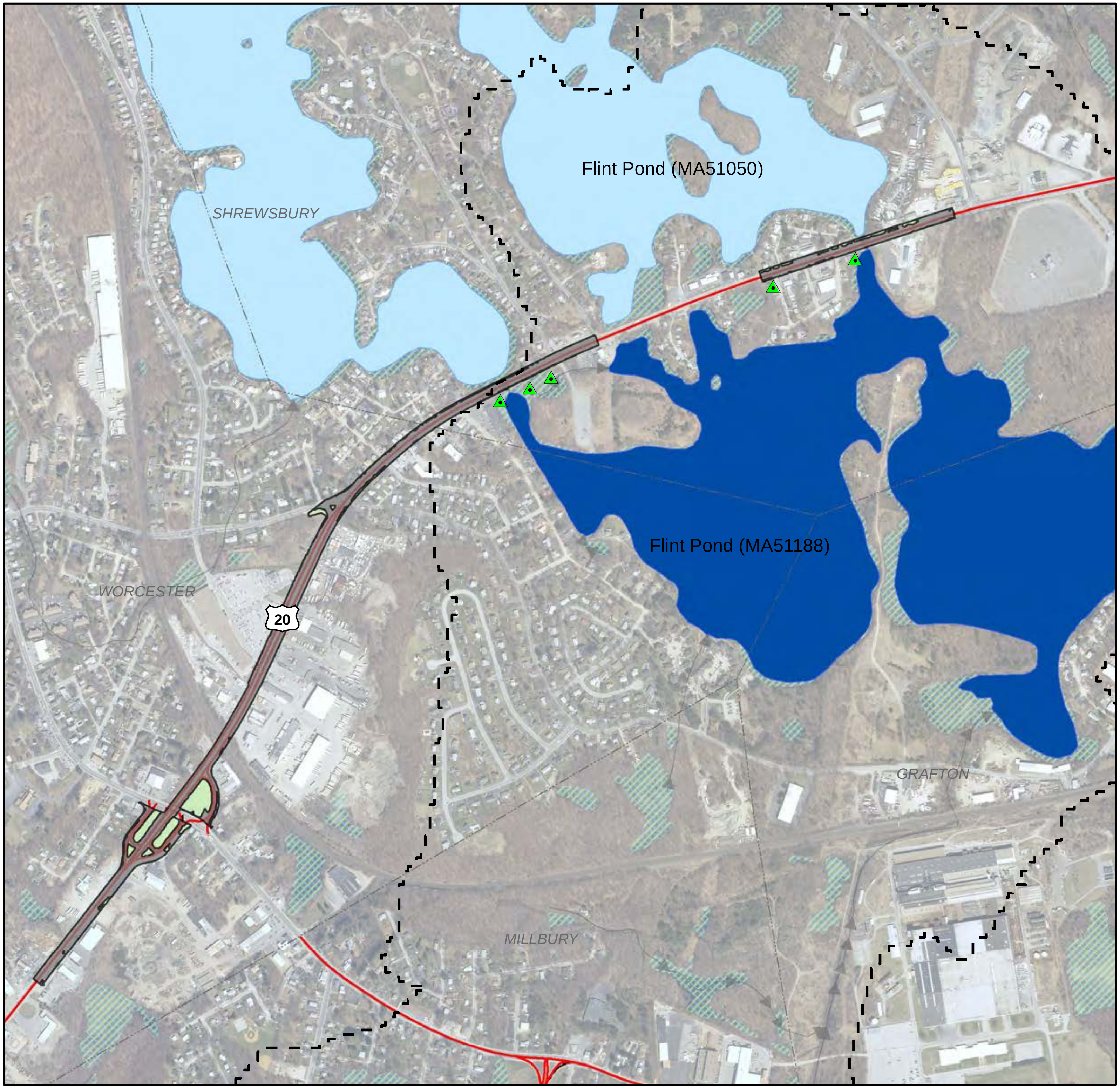

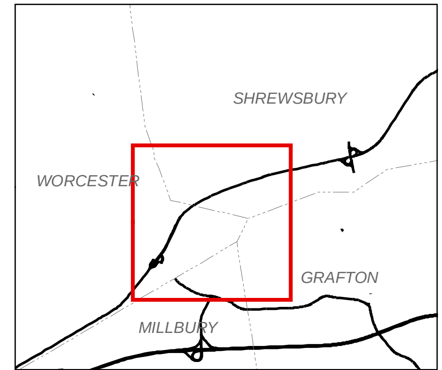

MassDOT Direct Watershed (Impervious)
MassDOT Direct Watershed (Pervious)
Subwatershed
Stormwater Outfalls
Impaired Stream Segment
Flint Pond (MA51188)
Impaired Water Bodies
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 500 1,000 1,500 2,000 ft

1 inch = 1,000 feet

Figure 3

Flint Pond (MA51188) Directly Contributing MassDOT Watershed

June 2013

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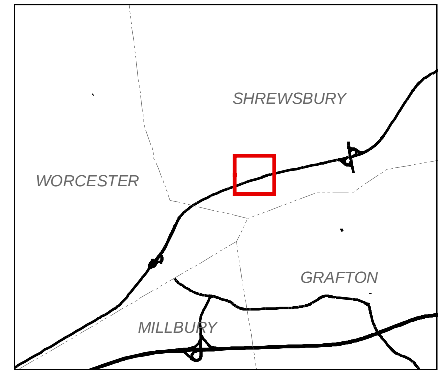

Proposed BMP - Basin
Proposed BMP - Swale
Impaired Stream Segment
Flint Pond (MA51188)
Impaired Water Bodies
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 100 200 300 400 Feet

1 inch = 250 feet

Figure 4

Flint Pond (MA51188) BMP Watersheds

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Impaired Waters Assessment for
Blackstone River (MA51-05) – Progress Report

Impaired Water Body

Name: Blackstone River

Location: Uxbridge and Millville, MA

Water Body ID: MA51-05

Impairments

The Blackstone River (MA51-05) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2010 Integrated List of Waters* (MassDEP, 2011). The Blackstone River is impaired for the following designated uses: aquatic life, primary contact recreation, secondary contact recreation, and aesthetics. The causes of these designated use impairments are listed as the following chemical, physical, and biological characteristics:

- aquatic macroinvertebrate bioassessments
- cadmium
- copper
- fecal coliform
- lead
- total phosphorus
- (other flow regime alterations*)
- PCB(s)
- pH, low
- taste and odor
- total suspended solids (TSS)
- turbidity

According to the final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013), Blackstone River (MA51-05) is impaired for the above conditions, in addition to the following, with the exception of low pH:

- excess algal growth
- nutrient/eutrophication biological indicators

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *314 CMR 4.05 (3)(b) 5 Solids*. These waters shall be free from floating, suspended and settleable solids in concentrations or combinations that would impair any use assigned to this class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.

- *314 CMR 4.05 (3)(b) 6 Color and Turbidity*. These waters shall be free from color and turbidity in concentrations or combinations that are aesthetically objectionable or would impair any use assigned to this class.
- *314 CMR 4.05 (3)(b) 1 Dissolved Oxygen.* Shall not be less than 6.0 mg/l in cold water fisheries and not less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.
- 315 CMR 4.05 (3)(b) 2 Temperature.

  a. Shall not exceed 68°F (20°C) based on the mean of the daily maximum temperature over a seven day period in cold water fisheries, unless naturally occurring. Where a reproducing cold water aquatic community exists at a naturally occurring higher temperature, the temperature necessary to protect the community shall not be exceeded and the natural daily and seasonal temperature fluctuations necessary to protect the community shall be maintained. Temperature shall not exceed 83°F (28.3°C) in warm water fisheries. The rise in temperature due to a discharge shall not exceed 3°F (1.7°0C) in rivers and streams designated as cold water fisheries nor 5°F (2.8°C) in rivers and streams designated as warm water fisheries (based on the minimum expected flow for the month); in lakes and ponds the rise shall not exceed 3°F (1.7°0C) in the epilimnion (based on the monthly average of maximum daily temperature);

  b. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained. There shall be no changes from natural background conditions that would impair any use assigned to this Class, including those conditions necessary to protect normal species diversity, successful migration, reproductive functions or growth of aquatic organisms;
- *314 CMR 5.04 (3)(b) 3 pH.* Shall be in the range of 6.5 through 8.3 standard units but not more than 0.5 units outside of the natural background range. There shall be no change from natural background conditions that would impair any use assigned to this Class.
- *314 CMR 4.05 (3)(b) 4 Bacteria*.

  a. At bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: where E. coli is the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml; alternatively, where enterococci are the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no single sample taken during the bathing season shall exceed 61 colonies per 100 ml;

  b. For other waters and, during the non bathing season, for waters at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: the geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml; alternatively, the geometric mean of all enterococci samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 61 colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department

- *314 CMR 4.05 (5) (b) Bottom Pollutants or Alterations*. All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.

- *314 CMR 4.05 (5)(c) Nutrients.* Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established by the Department pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.
- *314 CMR 4.05 (5)(e) Toxic Pollutants.* All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife. For pollutants not otherwise listed in 314 CMR 4.00, the National Recommended Water Quality Criteria: 2002, EPA 822R-02-047, November 2002 published by EPA pursuant to Section 304(a) of the Federal Water Pollution Control Act, are the allowable receiving water concentrations for the affected waters, unless the Department either establishes a site specific criterion or determines that naturally occurring background concentrations are higher. Where the Department determines that naturally occurring background concentrations are higher, those concentrations shall be the allowable receiving water concentrations. The Department shall use the water quality criteria for the protection of aquatic life expressed in terms of the dissolved fraction of metals when EPA's 304(a) recommended criteria provide for use of the dissolved fraction. The EPA recommended criteria based on total recoverable metals shall be converted to dissolved metals using EPA's published conversion factors. Permit limits will be written in terms of total recoverable metals. Translation from dissolved metals criteria to total recoverable metals permit limits will be based on EPA's conversion factors or other methods approved by the Department. The Department may establish site specific criteria for toxic pollutants based on site specific considerations.

Site Description

The MA51-05 segment of the Blackstone River is approximately 9.1 miles long and extends from the outlet of Rice City Pond (MA51131) in Uxbridge south to the railroad trestle due north of Collins Drive in Millville (**Figure 1**). This segment of the Blackstone River flows from the Rice City Pond outlet at Hartford Avenue, east of the center of North Uxbridge, south through a low gradient floodplain area for approximately 3.8 miles where it passes beneath Route 122. From this bridge the Blackstone River flows approximately 3.5 miles along the south and west side of Route 122 to the Central Street bridge in Millville center. The southernmost portion of this river segment flows from this bridge along the southern side of Route 122 to the railroad trestle that is approximately one mile west of the Town of Blackstone.

The subwatershed for this segment of the Blackstone River is approximately 8.25 square miles (**Figure 2**). There are many small tributaries in the subwatershed that contribute to the Blackstone

River along this river segment, some of which receive runoff from Route 122. There are some areas of Route 122 with stormwater sewers that discharge directly to the tributary streams. There are also many sections of roadway that discharge to low-lying areas or areas that are bordered by Route 122 and an adjacent railroad track that do not have established outlets. The soils along Route 122 in the Blackstone River (MA51-05) subwatershed are primarily classified as hydrologic soil group (HSG) type A or B, so infiltration of stormwater runoff from Route 122 is likely occurring at many outfall locations that do not directly discharge to the Blackstone River or a tributary. As a result, there are many sections of Route 122 that are not considered to be directly discharging to the Blackstone River because roadway runoff appears to be naturally infiltrating near the outfalls.

MassDOT's property that directly contributes stormwater runoff to the Blackstone River (MA51-05) consists of approximately 1.56 miles (4.3 acres) of Route 122 and approximately 360 feet (0.20 acres) of the Old Millville Road (**Figures 3a – 3f**). The directly contributing areas are described from north to south as follows:

Direct Drainage Area 1 – Route 122

The northernmost segment of Route 122 that directly discharges to the Blackstone River extends from approximately 300 feet north to approximately 960 feet south of the Route 122 /Blackstone River Bridge (**Figure 3a**). The northern 300 foot segment of Route 122 drains via sheet flow into the gravel parking area of the Blackstone River Valley Skull Rock Lock River Access point on the northwestern side of the bridge. Some road runoff may infiltrate in this parking area, but there is evidence of stormwater discharge to the Blackstone River along the grass drainage swale along the base of the roadway shoulder. The southern portion of this Route 122 segment drains via a network of catch basins and drain pipes to a 10" reinforced concrete outfall pipe that discharges approximately 30 feet from the Blackstone River (**Photos 1 & 2**). Soil and river bank erosion has resulted from this discharge.

Photo 1: Headwall of outfall southeast of bridge

Photo 2: Channel from outfall to Blackstone River

Direct Drainage Area 2 – Old Millville Road

Old Millville Road is located in Uxbridge, west of Route 122, south of the Route 122/Blackstone River bridge and passes within 100 feet of the Blackstone River for approximately 360 feet (**Figure 3a**). Runoff from approximately 0.20 acres of Old Millville Road drains over gravel and vegetated areas to the Blackstone River (**Photos 3 & 4**). This portion of Old Millville Road is considered a direct discharge because there are points of channelized flow over the river bank from this runoff.

Photo 3: Old Millville Road overland discharge

Photo 4: Old Millville Road overland discharge

Direct Drainage Area 3 – Route 122

An approximately 1.0 acre section of Route 122 located from 1,000 feet north to 750 feet south of the southern intersection of Old Millville Road and Route 122 drains to a tributary that discharges to the Blackstone River approximately 2,000 feet from Route 122 (**Figure 3b**). The northern portion of this segment of Route 122 drains along the edge of the curbed road to the low point where it discharges to the tributary stream via the road shoulder on the east side and Old Millville Road on the west side. The southern portion of this segment of Route 122 drains along the edge of the road where some runoff may migrate onto the shoulder, but otherwise discharges to an eroded ditch on the east side of Route 122 that leads to the tributary and discharges across Old Millville Road and the vegetated roadside into the tributary between Route 122 and Old Millville Road.

Direct Drainage Area 4 – Route 122

A 780 foot section of the northbound lane of Route 122 that is approximately 0.7 miles south of Old Millville Road drains via catch basins and storm drains directly to a tributary of the Blackstone River (**Figure 3c**). This tributary discharges to the Blackstone River approximately 1,500 feet from Route 122. This direct drainage area is approximately 0.23 acres.

Direct Drainage Area 5 – Route 122

A 690 foot section of Route 122 located approximately 0.6 miles south of Old Millville Road and 0.2 miles north of the Millville/Uxbridge town boundary drains to one catch basin on the southbound lane and over the road shoulder on the northbound lane into a tributary that discharges into the Blackstone River approximately 650 feet from Route 122 (**Figure 3c**). The catch basin discharges into a channel between Route 122 and railroad tracks approximately 75 feet from the tributary (**Photo 5**). The direct drainage area associated with this segment of Route 122 is approximately 0.34 acres.

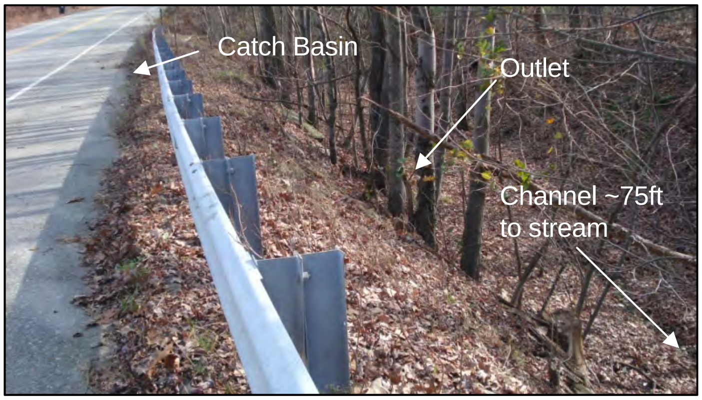

Photo 5: Drainage Area 5 catch basin and outlet

Direct Drainage Area 6 – Route 122

The 470 foot segment of Route 122 between Oak Street and approximately 110 feet south of Walnut Street in Millville drains to an asphalt swale on the northbound lane that directs runoff from the road to a tributary that discharges to the Blackstone River approximately 330 feet from Route 122 (**Figure 3d**). The swale appears to slope directly onto private property (**Photo 6**).

Photo 6: Asphalt swale from Drainage Area 6

Direct Drainage Area 7 – Route 122

Runoff from a 630 foot curbed segment of Route 122 at its intersection with Esty Street in Millville discharges from two curb cuts on the northbound lane adjacent to a tributary stream, and from a catch basin on the southbound lane that discharges directly to the tributary (**Figure 3e**) (**Photo 7**). This discharge location is approximately 560 feet from the Blackstone River. The curb cuts have asphalt swales, but there is some erosion of the embankment. This drainage area is approximately 0.34 acres.

Photo 7: Drainage Area 7 outlets

Direct Drainage Area 8 – Route 122

Approximately 0.42 miles of Route 122 south of Esty Street in Millville drain via catch basins and storm drains that discharge from five (5) outfalls directly into the Blackstone River which passes within 50 feet of this section of Route 122 (**Figure 3e**). The outfalls discharge to the steep bank of riprap along Route 122 (**Photo 8**). Drainage from the southern 580 feet of this road segment is conveyed via a 24" storm drain that discharges from an outfall located near the intersection of Route 122 and a dirt road that parallels the Blackstone River**.**

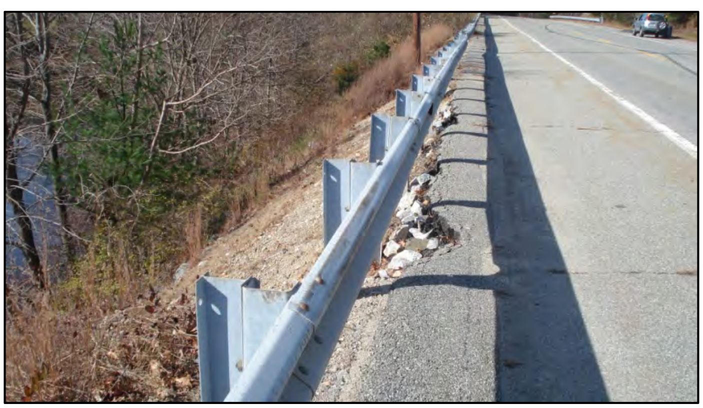

Photo 8: Roadside slope from Drainage Area 8 to Blackstone River

Direct Drainage Area 9 – Route 146

A 0.74 mile segment of Route 146 drains via catch basins and storm drains that discharge to a tributary of the Blackstone River from outfalls that are approximately 0.5 mile from the Blackstone River (**Figure 3f**). The catch basins along this segment of road drain to a reinforced concrete (RC) header pipe located in the median that conveys stormwater to an outfall on the east side of Route 146 directly into the tributary stream. The tributary stream is conveyed beneath Route 146 through a 60” RC culvert. Catch basins on Route 146 near the tributary discharge from two other outfalls (**Figure 3f**). A 15” RC outfall on the eastern side of Route 146 discharges to a concrete/paved channel approximately 200 feet from the tributary. The MassDOT area that drains to this outfall is approximately 0.69 acres. A gas pipeline passes through this area and may be a limiting factor for potential BMP options. Another outfall that is located on the western side of Route 146 discharges to a concrete channel that joins the tributary stream prior to entering the culvert that passes beneath Route 146. The MassDOT area that drains to this outfall is approximately 0.82 acres.

A total of 6.88 acres of MassDOT roadway drains to this tributary from Route 146.

Assessment under BMP 7U

None of the following impairments for the Blackstone River have been addressed by a TMDL. Therefore, MassDOT assessed the impairments using the approach described in BMP 7U of MassDOT’s Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT’s Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of stormwater on many impairments. For this water body, MassDOT used the IC method to assess the following impairments:

- nutrient/eutrophication biological indicators
- sedimentation/siltation
- turbidity
- metals (cadmium, copper, and lead)
- aquatic macroinvertebrate bioassessments
- total phosphorus
- pH, low
- taste and odor
- total suspended solids (TSS)

According to MassDEP’s final *Massachusetts Year 2010 Integrated List of Waters*, the impairment of other flow regime alterations is not caused by pollutants (MassDEP, 2011). Therefore, this impairment is not considered further.

MassDOT concluded that the impairment for PCBs is unrelated to storm water runoff. The Nationwide Urban Runoff Program (NURP) conducted by the EPA found that PCB was detected in less than 1% of stormwater samples collected (EPA, 1983). Therefore, MassDOT concluded that stormwater runoff from its roadways does not contribute to the impairments of PCBs.

The impairment for fecal coliform is assessed separately in the section titled, Assessment of Pathogen Impairment.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction necessary to attain the percent imperviousness in the watershed at which stormwater is not likely the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. IC data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer. In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for the Blackstone River (MA51-05):

Table 1. Site Parameters for Blackstone River (MA51-05)

Subwatershed		
Watershed Area	5,280	acres
Impervious Cover (IC) Area	655	acres
Percent Impervious	12.4	%
IC Area at 9% Goal	475	acres
Target Reduction % in IC	27.5	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	11.2	acres
MassDOT's Target Reduction in Effective IC (27.5% of DOT Directly Contributing IC)	3.1	acres

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 27.5%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 3.1 acres.

Existing BMPs

There are no existing BMPs in the Blackstone River (MA51-05) directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to the Blackstone River.

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 3.1 acres, MassDOT will consider the implementation of additional BMPs.

Assessment of Pathogen Impairment

MassDOT assessed the pathogen impairment using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by an order of magnitude within a given storm event at a single location (MassDEP, 2009b). Therefore, it is difficult to predict pathogen concentrations in stormwater with accuracy. Due to this difficulty, MassDOT generally will not conduct site specific assessments of loading at each location impaired for pathogens. Instead these sites will be assessed collectively based on available information on pathogen loading from highways, MassDOT actions, and information available from EPA and DEP. Based on this information MassDOT developed an approach to be consistent with relevant TMDL and permit condition requirements and an iterative adaptive management approach to stormwater management.

In addition, while there is a positive relationship between IC and pathogen loading, the relationship is not as direct as other impairments. According to the Center for Watershed Protection "…Other studies show that concentrations of bacteria are typically higher in urban areas than rural areas (USGS, 1999), but they are not always directly related to IC (CWP, 2003)." Therefore, DOT did not rely solely on the IC method to assess pathogen impairments. Instead, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

Pathogens in MassDOT Discharge

A study conducted on MassDOT's South East Expressway measured bacterial concentrations in stormwater runoff (Smith, 2002). This study found a geometric mean of 186 fecal coliforms/100 ml. Concentrations of pathogens in stormwater runoff from roadways can vary widely and pathogen concentrations in runoff across the state likely deviate significantly from this stretch of roadway's specific estimate. Event mean concentrations of fecal coliform bacteria in urban stormwater from other sources ranging between 14,000 and 17,000 fecal coliform organisms/100 mL have been reported (MassDEP, 2009b). These data suggest that pathogen loading from highways may be lower than other urban areas.

Consideration of the potential sources of pathogens supports the idea that pathogens are present in lower concentrations in highway runoff since potential pathogen sources are likely to be less prevalent in the highway environment than along other urban roadways:

- <u>Illicit discharges:</u> Due to the typical setback of highways from residential and commercial developments and the stand alone nature of the drainage system, the potential for illicit discharges (e.g. sewer connections, laundry tie-ins) is much lower than in other stormwater systems. This has been confirmed by MassDOT's illicit discharge detection on many miles of urban roadways within a broad range of areas across Massachusetts. After assessment of almost 140 miles, and investigation of more than 2,500 stormwater features, MassDOT's consultant performing the broad scope reviews has found no confirmed illicit discharges.
- <u>Limited Sewer Utilities in Road Right of Ways:</u> Since DOT does not provide sewer services, many MassDOT roads do not have sewer utilities within the road's right of way; thereby eliminating the chance of cross-connections or leaking pipes as a source of pathogens into the stormwater system.
- <u>Pet waste:</u> Pets are only present on highways in rare instances. In urban residential areas pets and their associated waste are much more common. MassDOT is aware that pet waste at road side rest stops may represent a potential source of pathogens to stormwater in certain situations.
- <u>Wildlife:</u> Highways are not generally an attractive place for wildlife. Wildlife generally avoids highways and only occasionally crosses them.

The dearth of pathogen sources on highways and the relatively low concentrations of pathogens measured in the South East Expressway study together suggest that pathogen loading from stormwater runoff from highways is lower than other urban sources.

Furthermore, in almost all cases the contribution of pathogens from MassDOT to a specific water body is likely to be very small relative to other sources of pathogens in the watershed. Since MassDOT urban roadways are linear and usually cross watersheds, they represent a small fraction of the receiving water body's watershed. The water quality within these water bodies is dependent on discharge from various sources, including discharges from other stormwater systems and a large number of other factors.

Assessment

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

TMDLs for pathogen impairments in Massachusetts recognize that pathogens are highly variable and difficult to address and emphasize the need for an iterative adaptive management approach to address pathogens. Examples of relevant language from these TMDLs are included below:

- “given the vast potential number of bacteria sources and the difficulty of identifying and removing them from some sources such as stormwater require an iterative process and will take some time to accomplish. While the stated goal in the TMDL is to meet the water quality standard at the point of discharge it also attempts to be clear that MassDEP’s expectation is that for stormwater an iterative approach is needed…” (MassDEP, 2009a)
- “The NPDES permit does not, however, establish numeric effluent limitations for stormwater discharges. Maximum extent practicable (MEP) is the statutory standard that establishes the level of pollutant reductions that regulated municipalities must achieve. The MEP standard is a narrative effluent limitation that is satisfied through implementation of SWMPs and achievement of measurable goals.”(MassDEP, 2009b)
- “Although the TMDL presents quantified WLAs for stormwater that are set equivalent to the criteria in the Massachusetts Water Quality Standards, the Phase II NPDES permits will not include numeric effluent limitations. Phase II permits are intended to be BMP based permits that will require communities to develop and implement comprehensive stormwater management programs involving the use of BMPs. Massachusetts and EPA believe that BMP based Phase II permits involving comprehensive stormwater management together with specific emphasis on pollutants contributing to existing water quality problems can be consistent with the intent of the quantitative WLAs for stormwater discharges in TMDLs.” (MassDEP, 2002).

This language clearly indicates that an iterative adaptive management approach is the appropriate way to address discharges to pathogen impaired waters. The recommendations in pathogen TMDLs for waters in Massachusetts generally require development and implementation of stormwater management programs, illicit discharge detection and elimination efforts, and in some cases installing BMPs to the maximum extent practicable.

The draft North Coastal Watershed General MS4 permit and the draft Interstate, Merrimack, and South Coastal (IMS) watershed permits contain specific requirements for compliance with pathogen TMDLs (in Appendix G). While these permits are still in draft form, MassDOT believes they represent the best available guidance on what EPA believes is appropriate for addressing stormwater discharges to pathogen-impaired waters. Section 2.2.1(c) of the permit states “For any discharge from its MS4 to impaired waters with an approved TMDL, the permittee shall comply with the specific terms of Part 2.1 of this permit. In addition, where an approved TMDL establishes a WLA that applies to its MS4 discharges, the permittee shall implement the specific BMPs and other permit requirements identified in Appendix G to achieve consistency with the WLA.” Appendix G references a number of programmatic BMPs that are necessary to address pathogen loading. These cover the following general topics:

- Residential educational program
- Illicit connection identification, tracking and removal
- Pet waste management

Mitigation Plan

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Stormwater Management Plan (SWMP) including educational programs, illicit connection review and source control. The specific BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In
- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

In addition, the structural BMPs that will be considered to reduce the IC will also have the effect of reducing pathogen loads.

MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations. MassDOT's existing stormwater management plan outlines BMPs that include education and illicit discharge detection and elimination. MassDOT will be implementing a pet waste management program at its rest stops that have discharges to pathogen impaired waters. In addition, MassDOT has requested coverage under an individual stormwater permit for the next permit term. This permit may contain additional programmatic BMPs to address pathogens.

Conclusions

MassDOT used the IC Method to assess the Blackstone River (MA51-05) for the impairments identified in MassDEP's final *Massachusetts Year 2010 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed by **3.1** acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to the Blackstone River to identify existing BMPs and found that no BMPs exist to reduce effective IC. This information is summarized in Table 2 below.

Table 2. Effective IC Reductions under Existing & Proposed Conditions

IC in Directly Contributing Watershed	11.2	acres
Target Reduction in Effective IC	3.1	acres
IC Effectively Reduced by Existing BMPs	0	acres
IC Remaining to Mitigate with Proposed BMPs	**3.1**	**acres**

MassDOT should reduce its effective IC within the directly contributing watershed by an additional 3.1 acres to achieve the targeted reduction in IC. MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs to treat directly contributing IC as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide the target IC reduction or treatment to the maximum extent practicable.

Furthermore, MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of additional BMPs, and finalized assessments including reductions achieved by finalized BMP designs. MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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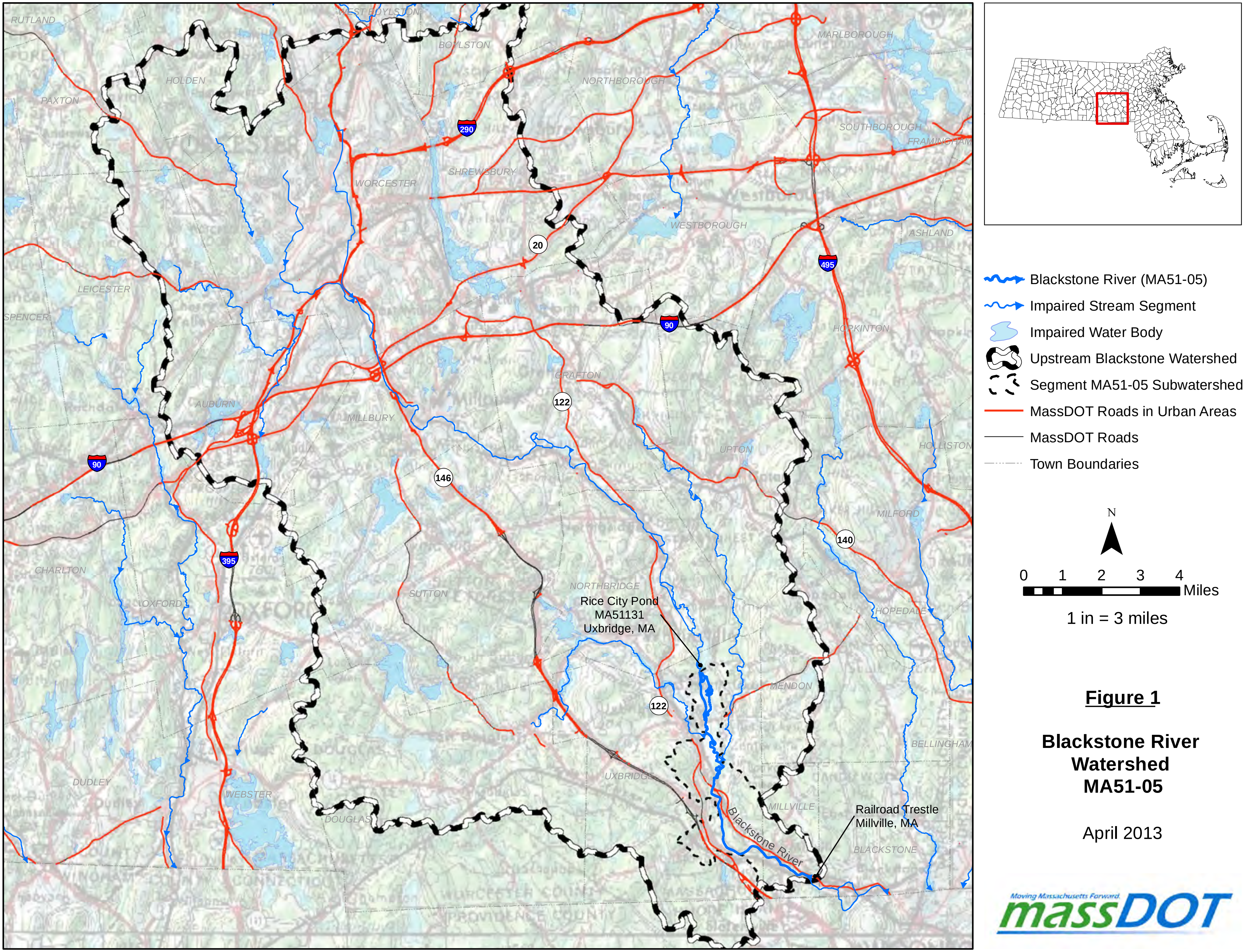

Figure 1

Blackstone River Watershed MA51-05

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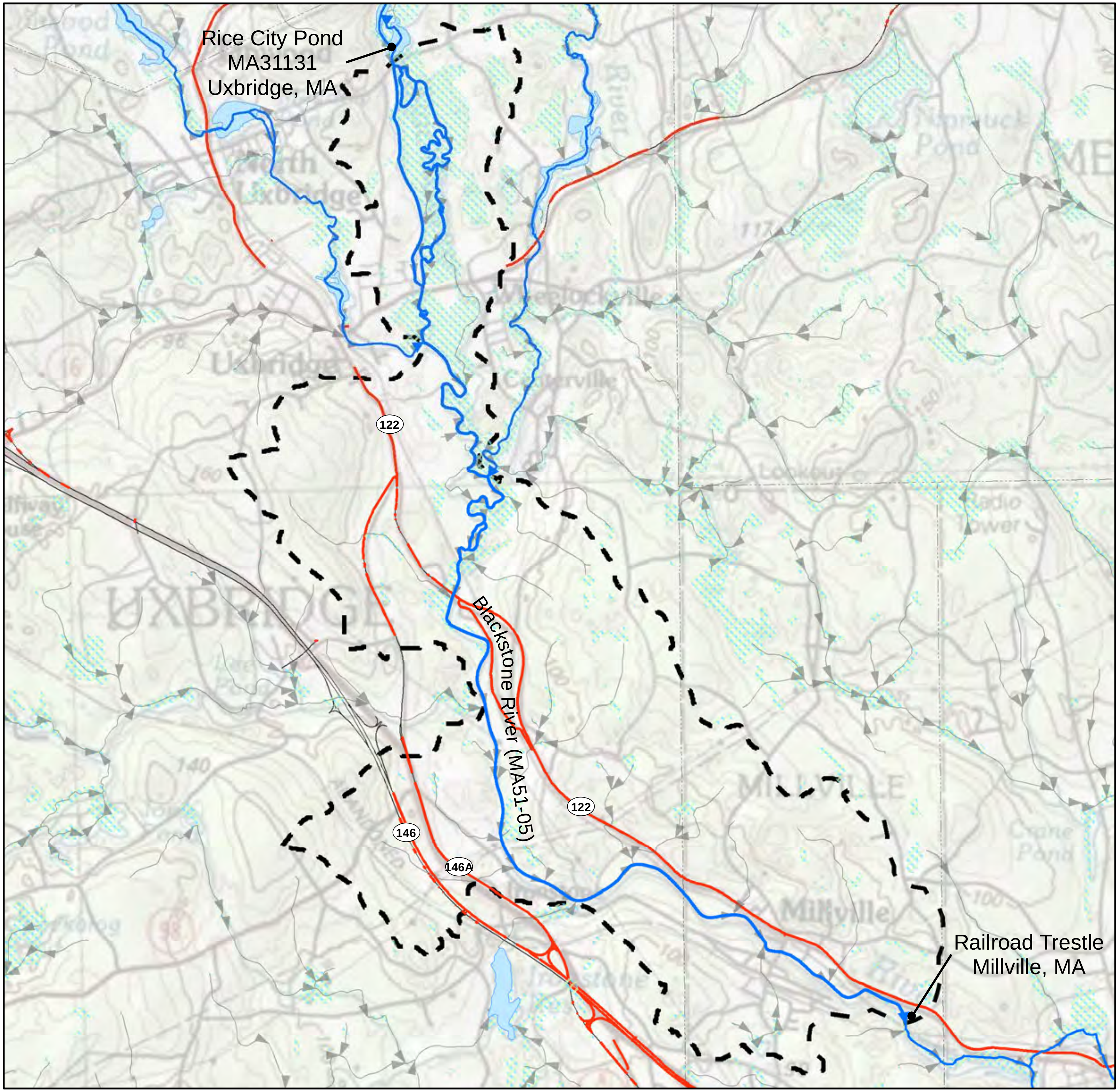

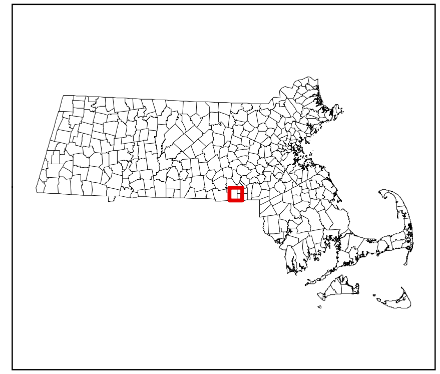

Blackstone River Subwatershed
Blackstone River (MA51-05)
Impaired Stream Segment
Non-Impaired Stream Segment
Impaired Water Bodies
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 0.25 0.5 0.75 1 1.25 Miles

1 in = 0.75 miles

Figure 2

Blackstone River Subwatershed MA51-05

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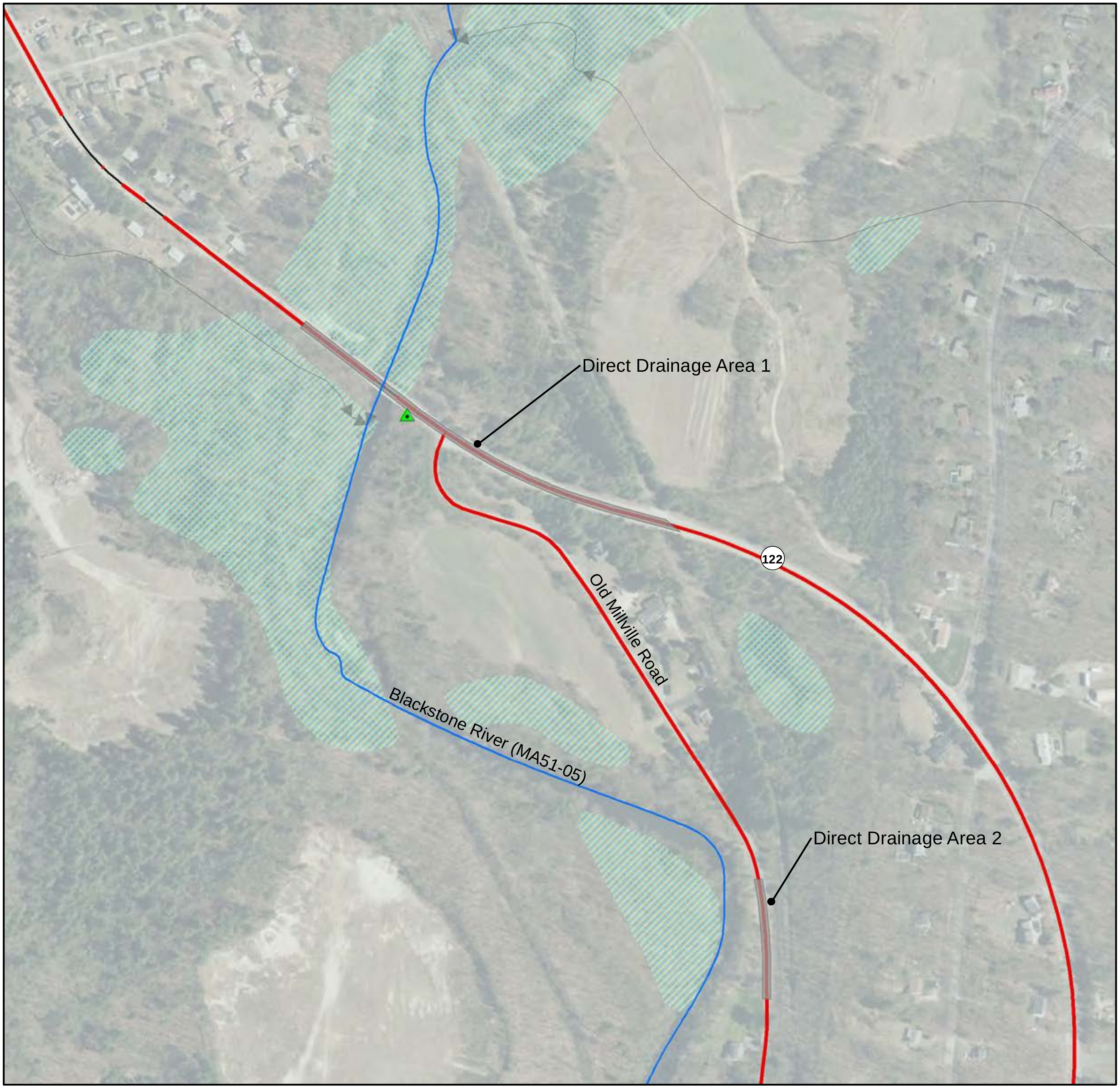

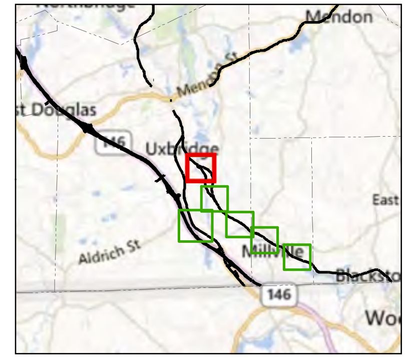

Stormwater Outfalls
MassDOT Directly Contributing Watershed
Impaired Stream Segment
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 200 400 600 800 Feet

1 inch = 400 feet

Figure 3 a

Blackstone River
MA51-05
Directly Contributing
MassDOT Watershed

1 of 6

April 2013

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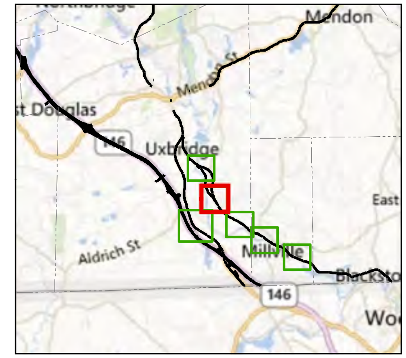

Stormwater Outfalls

MassDOT Directly Contributing Watershed

Impaired Stream Segment

Non-Impaired Stream Segment

NWI Wetland Areas

MassDOT Roads in Urban Areas

MassDOT Roads

Town Boundaries

N

0 200 400 600 800 Feet

1 inch = 400 feet

Figure 3 b

Blackstone River MA51-05 Directly Contributing MassDOT Watershed

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April 2013

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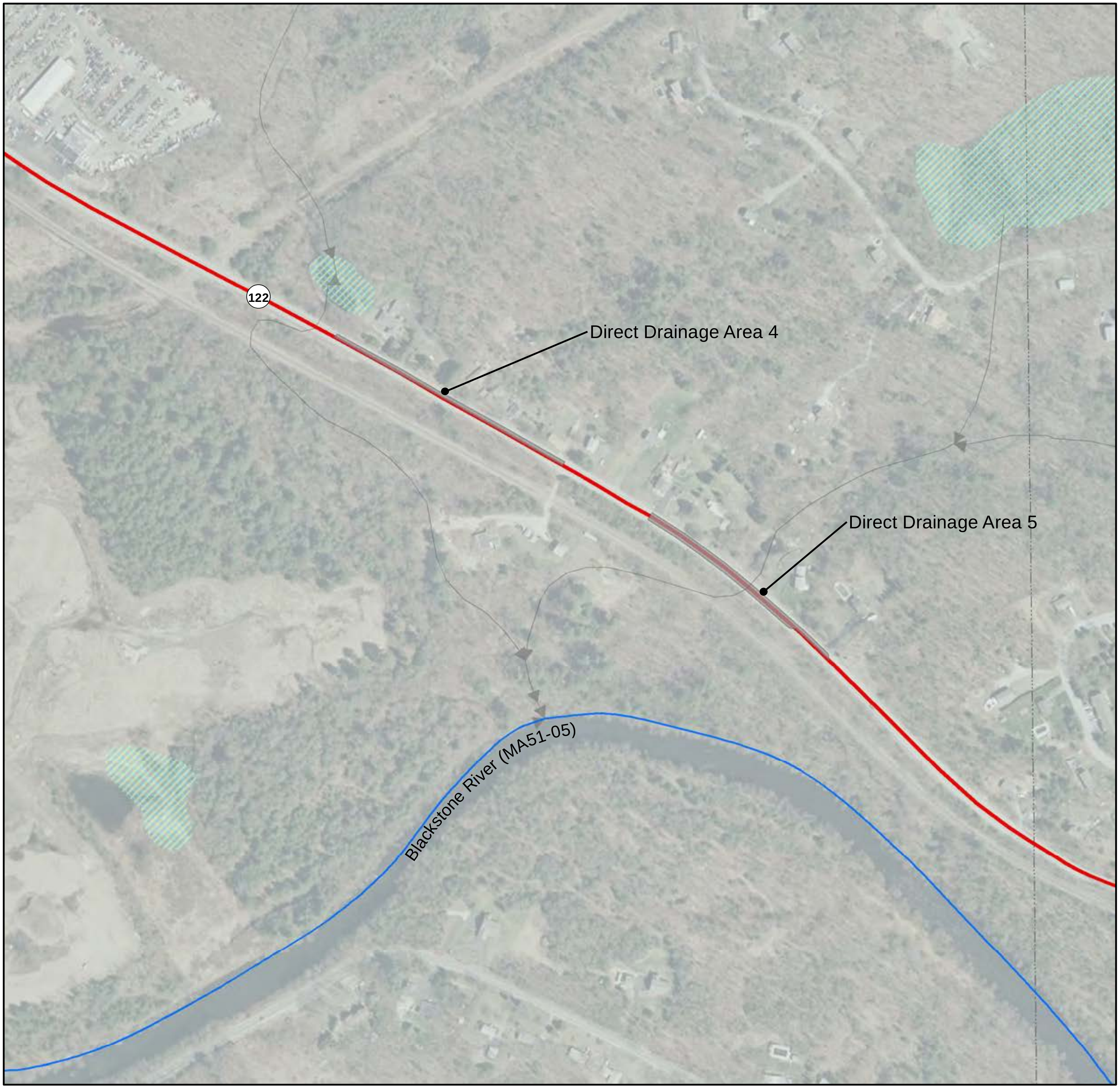

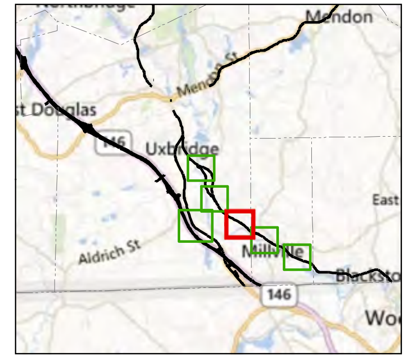

Stormwater Outfalls

MassDOT Directly Contributing Watershed

Impaired Stream Segment

Non-Impaired Stream Segment

NWI Wetland Areas

MassDOT Roads in Urban Areas

MassDOT Roads

Town Boundaries

N

0 200 400 600 800 Feet

1 inch = 400 feet

Figure 3 c

Blackstone River
MA51-05
Directly Contributing
MassDOT Watershed

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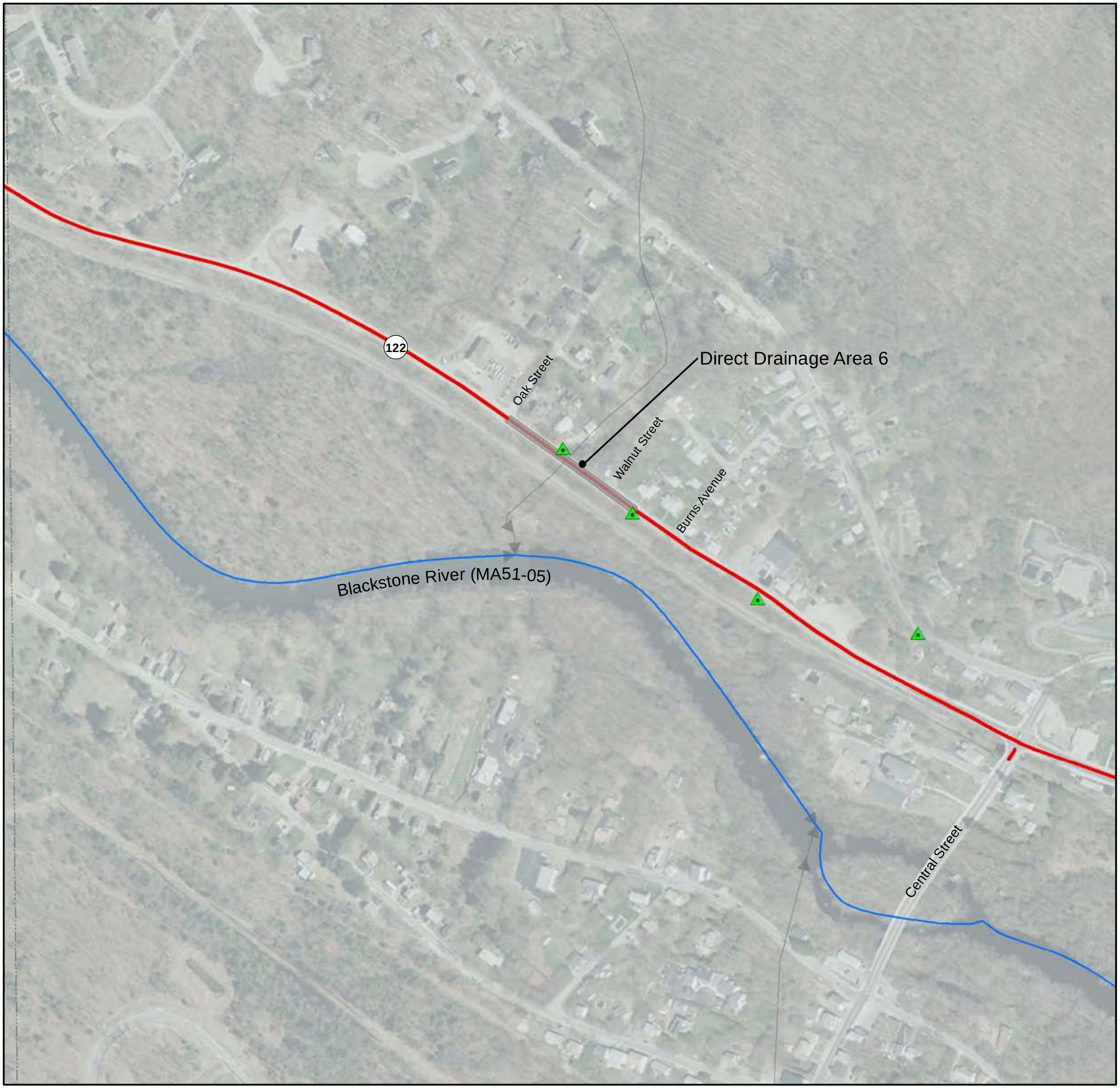

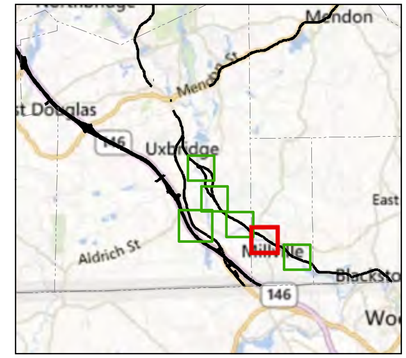

Stormwater Outfalls

MassDOT Directly Contributing Watershed

Impaired Stream Segment

Non-Impaired Stream Segment

NWI Wetland Areas

MassDOT Roads in Urban Areas

MassDOT Roads

Town Boundaries

N

0 200 400 600 800 Feet

1 inch = 400 feet

Figure 3 d

Blackstone River MA51-05 Directly Contributing MassDOT Watershed

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April 2013

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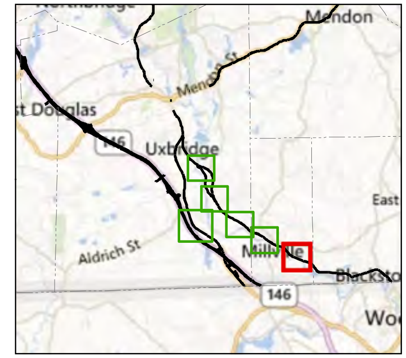

Stormwater Outfalls
MassDOT Directly Contributing Watershed
Impaired Stream Segment
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 200 400 600 800 Feet

1 inch = 400 feet

Figure 3 e

Blackstone River MA51-05 Directly Contributing MassDOT Watershed

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April 2013

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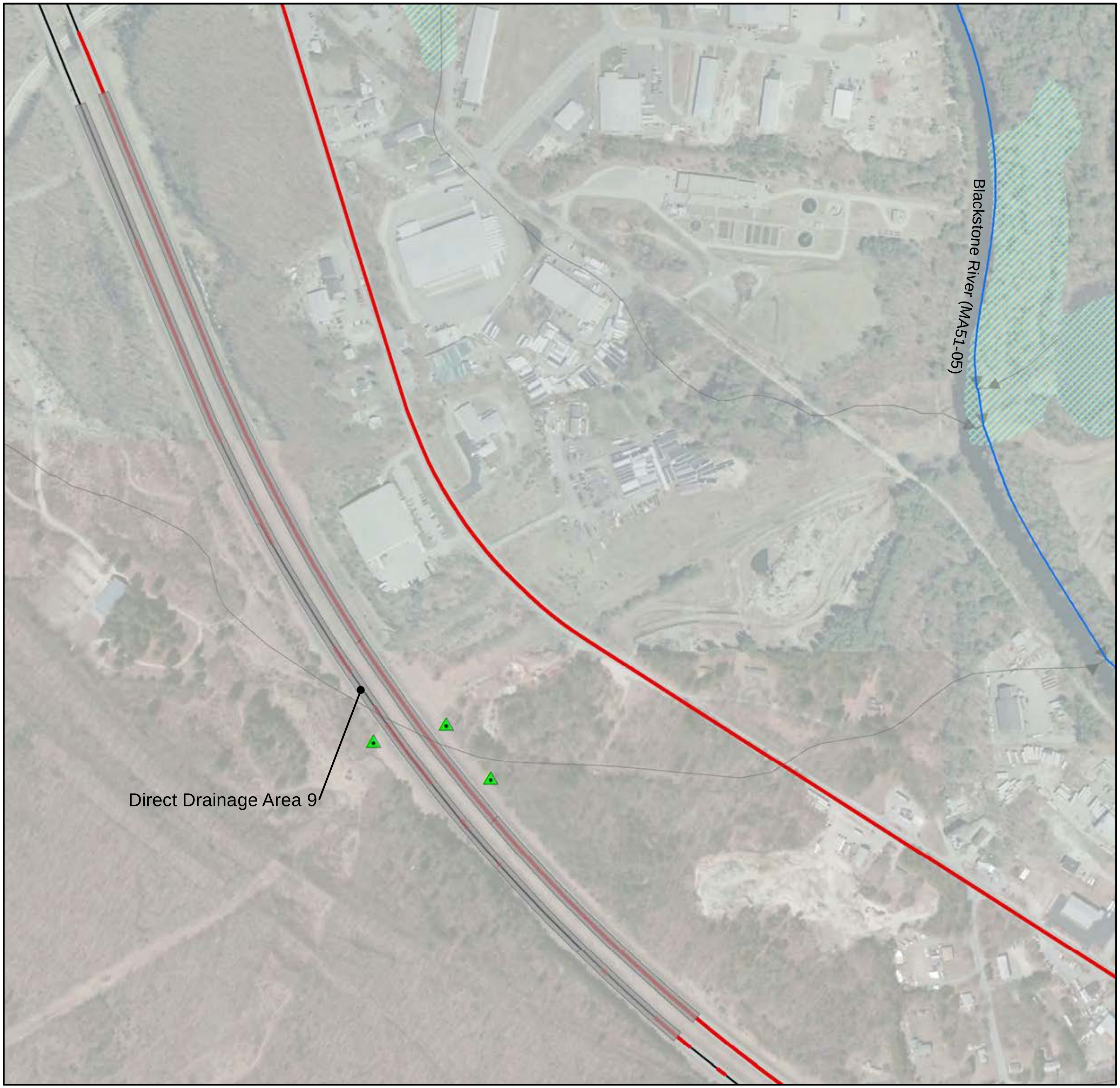

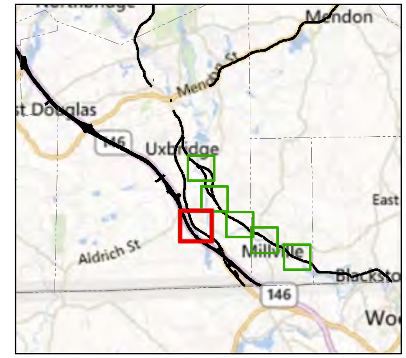

Stormwater Outfalls

MassDOT Directly Contributing Watershed

Impaired Stream Segment

Non-Impaired Stream Segment

NWI Wetland Areas

MassDOT Roads in Urban Areas

MassDOT Roads

Town Boundaries

N

0 225 450 675 900 Feet

1 inch = 475 feet

Figure 3 f

Blackstone River
MA51-05
Directly Contributing
MassDOT Watershed

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April 2013

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Impaired Waters Assessment for Blackstone River (MA51-06) – Progress Report

Impaired Water Body

Name: Blackstone River

Location: Millville and Blackstone, MA

Water Body ID: MA51-06

Impairments

The Blackstone River (MA51-06) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2010 Integrated List of Waters* (MassDEP, 2011*)*. The Blackstone River is impaired for the following designated uses: aquatic life, fish consumption, primary contact recreation, secondary contact recreation, and aesthetics. The causes of these designated use impairments are listed as the following chemical, physical, and biological characteristics:

- lead
- phosphorus (total)
- fecal coliform
- turbidity
- total suspended solids (TSS)
- taste and odor
- (low flow alterations*)
- copper
- cadmium
- PCB(s) in fish tissue

Based on new assessments, the following were removed from the list of impairments for Blackstone River (MA51-06) under the final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013):

- fecal coliform
- taste and odor
- turbidity
- (low flow alterations*)

The final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013) added the following as impairments for Blackstone River (MA51-06):

- (other flow regime alterations*)
- DDT

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *314 CMR 4.05 (3)(b) 5 Solids*. These waters shall be free from floating, suspended and settleable solids in concentrations or combinations that would impair any use assigned to this class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.
- *314 CMR 4.05 (3)(b) 6 Color and Turbidity*. These waters shall be free from color and turbidity in concentrations or combinations that are aesthetically objectionable or would impair any use assigned to this class.
- *314 CMR 4.05 (3)(b) 4 Bacteria*.

  a. At bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: where E. coli is the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml; alternatively, where enterococci are the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no single sample taken during the bathing season shall exceed 61 colonies per 100 ml;

  b. For other waters and, during the non bathing season, for waters at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: the geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml; alternatively, the geometric mean of all enterococci samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 61 colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department
- *314 CMR 4.05 (5)(c) Nutrients.* Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established by the Department pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.
- *314 CMR 4.05 (5)(e) Toxic Pollutants.* All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife. For pollutants not otherwise listed in 314 CMR 4.00, the National Recommended Water Quality Criteria: 2002, EPA 822R-02-047, November 2002 published by EPA pursuant to Section 304(a) of the Federal Water Pollution Control Act, are the allowable receiving water concentrations for the affected waters, unless the Department either establishes a site specific criterion or determines that naturally occurring background concentrations are higher. Where the Department determines that naturally occurring background concentrations are higher, those concentrations shall be the allowable receiving water concentrations. The Department shall use the water quality criteria for the protection of aquatic life expressed in terms of the dissolved fraction of metals when EPA's 304(a) recommended criteria provide for use of the dissolved fraction. The EPA recommended

criteria based on total recoverable metals shall be converted to dissolved metals using EPA's published conversion factors. Permit limits will be written in terms of total recoverable metals. Translation from dissolved metals criteria to total recoverable metals permit limits will be based on EPA's conversion factors or other methods approved by the Department. The Department may establish site specific criteria for toxic pollutants based on site specific considerations.

Site Description

The MA51-06 segment of the Blackstone River is approximately 3.8 miles long and extends from the railroad trestle due north of Collins Drive in Millville to the Rhode Island border west of Route 122 (Main Street) in Blackstone (**Figure 1**). This segment of the Blackstone River flows southeast from Millville and becomes impounded by the Tupperware Dam in Blackstone to form Millville Pond (**Figure 2**). The river is directed northeast to the Milliville Pond Impoundment through a power canal where it is used to generate hydropower by Synergics Hydropower. A portion of the Blackstone River is by-passed around the Tupperware Dam into the native channel that flows south into Rhode Island. The eastern portion of this segment of the Blackstone River flows along the southern side of Main Street in Blackstone into Rhode Island.

The subwatershed for this segment of the Blackstone River is approximately 2.86 square miles (**Figure 2**). MassDOT's property that directly contributes stormwater runoff to the Blackstone River (MA51-06) consists of approximately 1.39 miles (4.7 acres) of Route 122 (**Figures 3a – 3f**). The directly contributing areas are described from north to south as follows:

Direct Drainage Area 1 – Route 122

Direct Drainage Area 1 is approximately 0.90 acres of Route 122 between 0.17 and 0.45 miles west of the western bridge over the Blackstone River in Blackstone, MA. This area discharges from two outfalls directly into the Blackstone River (**Figure 3a**). The eastern portion of this drainage area is relatively flat and properties on the southern side Route 122 appear to receive some runoff which likely discharge directly to the Blackstone River since much of the area along this side of the road is impervious. This impervious drainage area consists of 0.9 acres of Mass DOT roadway.

Direct Drainage Area 2 – Route 122

Stormwater runoff from approximately 880 feet of Route 122 west of the western bridge over the Blackstone River drains to a wetland that is adjacent to Blackstone River (**Figure 3a**). There is considerable erosion along the roadside directly into the wetland area. The wetland likely provides some removal of pollutants to the Blackstone River, but due to its apparent hydraulic connection to the Blackstone River this drainage area is considered to be direct. This impervious drainage area consists of 0.5 acres of Mass DOT roadway.

Direct Drainage Area 3 – Route 122

Stormwater runoff from Route 122 between the two bridges over the Blackstone River in Blackstone appears to discharge from the 36" outfall located in the abutment of the western bridge directly into the Blackstone River (**Figure 3b**). Drainage drawings for much of this area are not available, but catch basins along this road segment were confirmed during the site visit. No other outfalls were identified during the site visit. This impervious drainage area consists of 1.2 acres of Mass DOT roadway.

Direct Drainage Area 4 – Route 122

Approximately 0.33 miles of Route 122 from the eastern bridge over the Blackstone River east to Bridge Street is curbed and is drained via catch basins and a storm drain (**Figure 3b**). Based on the topography in this area, and the presence of storm drains along Bridge Street and 1st Avenue, this portion of Route 122 is presumed to discharge directly to the Blackstone River. Drainage drawings are not available for this area. This impervious drainage area consists of 1.5 acres of Mass DOT roadway.

Direct Drainage Area 5 – Route 122

Direct Drainage Area 5 is an approximately 0.36 segment of Route 122 from the Rhode Island border to St. Paul Street (**Figure 3c**). This road segment is curbed, and based upon available drainage drawings stormwater runoff from this area directly discharges from three outfalls directly into the Blackstone River. This impervious drainage area consists of 1.4 acres of Mass DOT roadway.

Assessment under BMP 7U

None of the following impairments for the Blackstone River have been addressed by a TMDL. Therefore, MassDOT assessed the impairments using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of stormwater on many impairments. For this water body, MassDOT used the IC method to assess the following impairments:

- turbidity
- metals (cadmium, copper, and lead)
- phosphorus (total)
- total suspended solids (TSS)
- taste and odor

According to MassDEP's final *Massachusetts Year 2010 Integrated List of Waters*, the impairment of low flow alterations is not caused by pollutants (MassDEP, 2011). Therefore, this impairment is not considered further.

MassDOT concluded that the impairment for PCBs is unrelated to storm water runoff. The Nationwide Urban Runoff Program (NURP) conducted by the EPA found that PCB was detected in less than 1% of stormwater samples collected (EPA, 1983). Therefore, MassDOT concluded that stormwater runoff from its roadways does not contribute to the impairments of PCBs.

The impairment for fecal coliform is assessed separately in the section titled, Assessment of Pathogen Impairment.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction necessary to attain the percent imperviousness in the watershed at which stormwater is not likely the cause of the impairments.

Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. IC data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer. In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for the Blackstone River (MA51-06):

Table 1. Site Parameters for Blackstone River (MA51-06)

Subwatershed		
Watershed Area	1830	acres
Impervious Cover (IC) Area	253	acres
Percent Impervious	13.8	%
IC Area at 9% Goal	165	acres
Target Reduction % in IC	34.8	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	5.5	acres
MassDOT's Target Reduction in Effective IC (34.8% of DOT Directly Contributing IC)	1.9	acres

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 34.8%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 1.9 acres.

Existing BMPs

There are no existing BMPs in the Blackstone River (MA51-06) directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to the Blackstone River.

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 1.9 acres, MassDOT will consider the implementation of additional BMPs.

Assessment of Pathogen Impairment

MassDOT assessed the pathogen impairment using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by an order of magnitude within a given storm event at a single location (MassDEP, 2009b). Therefore, it is difficult to predict pathogen concentrations in stormwater with accuracy. Due to this difficulty, MassDOT generally will not conduct site specific assessments of loading at each location impaired for pathogens. Instead these sites will be assessed collectively based on available information on pathogen loading from highways, MassDOT actions, and information available from EPA and DEP. Based on this information MassDOT developed an approach to be consistent with relevant TMDL and permit condition requirements and an iterative adaptive management approach to stormwater management.

In addition, while there is a positive relationship between IC and pathogen loading, the relationship is not as direct as other impairments. According to the Center for Watershed Protection "…Other studies show that concentrations of bacteria are typically higher in urban areas than rural areas (USGS, 1999), but they are not always directly related to IC (CWP, 2003)."

Therefore, DOT did not rely solely on the IC method to assess pathogen impairments. Instead, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

Pathogens in MassDOT Discharge

A study conducted on MassDOT's South East Expressway measured bacterial concentrations in stormwater runoff (Smith, 2002). This study found a geometric mean of 186 fecal coliforms/100 ml. Concentrations of pathogens in stormwater runoff from roadways can vary widely and pathogen concentrations in runoff across the state likely deviate significantly from this stretch of roadway's specific estimate. Event mean concentrations of fecal coliform bacteria in urban stormwater from other sources ranging between 14,000 and 17,000 fecal coliform organisms/100 mL have been reported (MassDEP, 2009b). These data suggest that pathogen loading from highways may be lower than other urban areas.

Consideration of the potential sources of pathogens supports the idea that pathogens are present in lower concentrations in highway runoff since potential pathogen sources are likely to be less prevalent in the highway environment than along other urban roadways:

- <u>Illicit discharges:</u> Due to the typical setback of highways from residential and commercial developments and the stand alone nature of the drainage system, the potential for illicit discharges (e.g. sewer connections, laundry tie-ins) is much lower than in other stormwater systems. This has been confirmed by MassDOT's illicit discharge detection on many miles of urban roadways within a broad range of areas across Massachusetts. After assessment of almost 140 miles, and investigation of more than 2,500 stormwater features, MassDOT's consultant performing the broad scope reviews has found no confirmed illicit discharges.
- <u>Limited Sewer Utilities in Road Right of Ways:</u> Since DOT does not provide sewer services, many MassDOT roads do not have sewer utilities within the road's right of way; thereby eliminating the chance of cross-connections or leaking pipes as a source of pathogens into the stormwater system.
- <u>Pet waste:</u> Pets are only present on highways in rare instances. In urban residential areas pets and their associated waste are much more common. MassDOT is aware that pet waste at road side rest stops may represent a potential source of pathogens to stormwater in certain situations.
- <u>Wildlife:</u> Highways are not generally an attractive place for wildlife. Wildlife generally avoids highways and only occasionally crosses them.

The dearth of pathogen sources on highways and the relatively low concentrations of pathogens measured in the South East Expressway study together suggest that pathogen loading from stormwater runoff from highways is lower than other urban sources.

Furthermore, in almost all cases the contribution of pathogens from MassDOT to a specific water body is likely to be very small relative to other sources of pathogens in the watershed. Since MassDOT urban roadways are linear and usually cross watersheds, they represent a small fraction of the receiving water body's watershed. The water quality within these water bodies is dependent on discharge from various sources, including discharges from other stormwater systems and a large number of other factors.

Assessment

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

TMDLs for pathogen impairments in Massachusetts recognize that pathogens are highly variable and difficult to address and emphasize the need for an iterative adaptive management approach to address pathogens. Examples of relevant language from these TMDLs are included below:

- "given the vast potential number of bacteria sources and the difficulty of identifying and removing them from some sources such as stormwater require an iterative process and will take some time to accomplish. While the stated goal in the TMDL is to meet the water quality standard at the point of discharge it also attempts to be clear that MassDEP's expectation is that for stormwater an iterative approach is needed…" (MassDEP, 2009a)
- "The NPDES permit does not, however, establish numeric effluent limitations for stormwater discharges. Maximum extent practicable (MEP) is the statutory standard that establishes the level of pollutant reductions that regulated municipalities must achieve. The MEP standard is a narrative effluent limitation that is satisfied through implementation of SWMPs and achievement of measurable goals."(MassDEP, 2009b)
- "Although the TMDL presents quantified WLAs for stormwater that are set equivalent to the criteria in the Massachusetts Water Quality Standards, the Phase II NPDES permits will not include numeric effluent limitations. Phase II permits are intended to be BMP based permits that will require communities to develop and implement comprehensive stormwater management programs involving the use of BMPs. Massachusetts and EPA believe that BMP based Phase II permits involving comprehensive stormwater management together with specific emphasis on pollutants contributing to existing water quality problems can be consistent with the intent of the quantitative WLAs for stormwater discharges in TMDLs." (MassDEP, 2002).

This language clearly indicates that an iterative adaptive management approach is the appropriate way to address discharges to pathogen impaired waters. The recommendations in pathogen TMDLs for waters in Massachusetts generally require development and implementation of stormwater management programs, illicit discharge detection and elimination efforts, and in some cases installing BMPs to the maximum extent practicable.

The draft North Coastal Watershed General MS4 permit and the draft Interstate, Merrimack, and South Coastal (IMS) watershed permits contain specific requirements for compliance with pathogen TMDLs (in Appendix G). While these permits are still in draft form, MassDOT believes they represent the best available guidance on what EPA believes is appropriate for addressing stormwater discharges to pathogen-impaired waters. Section 2.2.1(c) of the permit states "For any discharge from its MS4 to impaired waters with an approved TMDL, the permittee shall comply with the specific terms of Part 2.1 of this permit. In addition, where an approved TMDL establishes a WLA that applies to its MS4 discharges, the permittee shall implement the specific BMPs and other permit requirements identified in Appendix G to achieve consistency with the WLA." Appendix G references a number of programmatic BMPs that are necessary to address pathogen loading. These cover the following general topics:

- Residential educational program
- Illicit connection identification, tracking and removal
- Pet waste management

Mitigation Plan

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Stormwater Management Plan (SWMP) including educational programs, illicit connection review and source control. The specific BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In
- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

In addition, the structural BMPs that will be considered to reduce the IC will also have the effect of reducing pathogen loads.

MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations. MassDOT's existing stormwater management plan outlines BMPs that include education and illicit discharge detection and elimination. MassDOT will be implementing a pet waste management program at its rest stops that have discharges to pathogen impaired waters. In addition, MassDOT has requested coverage under an individual stormwater permit for the next permit term. This permit may contain additional programmatic BMPs to address pathogens.

Conclusions

MassDOT used the IC Method to assess the Blackstone River (MA51-06) for the impairments identified in MassDEP's final *Massachusetts Year 2010 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed by **1.9** acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to the Blackstone River to identify existing BMPs and found that no BMPs exist to reduce effective IC. This information is summarized in Table 2 below.

Table 2. Effective IC Reductions under Existing & Proposed Conditions

IC in Directly Contributing Watershed	5.5	acres
Target Reduction in Effective IC	1.9	acres
IC Effectively Reduced by Existing BMPs	0	acres
IC Remaining to Mitigate with Proposed BMPs	**1.9**	**acres**

MassDOT should reduce its effective IC within the directly contributing watershed by an additional 1.9 acres to achieve the targeted reduction in IC. MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs to treat directly contributing IC as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide the target IC reduction or treatment to the maximum extent practicable.

Furthermore, MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of additional BMPs, and finalized assessments including reductions achieved by finalized BMP designs. MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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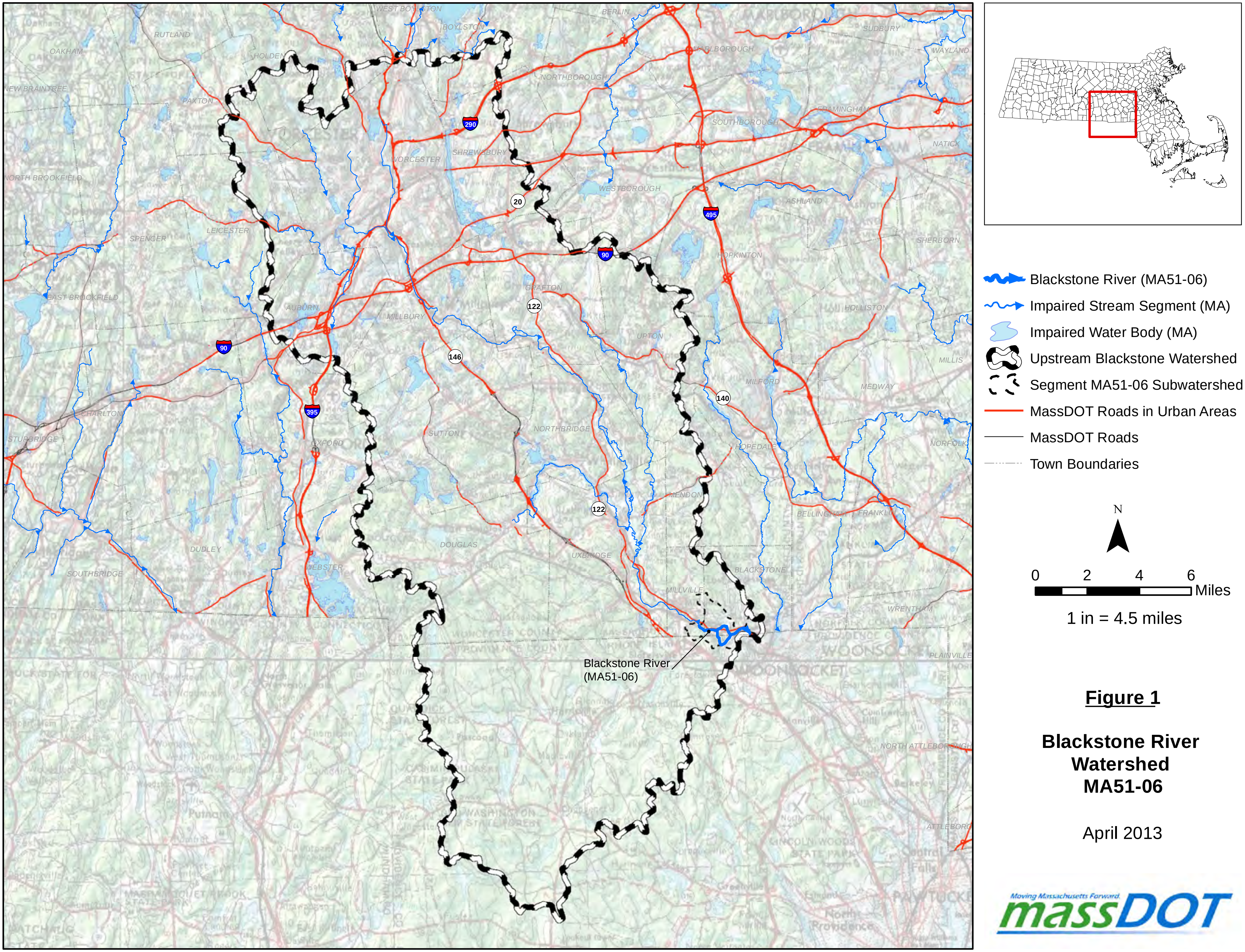

Figure 1

Blackstone River Watershed MA51-06

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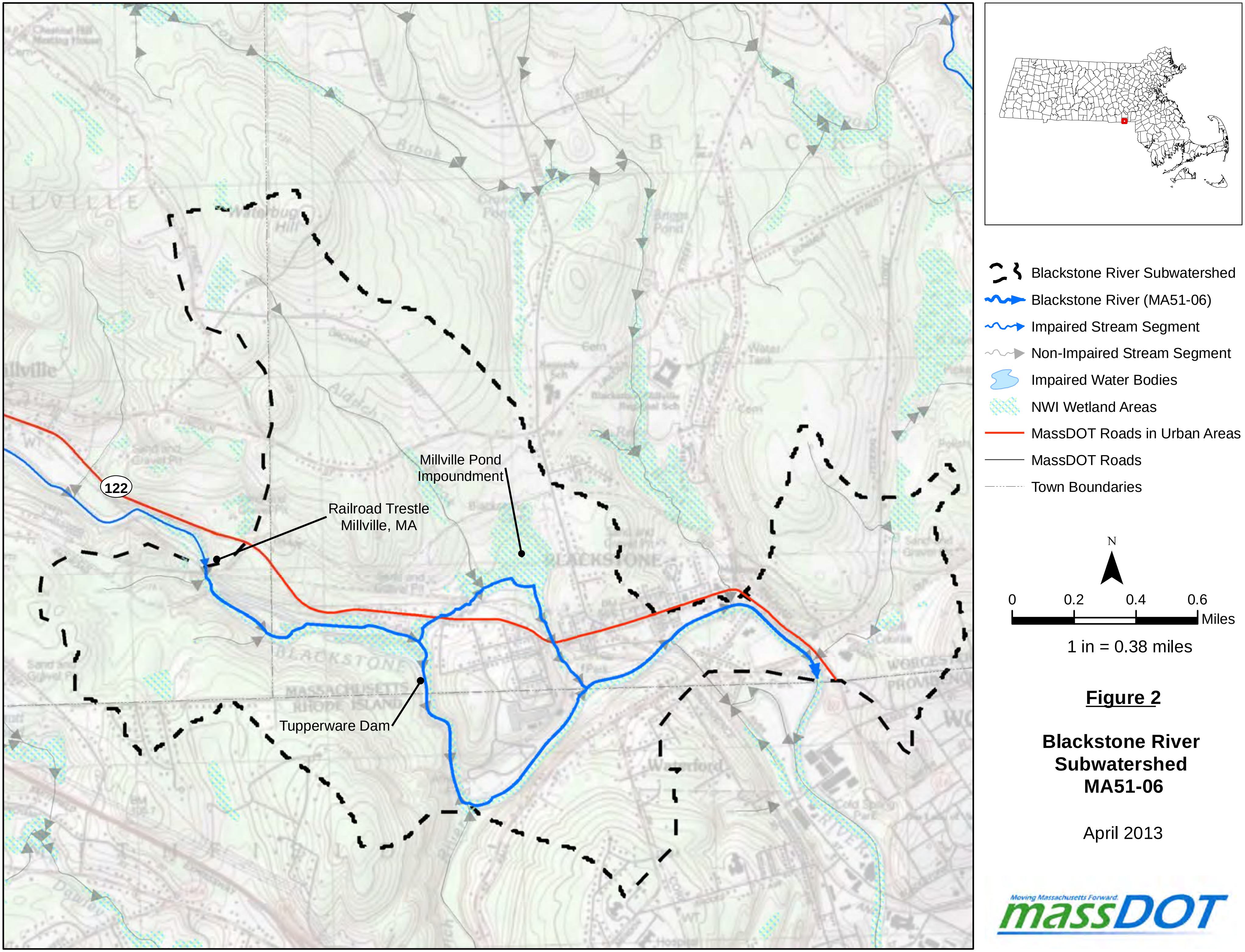

<u>Figure 2</u>

Blackstone River Subwatershed MA51-06

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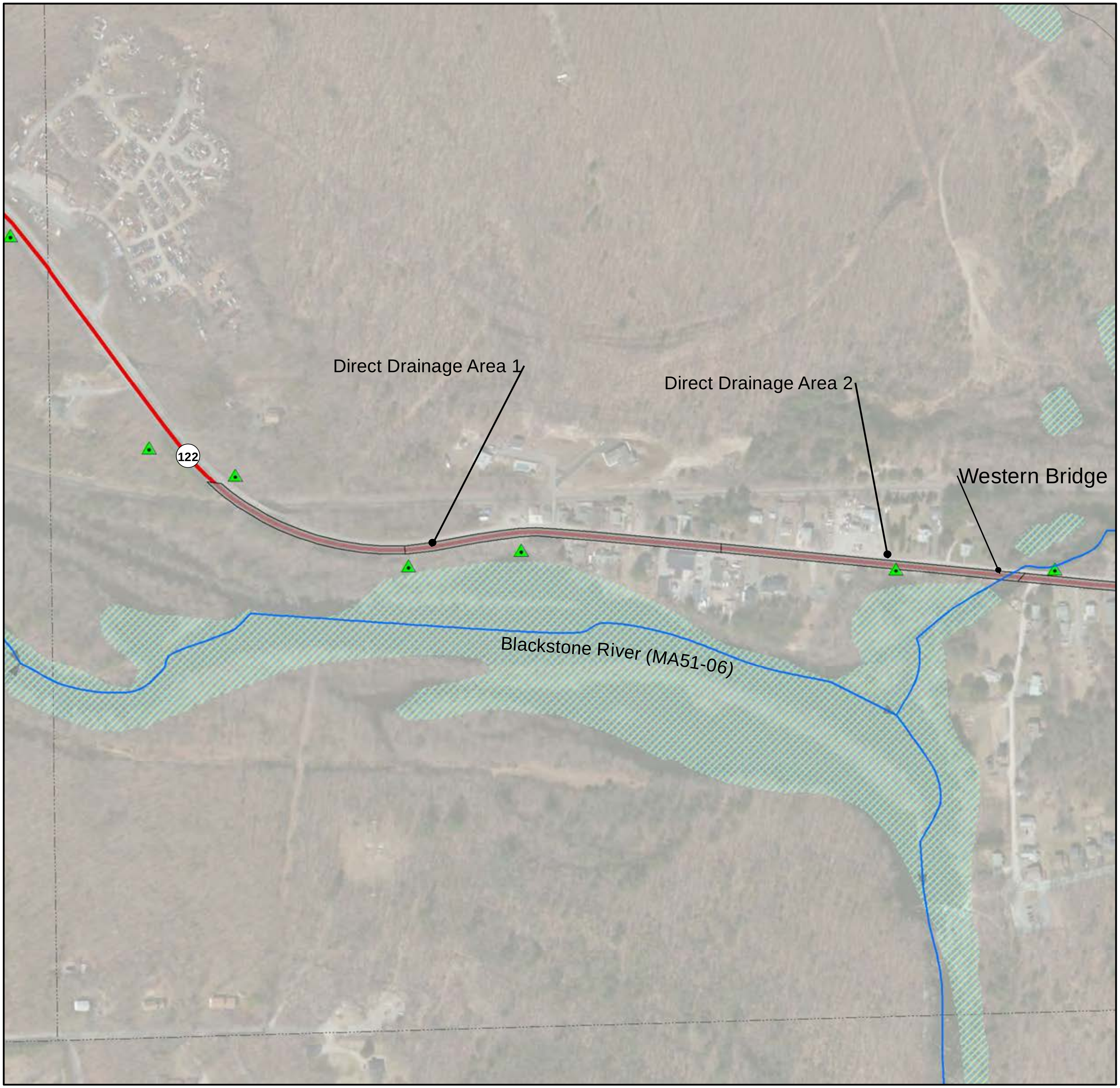

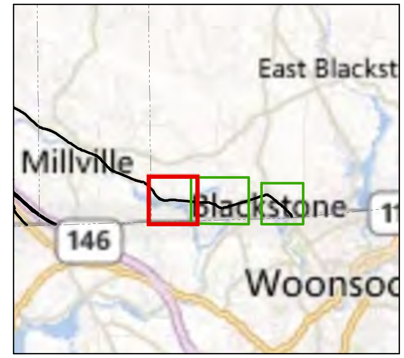

Stormwater Outfalls
Blackstone River Subwatershed
MassDOT Directly Contributing Watershed
Impaired Stream Segment
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
Town Boundaries

N

0 200 400 600 800 Feet

1 inch = 400 feet

Figure 3 a

Blackstone River
MA51-06
Directly Contributing
MassDOT Watershed

1 of 3

April 2013

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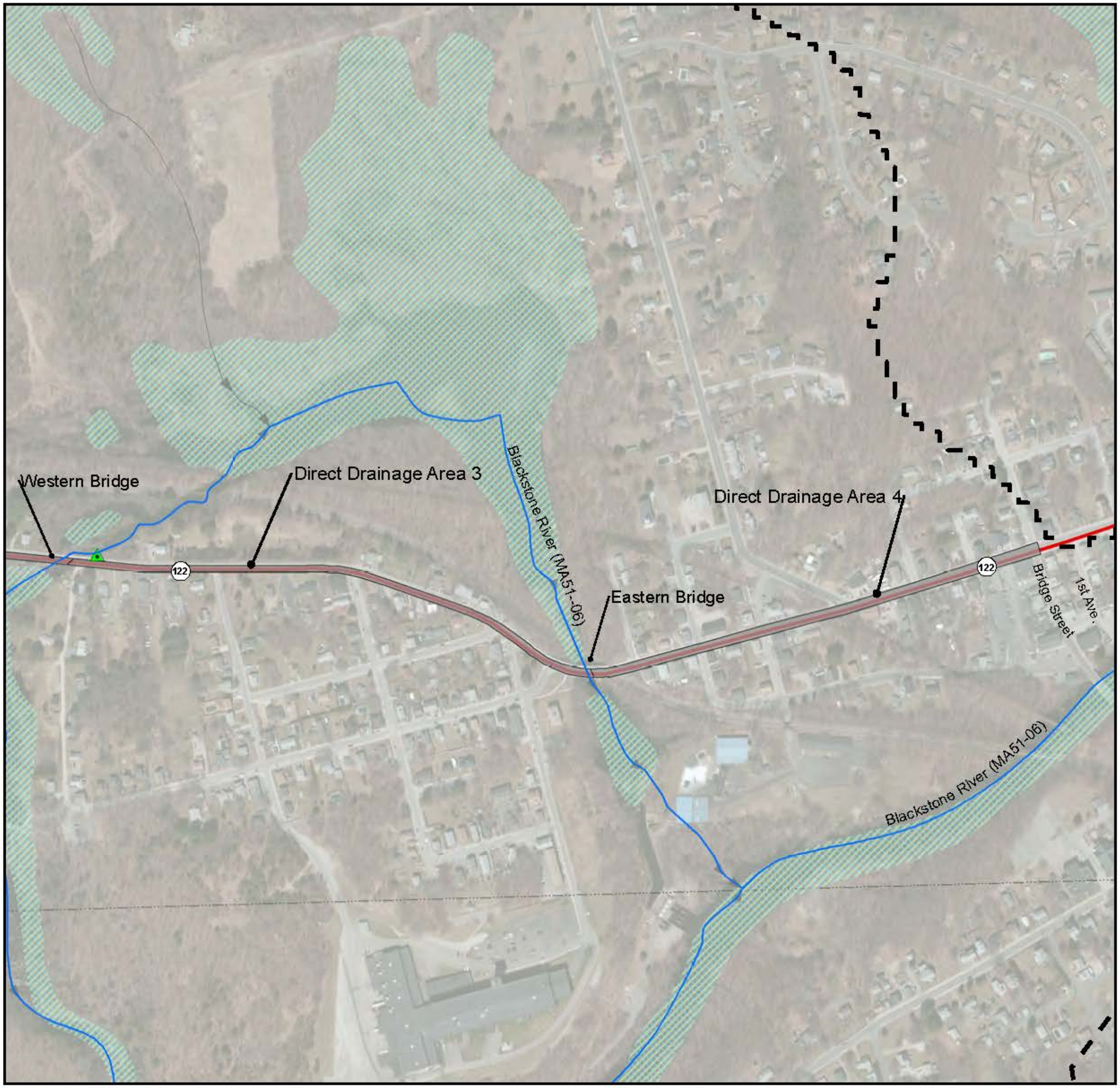

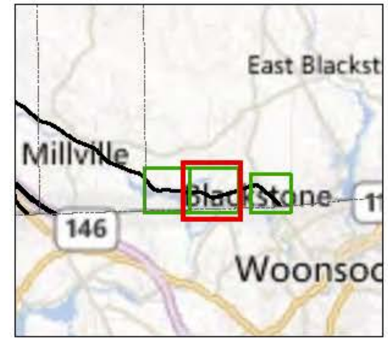

Stormwater Outfalls
Blackstone River Subwatershed
MassDOT Directly Contributing Watershed
Impaired Stream Segment
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
Town Boundaries

N

0 250 500 750 1,000 Feet

1 inch = 500 feet

Figure 3 b

Blackstone River MA51-06 Directly Contributing MassDOT Watershed

2 of 3

April 2013

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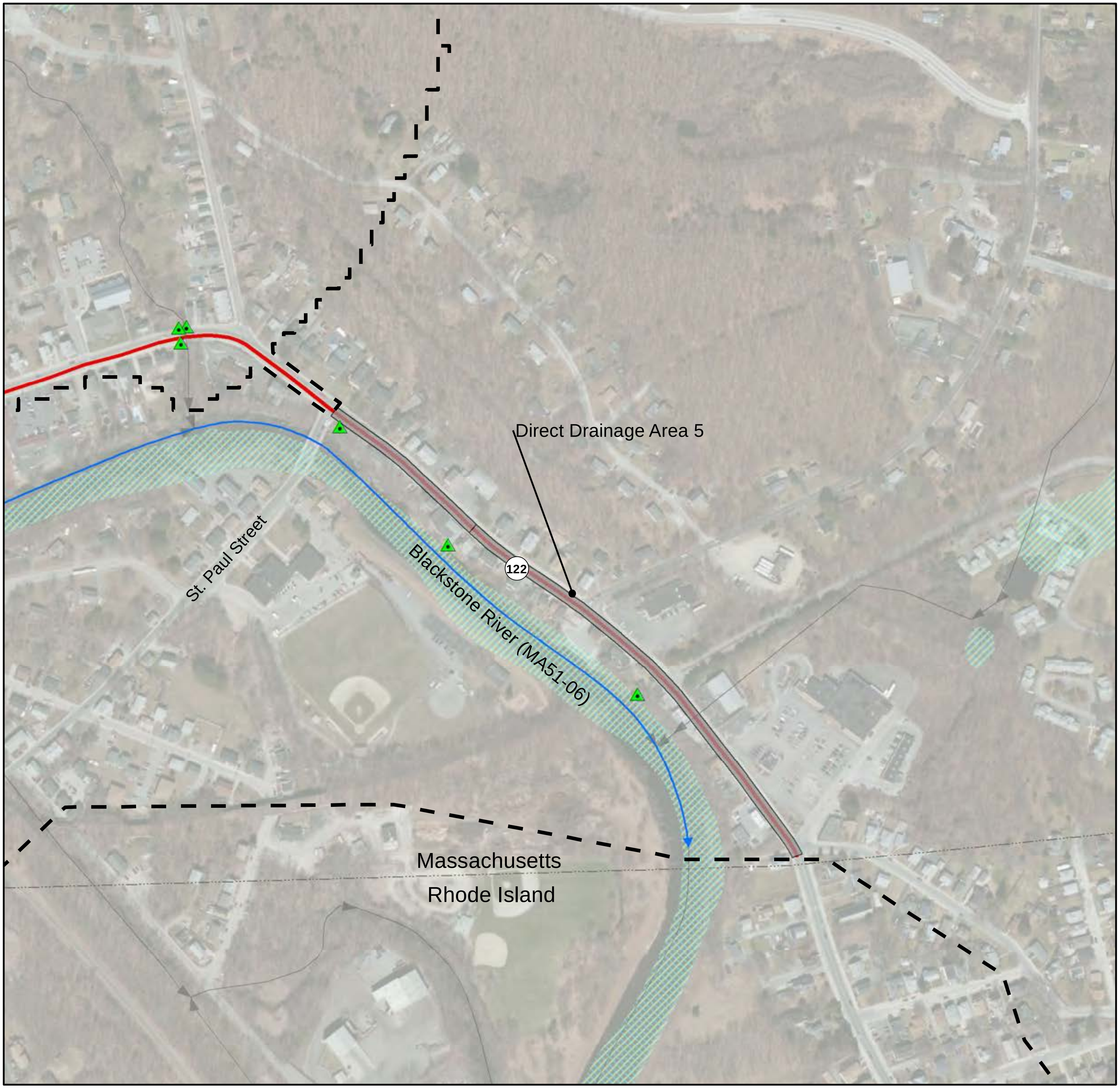

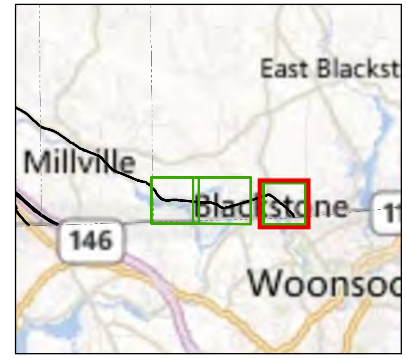

Stormwater Outfalls

Blackstone River Subwatershed

MassDOT Directly Contributing Watershed

Impaired Stream Segment

Non-Impaired Stream Segment

NWI Wetland Areas

MassDOT Roads in Urban Areas

Town Boundaries

N

0 200 400 600 800 Feet

1 inch = 400 feet

Figure 3 c

Blackstone River
MA51-06
Directly Contributing
MassDOT Watershed

3 of 3

April 2013

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Impaired Waters Assessment for Mill River (MA51-10) Including Former Segments: Fiske Millpond (MA51049) and Spindleville Pond (MA51158)

Impaired Water Body

Name: Mill River

Location: Upton, Milford, Hopedale, Mendon, and Blackstone, MA

Water Body ID: MA51-10 (including former segments MA51049 and MA51158)

Impairments

Mill River (MA51-10) is listed under Category 5, "Waters Requiring a TMDL", on the final *Massachusetts Year 2010 Integrated List of Waters* (MassDEP, 2011). The river is impaired for the following:

- aquatic plants (macrophytes)
- PCB in fish tissue
- (non-native aquatic plants*)
- other.

According to MassDEP's *Blackstone River Watershed 2003-2007 Water Quality Assessment Report* (MassDEP, 2010), the segment of Mill River (MA51-10) flows through the following water bodies (listed in order, upstream to downstream):

- Fiske Millpond (MA51049)
- Mill Pond (MA51102)
- Hopedale Pond (MA51065)
- Spindleville Pond (MA51158)
- Harris Pond (MA51058)

Due to relatively short estimated retention times, these water bodies will no longer be reported as lake segments and will instead be considered run-of-the-river impoundments (MassDEP, 2010). MassDOT only needs to assess Mill Pond (MA51102) and Spindleville Pond (MA51158) under the Impaired Waters Program, so only these water bodies have been included in this assessment.

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *314 CMR 4.05 (5) (b) Bottom Pollutants or Alterations*. All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.

- *314 CMR 4.05 (5) (c) Nutrients*. Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established by the Department pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.
- *314 CMR 4.05 (5)(e) Toxic Pollutants*. All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife. For pollutants not otherwise listed in 314 CMR 4.00, the National Recommended Water Quality Criteria: 2002, Environmental Protection Agency (EPA) 822R-02-047, November 2002 published by EPA pursuant to Section 304(a) of the Federal Water Pollution Control Act, are the allowable receiving water concentrations for the affected waters, unless the Department either establishes a site specific criterion or determines that naturally occurring background concentrations are higher. Where the Department determines that naturally occurring background concentrations are higher, those concentrations shall be the allowable receiving water concentrations. The Department shall use the water quality criteria for the protection of aquatic life expressed in terms of the dissolved fraction of metals when EPA's 304(a) recommended criteria provide for use of the dissolved fraction. The EPA recommended criteria based on total recoverable metals shall be converted to dissolved metals using EPA's published conversion factors. Permit limits will be written in terms of total recoverable metals. Translation from dissolved metals criteria to total recoverable metals permit limits will be based on EPA's conversion factors or other methods approved by the Department. The Department may establish site specific criteria for toxic pollutants based on site specific considerations.
- *314 CMR 4.05 (3)(b) 1 Dissolved Oxygen*. Shall not be less than 6.0 mg/l in cold water fisheries and not less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.
- *314 CMR 4.05 (3)(b) 2 Temperature.*
    - a. Shall not exceed 68°F (20°C) based on the mean of the daily maximum temperature over a seven day period in cold water fisheries, unless naturally occurring. Where a reproducing cold water aquatic community exists at a naturally occurring higher temperature, the temperature necessary to protect the community shall not be exceeded and the natural daily and seasonal temperature fluctuations necessary to protect the community shall be maintained. Temperature shall not exceed 83°F (28.3°C) in warm water fisheries. The rise in temperature due to a discharge shall not exceed 3°F (1.7°0C) in rivers and streams designated as cold water fisheries nor 5°F (2.8°C) in rivers and streams designated as warm water fisheries (based on the minimum expected flow for the month); in lakes and ponds the rise shall not exceed 3°F (1.7°0C) in the epilimnion (based on the monthly average of maximum daily temperature);
    - b. natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained. There shall be no changes from natural background conditions that would impair any use assigned to this Class, including

those conditions necessary to protect normal species diversity, successful migration, reproductive functions or growth of aquatic organisms.

- *314 CMR 4.05 (3)(b) 3 pH*. Shall be in the range of 6.5 through 8.3 standard units but not more than 0.5 units outside of the natural background range. There shall be no change from natural background conditions that would impair any use assigned to this Class.

Site Description

Mill River is a water body that originates in Milford, Massachusetts at the North Pond dam and flows for approximately 1.8 miles until it reaches Fiske Millpond (MA51049) which is considered run-of-the-river. Mill River crosses into the town of Hopedale and into Mill Pond (MA51102), flows under Route 140, and then flows into Hopedale Pond (MA51065), both run-of-the-river water bodies. The path of Mill River flows through Spindleville Pond (MA51158) in Hopedale. Mill River also flows through the Hopedale Country Club which is listed as a water withdrawal point in the MassDEP's *Blackstone River Watershed 2003-2007 Water Quality Assessment Report* (MassDEP, 2010). Mill River flows through Mendon and into Blackstone. Near the Massachusetts / Rhode Island state border, Mill River enters the run-of–the-river Harris Pond (MA51058), and at the southern end of Harris Pond, flows across the state border into Rhode Island. There is only one location where MassDOT roadway crosses the river and this is Route 140 (Milford Road) just south of Fiske Millpond. **Figure 1** shows the path of Mill River. The total and subwatershed are the same for this segment of Mill River and are also shown in Figure 1.

The watershed of MassDOT's property directly contributing stormwater runoff to Mill River is comprised of one segment of Route 140 (Milford Road). See **Figure 2**. The segment crosses Mill River just south of Fiske Millpond (MA51049) on the border between the towns of Hopedale and Milford. Stormwater runoff flows towards Mill River along the edge of the roadway for approximately 960 feet. Stormwater from MassDOT's property in the eastbound lane of Route 140 enters Mill River through an asphalt channel on the southern side of the bridge over Mill River, while stormwater from the westbound lane of Route 140 enters Mill River from an asphalt channel on the northern side of the bridge. This runoff from the eastbound and westbound lanes of Route 140 is considered direct discharge to Mill River because there is minimal opportunity for stormwater runoff to infiltrate before flowing into Mill River.

Assessment under BMP 7U

None of the impairments for Mill River (MA51-10) have been addressed by a TMDL. Therefore, MassDOT assessed the impairments using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of stormwater on many impairments. For this water body, MassDOT used the IC method to assess the following impairments:

- aquatic plants (macrophytes)
- other

MassDOT concluded that the impairment for PCB in fish tissue is unrelated to storm water runoff. The Nationwide Urban Runoff Program (NURP) conducted by the EPA found that PCB was detected in less than 1% of stormwater samples collected (EPA, 1983). Therefore, MassDOT concluded that stormwater runoff from its roadways does not contribute to the impairments of PCB in fish tissue.

Additionally, according to the final *Massachusetts Year 2010 Integrated List of Waters*, non-native aquatic plants are considered a non-pollutant and unrelated to stormwater. Therefore, MassDOT has determined that further assessment of this impairment for the water bodies is not required under BMP 7U.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of EPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction necessary to attain the percent imperviousness in the watershed at which stormwater is not likely the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. IC data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer. In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for Mill River (MA51-10):

Table 1. Site Parameters for Mill River (MA51-10)

Total and Subwatershed		
Watershed Area	21,300	acres
Impervious Cover (IC) Area	2,150	acres
Percent Impervious	10.1	%
IC Area at 9% Goal	1,920	acres
Target Reduction % in IC	10.9*	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	0.7	acres
MassDOT's Target Reduction in Effective IC (10.9% of DOT Directly Contributing IC)	0.07*	acres

*****Rounding accounts for differences in calculations.

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 10.9%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 0.07 acres.

Existing BMPs

There are no existing BMPs in the Mill River directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to Mill River.

Mitigation Plan

Because there is no mitigation of impervious surface achieved by MassDOT BMPs to meet the reduction requirement of 0.07 acres, MassDOT considered the implementation of BMPs.

Based on the review of MassDOT's directly contributing drainage area, no BMPs have been identified that can be implemented on MassDOT property to address the impairments of Mill River given the site constraints described below.

Site limitations in the Mill River subwatershed include limited right-of-way owned by MassDOT. In addition, is the only stormwater infrastructure at this location are two, short and steep paved channels that discharge stormwater runoff directly to Mill River. A consequence of this stormwater system is that there is no space to install any type of stormwater infiltration BMPs prior to discharge to Mill River. The photographs below document the existing concrete channels and illustrate the lack of area to implement any infiltration stormwater BMPs. However, stormwater improvements could be made to the existing paved channels by replacing them with rip rap or other measures of protection against erosive velocities.

Curb cut and paved channel off of eastbound Rt 140.

Flow path from curb cut to Mill River.

Curb cut and paved channel off of westbound Rt 140.

Flow path from curb cut to Mill River.

Conclusions

MassDOT used the IC Method to assess Mill River (MA51-10) for the impairments identified in MassDEP's final *Massachusetts Year 2010 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed by 0.07 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Mill River to identify existing BMPs and found that no BMPs exist to reduce effective IC. This information is summarized in Table 2 below.

Table 2. Effective IC Reductions under Existing & Proposed Conditions

IC in Directly Contributing Watershed	0.7	acres
Target Reduction in Effective IC	0.07	acres
IC Effectively Reduced by Existing BMPs	0	acres
IC Remaining to Mitigate with Proposed BMPs	**0.07**	**acres**

MassDOT should reduce its effective IC within the directly contributing watershed by an additional 0.07 acres to achieve the targeted reduction in IC. However, site limitations in the Mill River subwatershed include limited right-of-way owned by MassDOT and the lack of stormwater infrastructure which do not allow for the construction of stormwater infiltration BMPs that would provide effective treatment of the impervious area for this location. However, MassDOT should consider stormwater improvements to the existing paved channels by replacing them with rip rap or other measures of protection against erosive velocities.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of additional BMPs, and finalized assessments including reductions achieved by finalized BMP designs. MassDOT will also continue to implement non-structural BMPs that reduce the impacts of stormwater.

References

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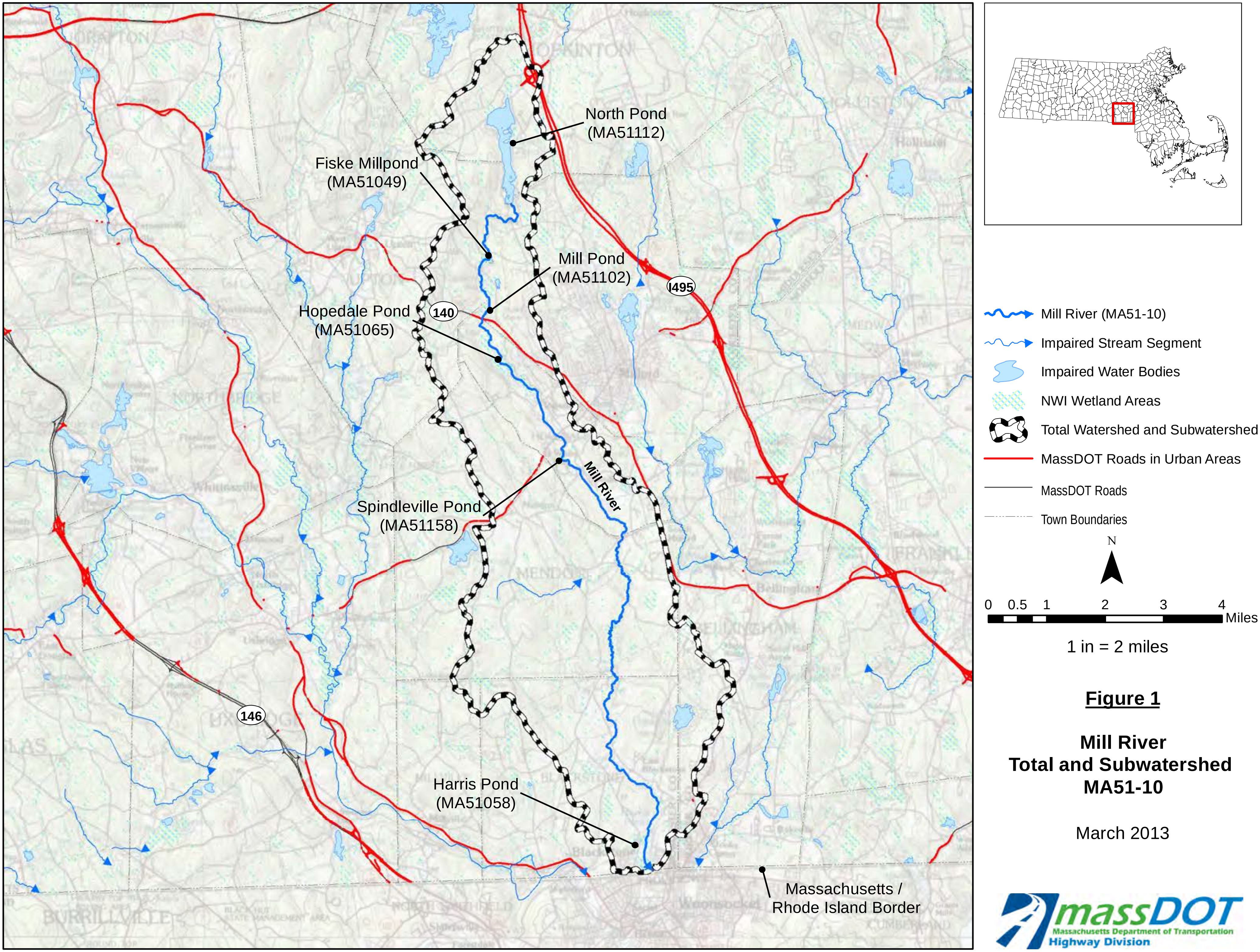

Figure 1

Mill River
Total and Subwatershed
MA51-10

March 2013

massDOT
Massachusetts Department of Transportation
Highway Division

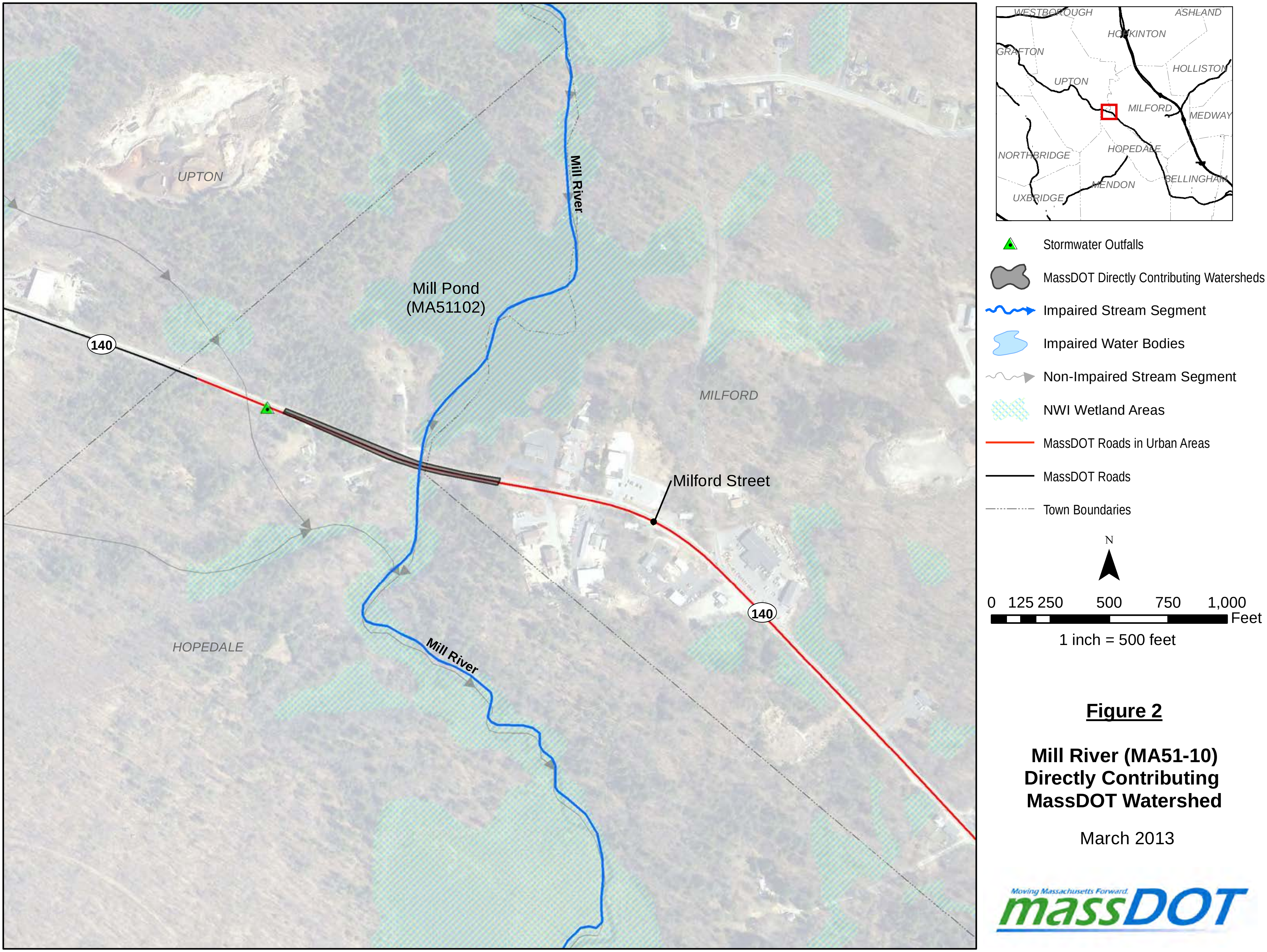

Figure 2

Mill River (MA51-10) Directly Contributing MassDOT Watershed

March 2013

Moving Massachusetts Forward. massDOT

Impaired Waters Assessment for Lake Ripple (MA51135) – Progress Report

Impaired Waterbody

Name: Lake Ripple

Location: Grafton, MA

Water Body ID: MA51135

Impairments

Lake Ripple (MA51135) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2010 Integrated List of Waters*. Lake Ripple is impaired for the following:

- aquatic plants (macrophytes)
- (non-native aquatic plants*)

According to MassDEP's *Blackstone River Watershed 2003-2007 Water Quality Assessment Report* (MassDEP, 2010), Lake Ripple is impaired due to an infestation with the non-native aquatic plant species *Cabomba caroliniana*. A second potentially non-native aquatic plant species (*Myriophyllum* sp., possibly *M. heterophyllum*) was found present in the lake by Department of Watershed Management (DWM) biologists.

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *314 CMR 4.05 (5) (a) Aesthetics*. All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.
- *314 CMR 4.05 (5) (c) Nutrients*. Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established by the Department pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.

Site Description

Lake Ripple is a water body of approximately 47 acres located in the Blackstone River Watershed in Grafton, MA. The lake bisects the Quinsigamond River (MA51-09), which flows north-south through the water body and is impounded by the Lake Ripple Dam at its south boundary. In addition to the Quinsigamond River, Lake Ripple receives inflow from Axtell Brook and three additional unnamed tributaries. Grafton Senior High School and Athletic Fields are adjacent to the lake to the south. Adjacent land use includes a mix of forest and low density residential to the west and residential and commercial properties to the east and north of the lake.

Lake Ripple has a total contributing watershed of approximately 22,419 acres and a subwatershed of approximately 2,520 acres. The total watershed is shown in Figure 1 and the subwatershed is shown in Figure 2. MassDOT's property directly contributing stormwater runoff to Lake Ripple is comprised of approximately 0.7 miles of Route 122 (Worcester St/Providence Road), a two-lane roadway that runs north-south to the east of the lake. Route 122 is curbed and stormwater is collected in catch basins and piped via small to medium drainage systems which discharge to outfalls directly to Lake Ripple. Stormwater along the eastern portion of Route 122 just east of Lake Ripple drains to the shoulder via country drainage. MassDOT's directly contributing watershed is shown in Figure 3.

Assessment under BMP 7U

None of the impairments for Lake Ripple have been addressed by a TMDL. Therefore, MassDOT assessed the impairments using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of storm water on many impairments. For this water body, MassDOT used the IC method to assess the following impairments:

- aquatic plants (macrophytes)

According to MassDEP's final *Massachusetts Year 2010 Integrated List of Waters*, the impairment of non-native aquatic plants is not caused by pollutants (MassDEP, 2011). Therefore, this impairment was not considered further.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction necessary to attain the percent imperviousness in the watershed at which stormwater is not likely the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. IC data were available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer.

In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for Lake Ripple (MA51135):

Table 1. Site Parameters for Lake Ripple (MA51135)

Total Watershed		
Watershed Area	22,420	acres
Impervious Cover (IC) Area	4,430	acres
Percent Impervious	19.8	%
IC Area at 9% Goal	2,020	acres
Target Reduction % in IC	54	%
Subwatershed		
Subwatershed Area	2,520	acres
Impervious Cover (IC) Area	314	acres
Percent Impervious	12.5	%
IC Area at 9% Goal	227	acres
Target Reduction % in IC	28	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	3.3	acres
MassDOT's Target Reduction in Effective IC (28% of DOT Directly Contributing IC)	0.9	acres

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 28%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 0.9 acres.

Existing BMPs

There are no existing BMPs in the Lake Ripple directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to the water body.

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 0.9 acres, MassDOT will consider the implementation of additional BMPs.

Conclusions

MassDOT used the IC Method to assess Lake Ripple for the impairments identified in MassDEP's final *Massachusetts Year 2010 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed by 0.9 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Lake Ripple to identify existing BMPs and found that no BMPs exist to reduce effective IC. This information is summarized in Table 2 below

Table 2. Effective IC Reductions under Existing & Proposed Conditions

IC in Directly Contributing Watershed	3.3	acres
Target Reduction in Effective IC	0.9	acres
IC Effectively Reduced by Existing BMPs	0	acres
IC Remaining to Mitigate with Proposed BMPs	**0.9**	**acres**

MassDOT should reduce its effective IC within the directly contributing watershed by 0.9 acres to achieve the targeted reduction in IC. MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs to treat directly contributing IC as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide the target IC reduction or treatment to the maximum extent practicable.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of additional BMPs, and finalized assessments including reductions achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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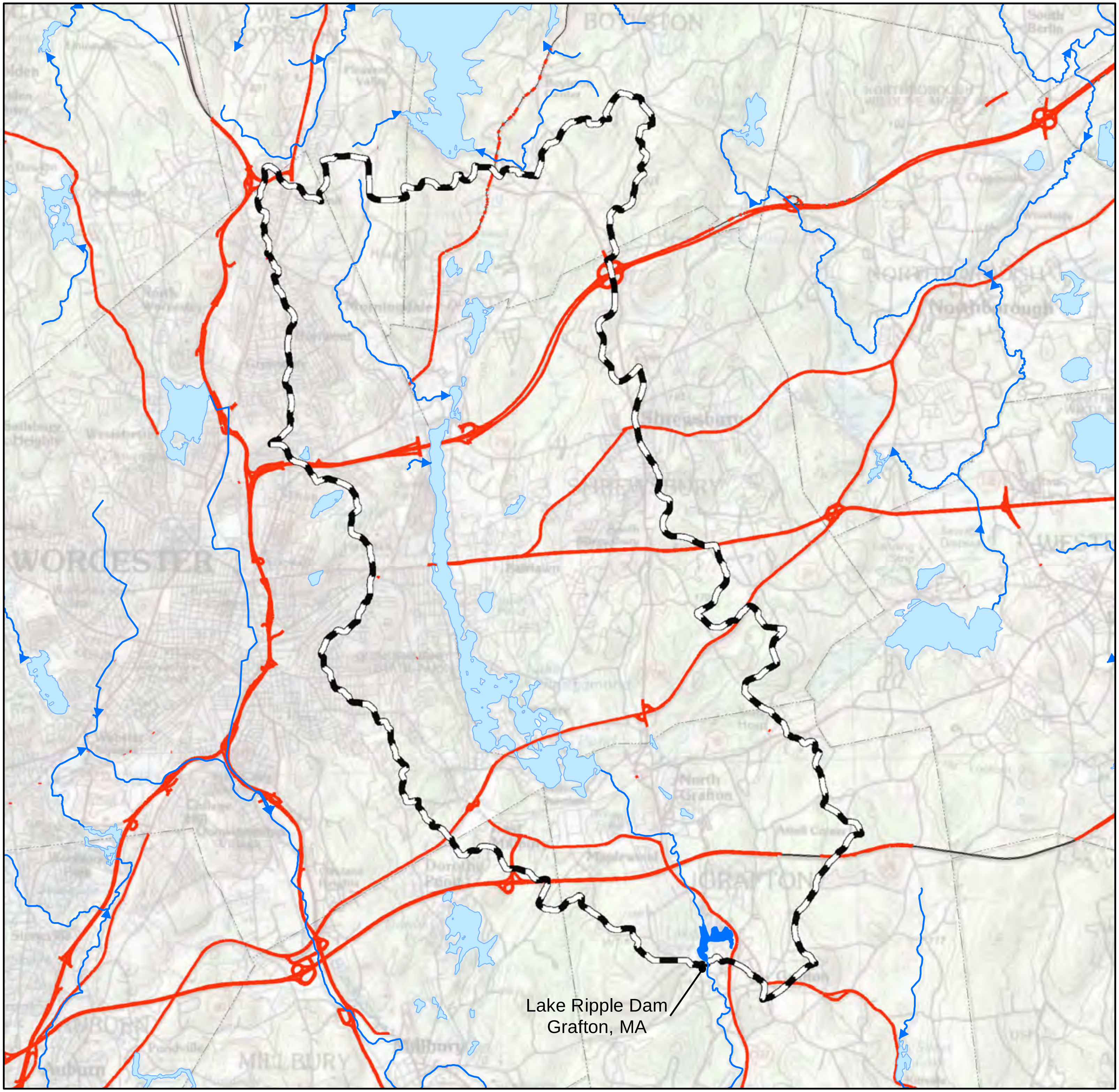

Figure 1

Lake Ripple
Total Watershed
MA51135

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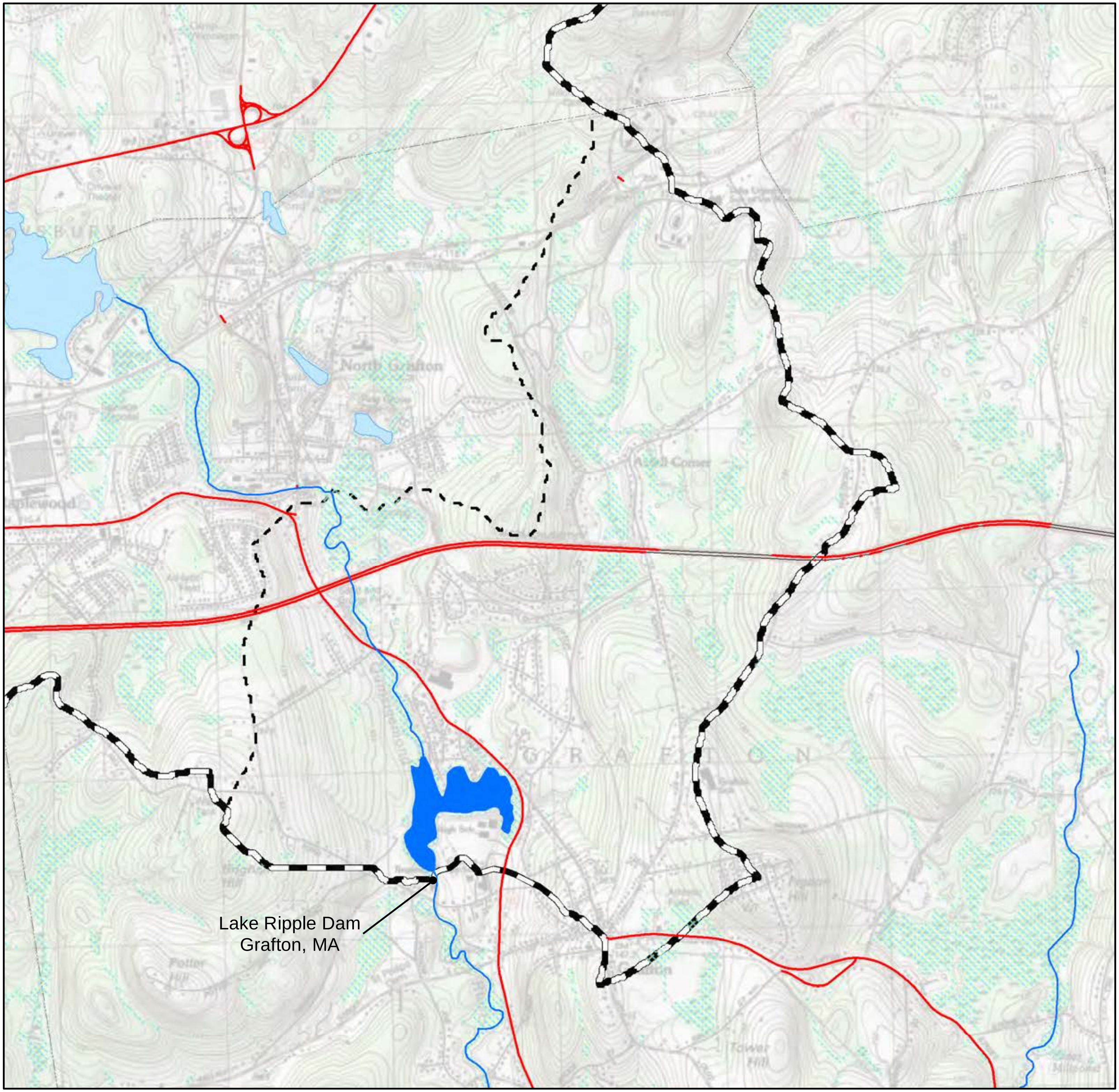
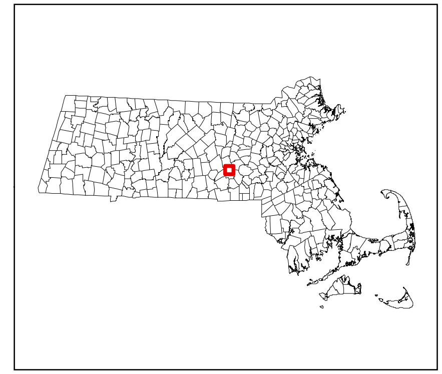
Highway Division





Impaired Stream Segment

Lake Ripple

Impaired Water Bodies

NWI Wetland Areas

MassDOT Roads in Urban Area

MassDOT Roads

Total Contributing Watershed

Lake Ripple Sub Watershed

Town Boundaries

N

0 0.25 0.5 0.75 1 Miles

1 in = 0.5 miles

Figure 2

Lake Ripple Subwatershed MA51135

February 2013

massDOT Massachusetts Department of Transportation Highway Division

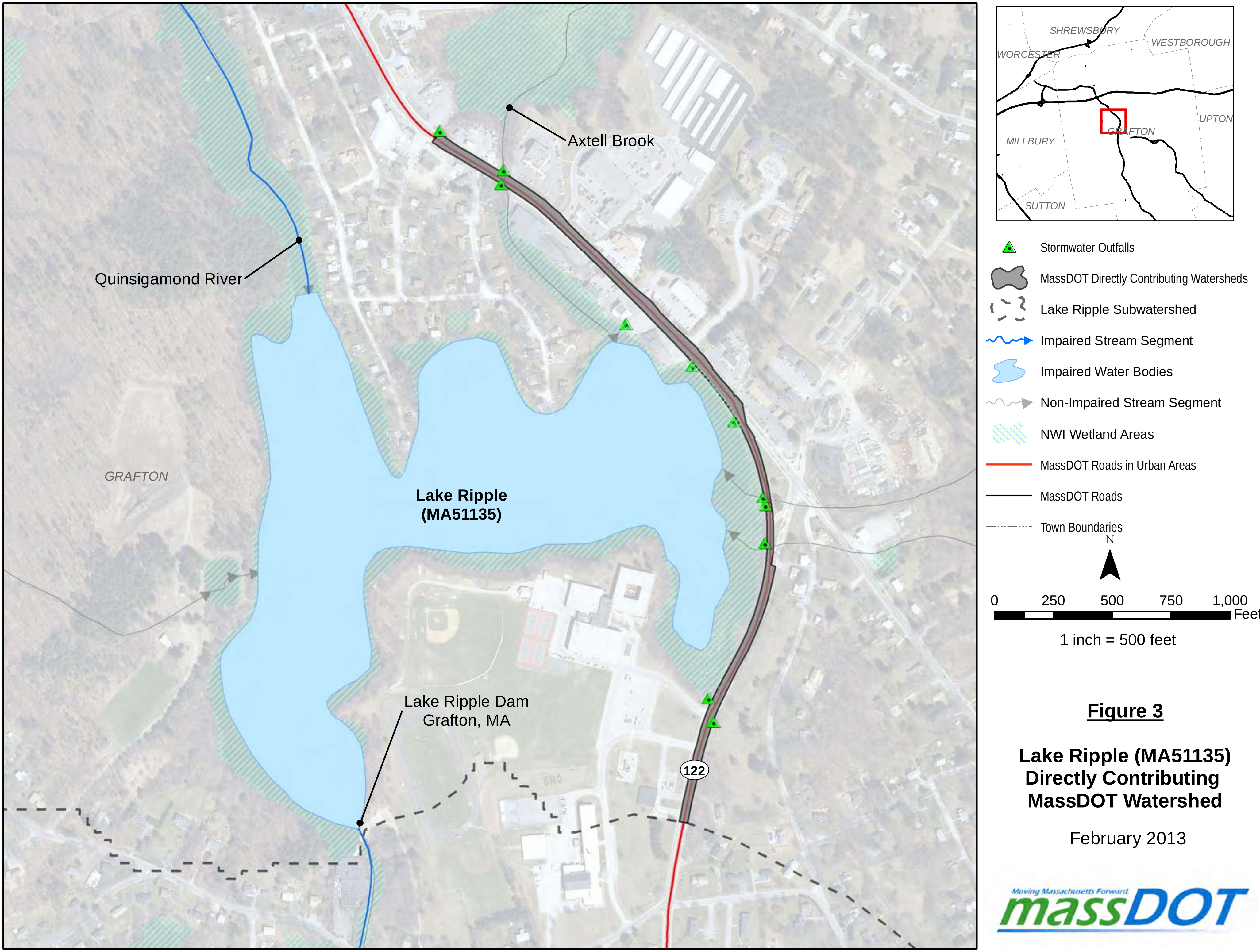


Figure 3

Lake Ripple (MA51135) Directly Contributing MassDOT Watershed

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Impaired Waters Assessment for Mumford River (MA51-14) Including Former Segments: Gilboa Pond (MA51052) and Meadow Pond (MA51193)

Impaired Water Body

Name: Mumford River

Location: Douglas, Uxbridge, Sutton, and Northbridge, MA

Water Body ID: MA51-14 (including former segments MA51052 and MA51193)

Impairments

Segment MA51-14 of the Mumford River (Segment MA51-14) is listed under Category 5, "Waters Requiring a TMDL", on the final *Massachusetts Year 2010 Integrated List of Waters* (MassDEP, 2011). The river segment is impaired for the following:

- aquatic plants (macrophytes)
- copper
- dissolved oxygen
- fecal coliform
- lead
- low pH
- (low flow alterations*)
- (non-native aquatic plants*)

According to MassDEP's *Blackstone River Watershed 2003-2007 Water Quality Assessment Report* (MassDEP, 2010), Segment MA51-14 flows through the following water bodies (listed in order, upstream to downstream):

- Gilboa Pond (MA51052)
- Lackey Pond (MA51083)
- Meadow Pond (MA51193)
- Linwood Pond (MA51088)
- Whittin Pond (MA51178)
- Caprons Pond (MA51014)

Due to relatively short estimated retention times, these water bodies will no longer be reported as lake segments and will instead be considered run-of-the-river impoundments (MassDEP, 2010). MassDOT only needs to assess Gilboa Pond (MA51052) and Meadow Pond (MA51193) under the Impaired Waters Program, so only these two water bodies are included in this assessment.

Segment MA51-14 is also included in the *Draft Pathogen TMDL for the Blackstone River Watershed* (MassDEP, 2005).

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *314 CMR 4.05 (5) (c) Nutrients*. Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established by the Department pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.
- *314 CMR 4.05 (5)(e) Toxic Pollutants*. All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife. For pollutants not otherwise listed in 314 CMR 4.00, the National Recommended Water Quality Criteria: 2002, EPA 822R-02-047, November 2002 published by EPA pursuant to Section 304(a) of the Federal Water Pollution Control Act, are the allowable receiving water concentrations for the affected waters, unless the Department either establishes a site specific criterion or determines that naturally occurring background concentrations are higher. Where the Department determines that naturally occurring background concentrations are higher, those concentrations shall be the allowable receiving water concentrations. The Department shall use the water quality criteria for the protection of aquatic life expressed in terms of the dissolved fraction of metals when EPA's 304(a) recommended criteria provide for use of the dissolved fraction. The EPA recommended criteria based on total recoverable metals shall be converted to dissolved metals using EPA's published conversion factors. Permit limits will be written in terms of total recoverable metals. Translation from dissolved metals criteria to total recoverable metals permit limits will be based on EPA's conversion factors or other methods approved by the Department. The Department may establish site specific criteria for toxic pollutants based on site specific considerations.
- *314 CMR 4.05 (3)(b) 1 Dissolved Oxygen*. Shall not be less than 6.0 mg/l in cold water fisheries and not less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.
- *314 CMR 4.05 (3)(b) 3 pH*. Shall be in the range of 6.5 through 8.3 standard units but not more than 0.5 units outside of the natural background range. There shall be no change from natural background conditions that would impair any use assigned to this Class.
- *314 CMR 4.05 (3)(b) 4 Bacteria*.
    - a. At bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: where E. coli is the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml; alternatively, where enterococci are the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no

single sample taken during the bathing season shall exceed 61 colonies per 100 ml;

- b. For other waters and, during the non bathing season, for waters at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: the geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml; alternatively, the geometric mean of all enterococci samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 61 colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department.

Site Description

The headwaters of the Mumford River arise in Sutton at the outlet of Tuckers Pond (MA51169). For the purposes of the *Massachusetts Year 2010 Integrated List of Waters*, the Mumford River is broken up into two segments: the upper segment, MA51-13, and the lower segment, MA51-14. This assessment addresses the lower segment of the Mumford River, Segment MA51-14.

Segment MA51-14 begins at the Town of Douglas waste water treatment plant (WWTP), where it flows east through Gilboa Pond (MA51052) and into Uxbridge, passing under the Providence Turnpike (Route 146). The river then flows through Lackey Pond (MA51083) and Meadow Pond (MA51193) before entering Northbridge. In Northbridge, the river flows through Linwood Pond (MA51088) before heading south back into Uxbridge. In Uxbridge, the river flows through Whittin Pond (MA51178) and Capron Pond (MA51014), eventually discharging to the Blackstone River. See **Figure 1** and **Figure 2** for the total watershed and subwatershed, respectively, to Segment MA51-14.

Direct stormwater runoff from MassDOT's roadways enters Segment MA51-14 at three main locations: the Route 146/Lackey Dam Road interchange in Uxbridge, the Route 122 (North Main Street) bridge crossing in Uxbridge, and the Route 16 (Mendon Street) bridge crossing in Uxbridge. See **Figure 3**, **Figure 4**, and **Figure 5**, respectively, for each roadway segment.

Figure 3 shows where Route 146 passes over Segment MA51-14. After this intersection, Segment MA51-14 turns north and runs parallel to Route 146 up to Lackey Dam Road. The MassDOT directly contributing watershed is limited on the southern end by a number of indirect discharges to nearby woodlands and wetlands. Two outfalls that are substantially closer to the Mumford River (approximately 400 feet) do not have ample time to infiltrate and constitute direct discharges. On the northern end, the MassDOT directly contributing watershed is limited by road grading. Both Route 146 and a portion of the Lackey Dam Road interchange are part of the MassDOT directly contributing watershed. The directly contributing watershed is composed of a number of outfalls that discharge to different portions of Segment MA51-14. While there are no existing BMPs in this area, there is ample opportunity for the installation of BMPs prior to discharge to Segment MA51-14 for much of the MassDOT directly contributing watershed.

Figure 4 shows the section of Route 122 which constitutes the MassDOT directly contributing watershed. Stormwater from this section discharges directly to Segment MA51-14. **Figure 5** shows a section of bridge that is owned by MassDOT. There are no apparent direct discharges to Segment MA51-14 from the bridge, but based on the results of the site visit, stormwater from the bridge is collected by the adjacent municipal stormwater system. The outfall from the municipal stormwater system could not be confirmed but based on topography, the system most likely discharges directly to Segment MA51-14, so this area is considered part of MassDOT's directly contributing watershed.

Assessment under BMP 7U

None of the impairments for Mumford River (MA51-14) have been addressed by a TMDL. Therefore, MassDOT assessed the impairments potentially linked to highway runoff using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of stormwater on many impairments. For this water body, MassDOT used the IC method to assess the following impairments:

- dissolved oxygen
- lead
- copper
- aquatic plants (macrophytes)
- low pH

According to the final *Massachusetts Year 2010 Integrated List of Waters*, the impairments for (non-native aquatic plants*) and (low flow alterations*) are not caused by a pollutant. Therefore these impairments are not influenced by stormwater runoff, and are consequently not considered further in this assessment.

The impairment for fecal coliform is assessed separately in the section titled "Assessment of Pathogen Impairment."

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction necessary to attain the percent imperviousness in the watershed at which stormwater is not likely the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. IC data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer. In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for Segment MA51-14 of the Mumford River:

Table 1. Site Parameters for Mumford River (MA51-14)

Total Watershed		
Watershed Area	36,000	acres
Impervious Cover (IC) Area	2,710	acres
Percent Impervious	7.5	%
Subwatershed		
Subwatershed Area	7,330	acres
Impervious Cover (IC) Area	1,100	acres
Percent Impervious	15.0	%
IC Area at 9% Goal	700	acres
Target Reduction % in IC	40.0*	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area Directly Contributing to Impaired Segment	19.5	acres
MassDOT's Target Reduction in Effective IC (40.0% of DOT Directly Contributing IC)	7.8	acres

*Rounding accounts for differences in calculations.

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 40.0%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 7.8 acres.

Existing BMPs

There are no existing BMPs within MassDOT's directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to Mumford River.

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 7.8 acres, MassDOT will consider the implementation of additional BMPs.

Assessment of Pathogen Impairment

MassDOT assessed the pathogen impairment using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by an order of magnitude within a given storm event at a single location (MassDEP, 2009b). Therefore, it is difficult to predict pathogen concentrations in stormwater with accuracy. Due to this difficulty, MassDOT generally will not conduct site specific assessments of loading at each location impaired for pathogens. Instead these sites will be assessed collectively based on available information on pathogen loading from highways, MassDOT actions, and information available from EPA and DEP. Based on this information MassDOT developed an approach to be consistent with relevant TMDL and permit condition requirements and an iterative adaptive management approach to stormwater management.

In addition, while there is a positive relationship between IC and pathogen loading, the relationship is not as direct as other impairments. According to the Center for Watershed Protection "…Other studies show that concentrations of bacteria are typically higher in urban areas than rural areas (USGS, 1999), but they are not always directly related to IC (CWP, 2003)." Therefore, DOT did not rely solely on the IC method to assess pathogen impairments. Instead, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

Pathogens in MassDOT Discharge

A study conducted on MassDOT's South East Expressway measured bacterial concentrations in stormwater runoff (Smith, 2002). This study found a geometric mean of 186 fecal coliforms/100 ml. Concentrations of pathogens in stormwater runoff from roadways can vary widely and pathogen concentrations in runoff across the state likely deviate significantly from this stretch of roadway's specific estimate. Event mean concentrations of fecal coliform bacteria in urban stormwater from other sources ranging between 14,000 and 17,000 fecal coliform organisms/100 mL have been reported (MassDEP, 2009b). These data suggest that pathogen loading from highways may be lower than other urban areas.

Consideration of the potential sources of pathogens supports the idea that pathogens are present in lower concentrations in highway runoff since potential pathogen sources are likely to be less prevalent in the highway environment than along other urban roadways:

- Illicit discharges: Due to the typical setback of highways from residential and commercial developments and the stand alone nature of the drainage system, the potential for illicit discharges (e.g. sewer connections, laundry tie-ins) is much lower than in other stormwater systems. This has been confirmed by MassDOT's illicit discharge detection on many miles

of urban roadways within a broad range of areas across Massachusetts. After assessment of almost 140 miles, and investigation of more than 2,500 stormwater features, MassDOT's consultant performing the broad scope reviews has found no confirmed illicit discharges.
- Limited Sewer Utilities in Road Right of Ways: Since DOT does not provide sewer services, many MassDOT roads do not have sewer utilities within the road's right of way; thereby eliminating the chance of cross-connections or leaking pipes as a source of pathogens into the stormwater system.
- Pet waste: Pets are only present on highways in rare instances. In urban residential areas pets and their associated waste are much more common. MassDOT is aware that pet waste at road side rest stops may represent a potential source of pathogens to stormwater in certain situations.
- Wildlife: Highways are not generally an attractive place for wildlife. Wildlife generally avoids highways and only occasionally crosses them.

The dearth of pathogen sources on highways and the relatively low concentrations of pathogens measured in the South East Expressway study together suggest that pathogen loading from stormwater runoff from highways is lower than other urban sources.

Furthermore, in almost all cases the contribution of pathogens from MassDOT to a specific water body is likely to be very small relative to other sources of pathogens in the watershed. Since MassDOT urban roadways are linear and usually cross watersheds, they represent a small fraction of the receiving water body's watershed. The water quality within these water bodies is dependent on discharge from various sources, including discharges from other stormwater systems and a large number of other factors.

Assessment

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

TMDLs for pathogen impairments in Massachusetts recognize that pathogens are highly variable and difficult to address and emphasize the need for an iterative adaptive management approach to address pathogens. Examples of relevant language from these TMDLs are included below:

- "given the vast potential number of bacteria sources and the difficulty of identifying and removing them from some sources such as stormwater require an iterative process and will take some time to accomplish. While the stated goal in the TMDL is to meet the water quality standard at the point of discharge it also attempts to be clear that MassDEP's expectation is that for stormwater an iterative approach is needed…" (MassDEP, 2009a)
- "The NPDES permit does not, however, establish numeric effluent limitations for stormwater discharges. Maximum extent practicable (MEP) is the statutory standard that establishes the level of pollutant reductions that regulated municipalities must achieve. The MEP standard is a narrative effluent limitation that is satisfied through implementation of SWMPs and achievement of measurable goals."(MassDEP, 2009b)
- "Although the TMDL presents quantified WLAs for stormwater that are set equivalent to the criteria in the Massachusetts Water Quality Standards, the Phase II NPDES permits will not include numeric effluent limitations. Phase II permits are intended to be BMP based permits that will require communities to develop and implement comprehensive stormwater management programs involving the use of BMPs. Massachusetts and EPA believe that BMP based Phase II permits involving comprehensive stormwater management together with specific emphasis on pollutants contributing to existing water quality problems can be consistent with the intent of the quantitative WLAs for stormwater discharges in TMDLs." (MassDEP, no date).

This language clearly indicates that an iterative adaptive management approach is the appropriate way to address discharges to pathogen impaired waters. The recommendations in pathogen TMDLs for waters in Massachusetts generally require development and implementation of stormwater management programs, illicit discharge detection and elimination efforts, and in some cases installing BMPs to the maximum extent practicable

The draft North Coastal Watershed General MS4 permit and the draft Interstate, Merrimack, and South Coastal (IMS) watershed permits contain specific requirements for compliance with pathogen TMDLs (in Appendix G). While these permits are still in draft form, MassDOT believes they represent the best available guidance on what EPA believes is appropriate for addressing stormwater discharges to pathogen-impaired waters. Section 2.2.1(c) of the permit states “For any discharge from its MS4 to impaired waters with an approved TMDL, the permittee shall comply with the specific terms of Part 2.1 of this permit. In addition, where an approved TMDL establishes a WLA that applies to its MS4 discharges, the permittee shall implement the specific BMPs and other permit requirements identified in Appendix G to achieve consistency with the WLA.” Appendix G references a number of programmatic BMPs that are necessary to address pathogen loading. These cover the following general topics:

- Residential educational program
- Illicit connection identification, tracking and removal
- Pet waste management

Mitigation Plan

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Stormwater Management Plan (SWMP) including educational programs, illicit connection review and source control. The specific BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In
- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

In addition, the structural BMPs that will be considered to reduce the IC will also have the effect of reducing pathogen loads.

MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit’s requirements and TMDL recommendations. MassDOT’s existing stormwater management plan outlines BMPs that include education and illicit discharge detection and elimination. MassDOT will be implementing a pet waste management program at its rest stops that have discharges to pathogen impaired waters.

Conclusions

MassDOT used the IC Method to assess Segment MA51-14 of the Mumford River for the impairments identified in MassDEP's final *Massachusetts Year 2010 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed by 7.8 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Segment MA51-14 to identify existing BMPs and found that no structural BMPs exist to reduce effective IC. This information is summarized in Table 2 below.

Table 2. Effective IC Reductions under Existing & Proposed Conditions

IC in Directly Contributing Watershed	19.5	acres
Target Reduction in Effective IC	7.8	acres
IC Effectively Reduced by Existing BMPs	0	acres
IC Remaining to Mitigate with Proposed BMPs	**7.8**	**acres**

MassDOT will now work with its design consultants to identify locations suitable for the construction of structural BMPs to treat directly contributing IC as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide the target IC reduction or treatment to the maximum extent practicable.

Regarding the pathogen impairment of Segment MA51-14, MassDOT has concluded based on review of the draft North Coastal Watershed General MS4 permit, the draft Interstate, Merrimack, and South Coastal watershed permits, and pathogen TMDLs for Massachusetts waters, that the BMPs outlined in MassDOT's stormwater management plan and those under consideration for reducing effective IC from MassDOT areas are consistent with its existing permit requirements. MassDOT believes that these measures achieve pathogen reductions (including fecal coliform) to the maximum extent practicable and are consistent with the intent of its existing stormwater permit and the applicable Pathogen TMDLs.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of additional BMPs, and finalized assessments including reductions achieved by finalized BMP designs. MassDOT will also continue to implement non-structural BMPs that reduce the impacts of stormwater.

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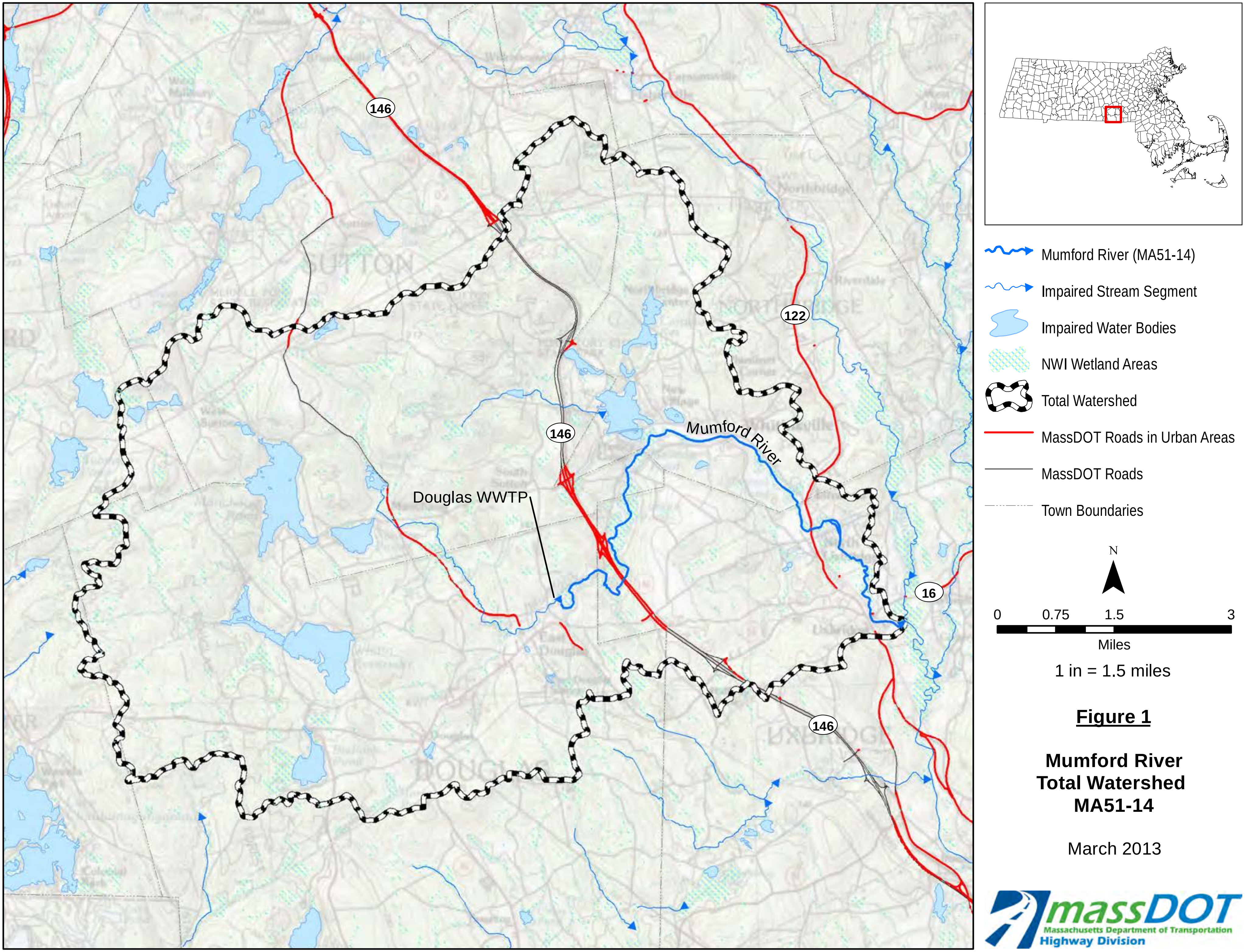
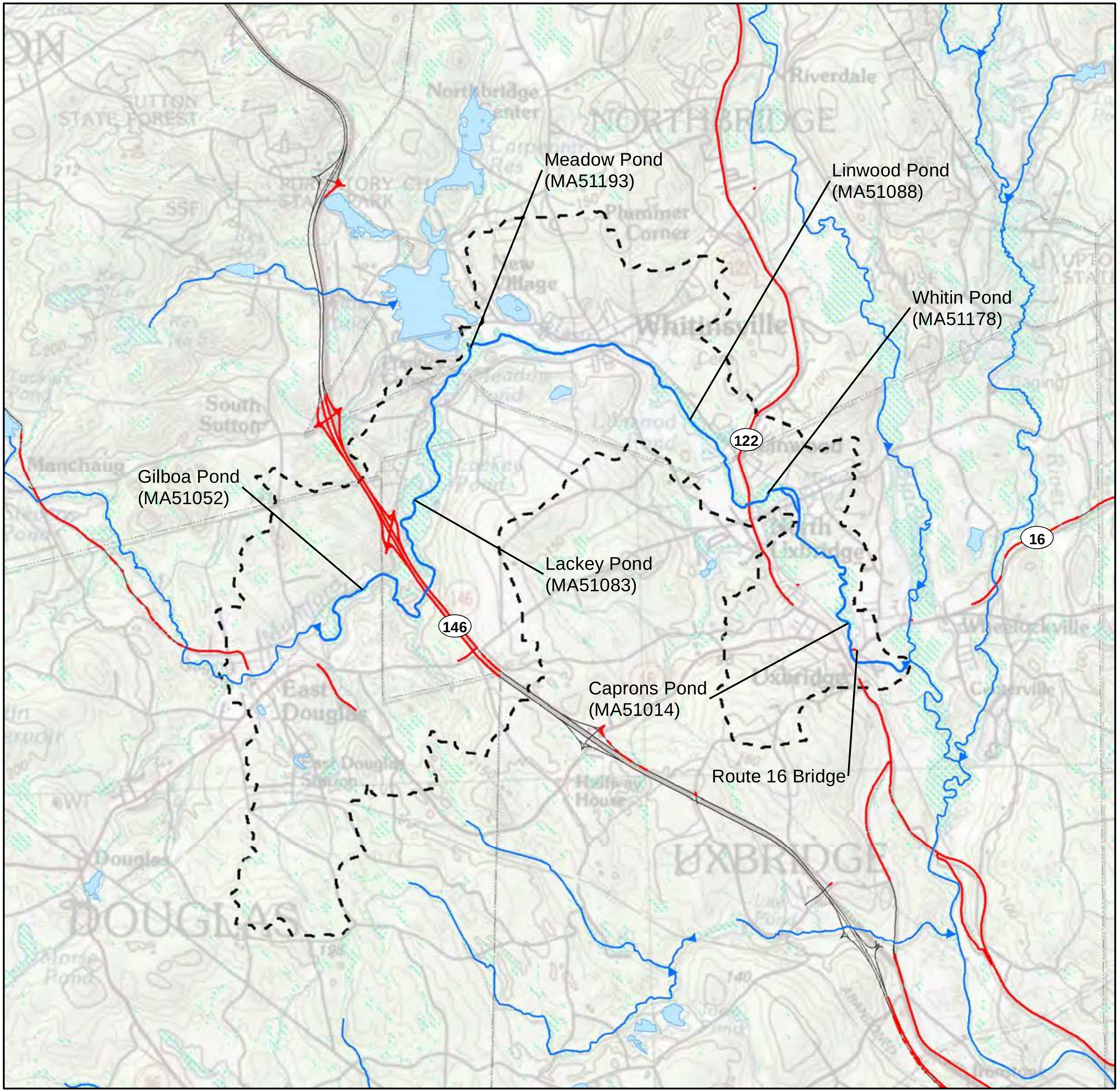
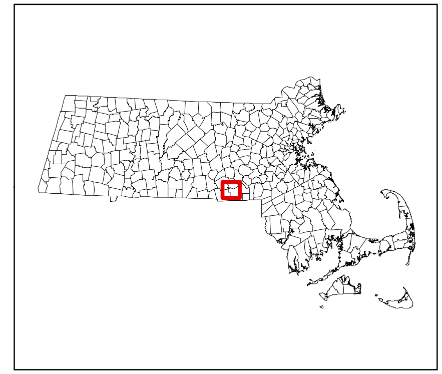


Figure 1

Mumford River Total Watershed MA51-14

March 2013





Mumford River (MA51-14)

Impaired Stream Segments

Impaired Water Bodies

NWI Wetland Areas

Mumford River Subwatershed

MassDOT Roads in Urban Areas

MassDOT Roads

Town Boundaries

N

0 1 2

Miles

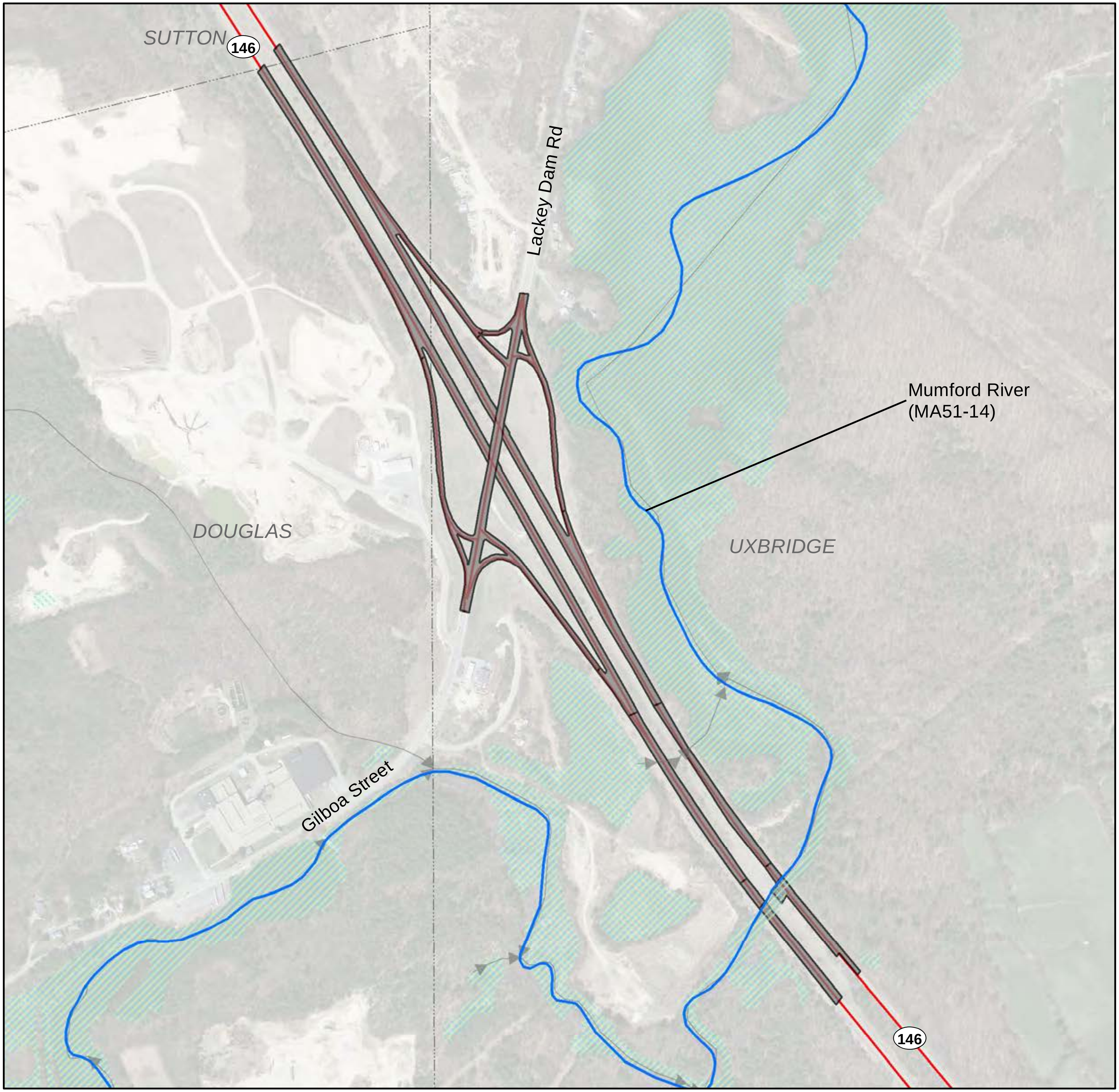
1 in = 1 miles

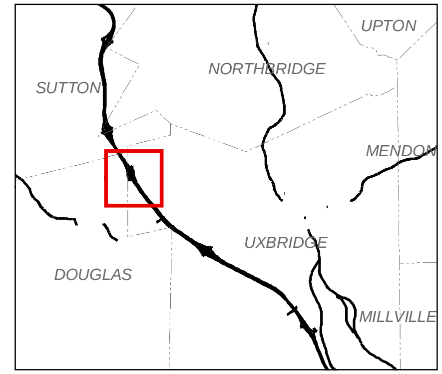
Figure 2

Mumford River Subwatershed MA51-14

March 2013

massDOT Massachusetts Department of Transportation Highway Division





Mumford River (MA51-14)
Impaired Stream Segment
Impaired Water Bodies
Non-Impaired Stream Segment
MassDOT Direct Watershed
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

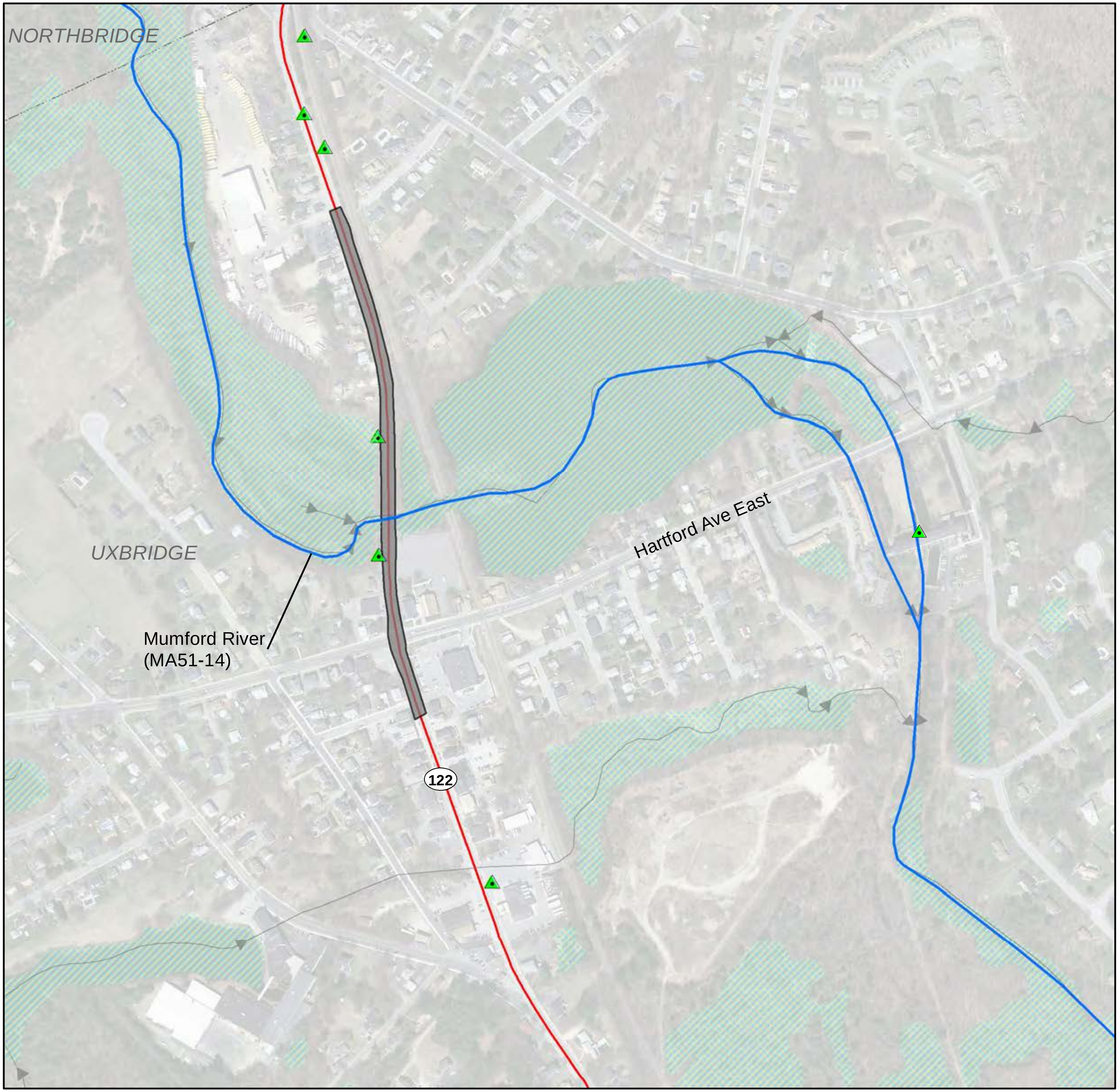
0 350 700 1,400
Feet
1 inch = 700 feet

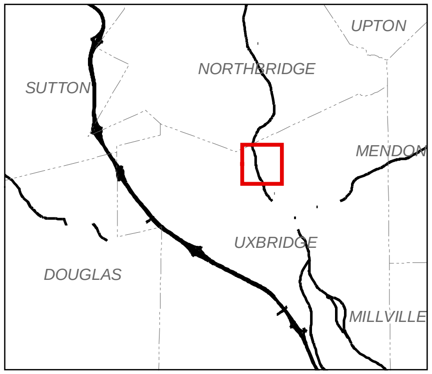
Figure 3

Mumford River (MA51-14) Directly Contributing MassDOT Watershed

March 2013

massDOT Massachusetts Department of Transportation Highway Division





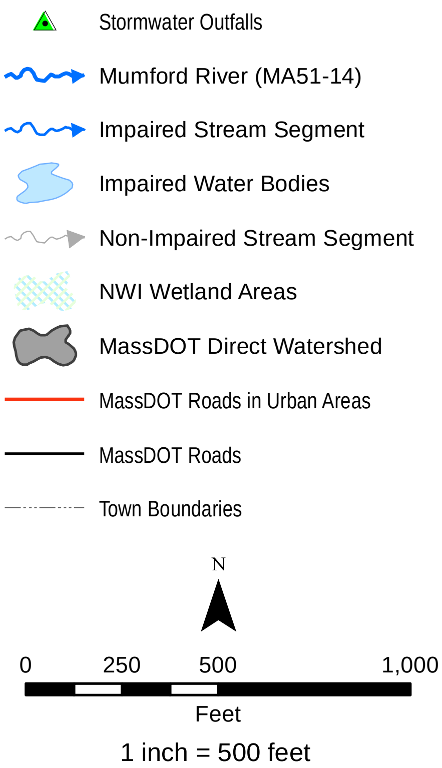
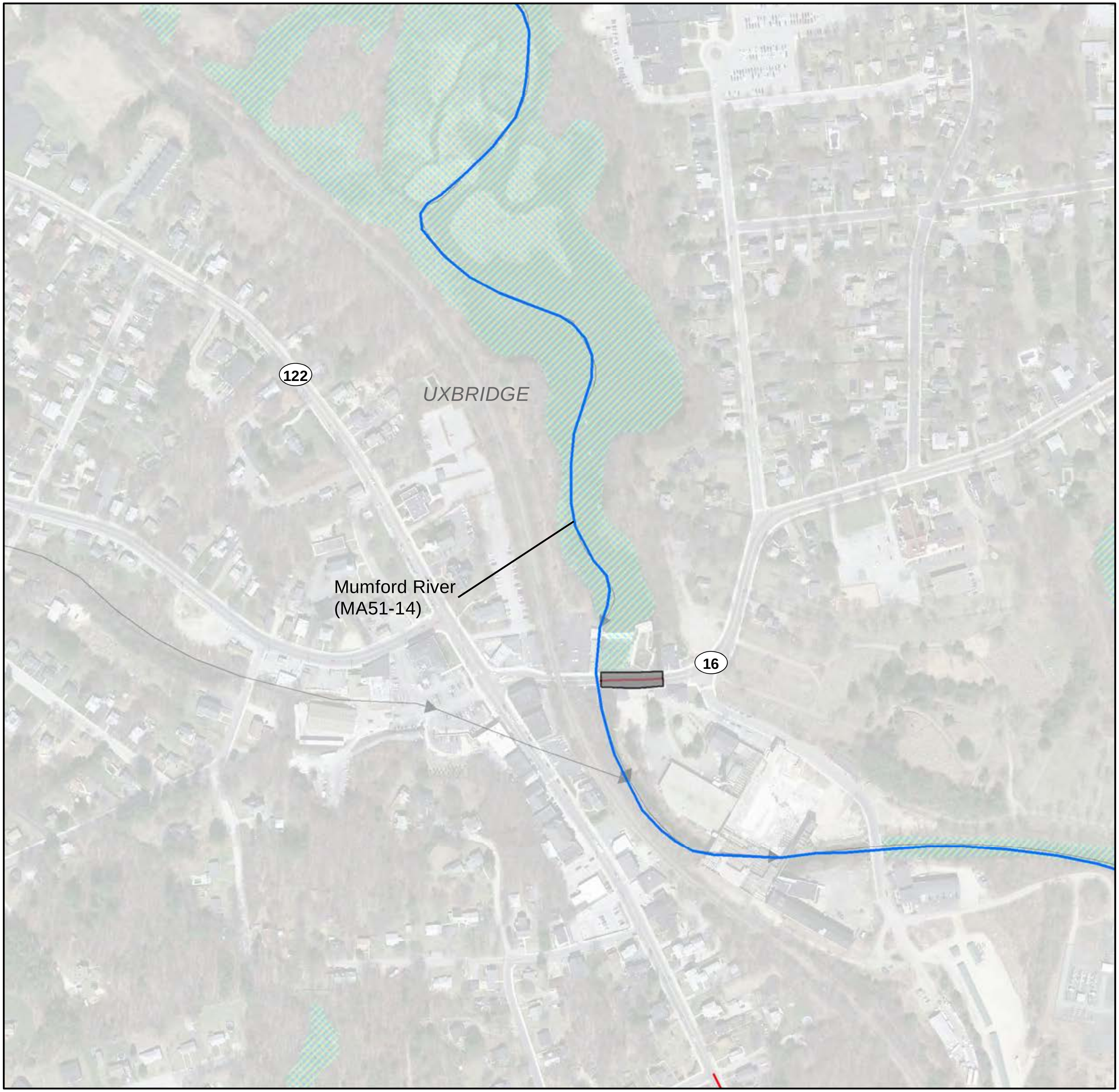


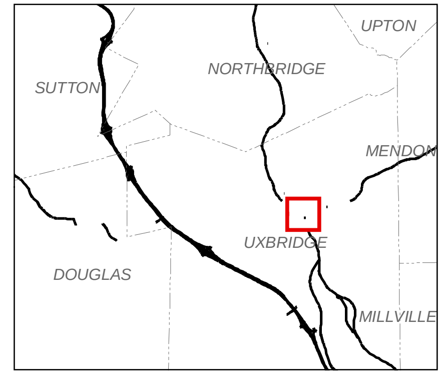
Figure 4

Mumford River (MA51-14) Directly Contributing MassDOT Watershed

March 2013

massDOT Massachusetts Department of Transportation Highway Division





Impaired Stream Segment

Impaired Water Bodies

Non-Impaired Stream Segment

NWI Wetland Areas

MassDOT Direct Watershed

MassDOT Roads in Urban Areas

MassDOT Roads

Town Boundaries

N

0 200 400 800

Feet

1 inch = 400 feet

Figure 5

Mumford River (MA51-14) Directly Contributing MassDOT Watershed

March 2013

massDOT Massachusetts Department of Transportation Highway Division

Impaired Waters Assessment for Tatnuck Brook (MA51-15) – Progress Report

Impaired Waterbody

Name: Tatnuck Brook

Location: Holden and Worcester, MA

Water Body ID: MA51-15

Impairments

Tatnuck Brook (MA51-15) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2010 Integrated List of Waters* (MassDEP, 2011). Tatnuck Brook includes the formerly separate run of the river impoundments, Cook Pond (MA51027) and Patch Reservoir (MA51118). Tatnuck Brook is impaired for the following:

- turbidity
- (non-native aquatic plants*)
- (other flow regime alterations*)
- (debris/floatables/trash*)
- sedimentation/siltation
- aquatic macroinvertebrate bioassessments.

According to MassDEP's *Blackstone River Watershed 2003-2007 Water Quality Assessment Report* (MassDEP, 2010), the aquatic life use is impaired due to an infestation of non-native aquatic macrophyte along the 0.3 mile reach through Cook Pond.

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *301 CMR 4.05 (3)(b) 6 Color and Turbidity.* These waters shall be free from color and turbidity in concentrations or combinations that are aesthetically objectionable or would impair any use assigned to this Class.
- *314 CMR 4.05 (5) (b) Bottom Pollutants or Alterations*. All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.
- *314 CMR 4.05 (3)(b) 5 Solids*. These waters shall be free from floating, suspended and settleable solids in concentrations or combinations that would impair any use assigned to this class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.
- *314 CMR 4.05 (5) (a) Aesthetics*. All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris,

scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.

Site Description

Tatnuck Brook (MA51-15) flows for 3.2 miles from the outlet at Holden Reservoir #2 in Holden, through Cook Pond,and Patch Reservoir in Worcester, and into Williams Millpond in Worcester. Tatnuck Brook's total and subwatershed are the same, as shown in **Figure 1**.

MassDOT-owned Route 122 crosses Tatnuck Brook after the brook flows through Cook Pond in Worcester. This section of Route 122 is a two lane roadway with several catch basins on either side of the road draining to outfalls along the northern side of the roadway and one on the south side of the roadway near Tatnuck Brook. As displayed in **Figure 2**, the most eastern outfall is located at the Route 122 bridge over Tatnuck Brook and flows directly to the brook. The next two upstream outfalls drain into the nearby city municipal system, where stormwater runoff ultimately drains to Tatnuck Brook. Therefore, as shown in Figure 2, the three most eastern outfalls along Route 122 contribute direct stormwater runoff to Tatnuck Brook. The directly contributing DOT watershed covers 2.0 acres of Route 122.

Assessment under BMP 7U

None of the following impairments for Tatnuck Brook (MA51-15) have been addressed by a TMDL: turbidity, non-native aquatic plants, other flow regime alterations, debris/floatables/trash, sedimentation/siltation and aquatic macroinvertebrate bioassessments.. Therefore, MassDOT assessed the impairments using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of stormwater on many impairments. For this water body, MassDOT used the IC method to assess the following impairments:

- turbidity
- sedimentation/siltation
- aquatic microinvertebrate bioassessments

According to MassDEP's final *Massachusetts Year 2010 Integrated List of Waters*, the impairments of non-native aquatic plants, other flow regime alterations and debris/floatables/trash are not caused by pollutants (MassDEP, 2011). Therefore, these impairments are not considered further.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction necessary to attain the percent imperviousness in the watershed at which stormwater is not likely the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. IC data were available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer.

In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for Tatnuck Brook (MA51-15):

Table 1. Site Parameters for Tatnuck Brook (MA51-15)

Total & Subwatershed		
Watershed Area	6,550	acres
Impervious Cover (IC) Area	662	acres
Percent Impervious	10.1	%
IC Area at 9% Goal	599	acres
Target Reduction % in IC	10.8	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	2.0	acres
MassDOT's Target Reduction in Effective IC (10.8 % of DOT Directly Contributing IC)	0.2	acres

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 10.8%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 0.2 acres.

Existing BMPs

There are no existing BMPs in the Tatnuck Brook directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to Tatnuck Brook.

Mitigation Plan

Because there is no mitigation of impervious surface achieved by MassDOT BMPs to meet the reduction requirement of 0.2 acres, MassDOT will consider the implementation of BMPs.

Conclusions

MassDOT used the IC Method to assess Tatnuck Brook (MA51-15) for the impairments identified in MassDEP's final *Massachusetts Year 2010 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed by 0.2 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Tatnuck Brook (MA51-15) to identify existing BMPs and found that no BMPs exist to reduce effective IC. This information is summarized in Table 2 below.

Table 2. Effective IC Reductions under Existing & Proposed Conditions

IC in Directly Contributing Watershed	2.0	acres
Target Reduction in Effective IC	0.2	acres
IC Effectively Reduced by Existing BMPs	0	acres
IC Remaining to Mitigate with Proposed BMPs	**0.2**	**acres**

MassDOT should reduce its effective IC within the directly contributing watershed by an additional 0.2 acres to achieve the targeted reduction in IC. MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs to treat directly contributing IC as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide the target IC reduction or treatment to the maximum extent practicable.

Furthermore, MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of additional BMPs, and finalized assessments including reductions achieved by finalized BMP designs. MassDOT will also continue to implement non-structural BMPs that reduce the impacts of stormwater.

References

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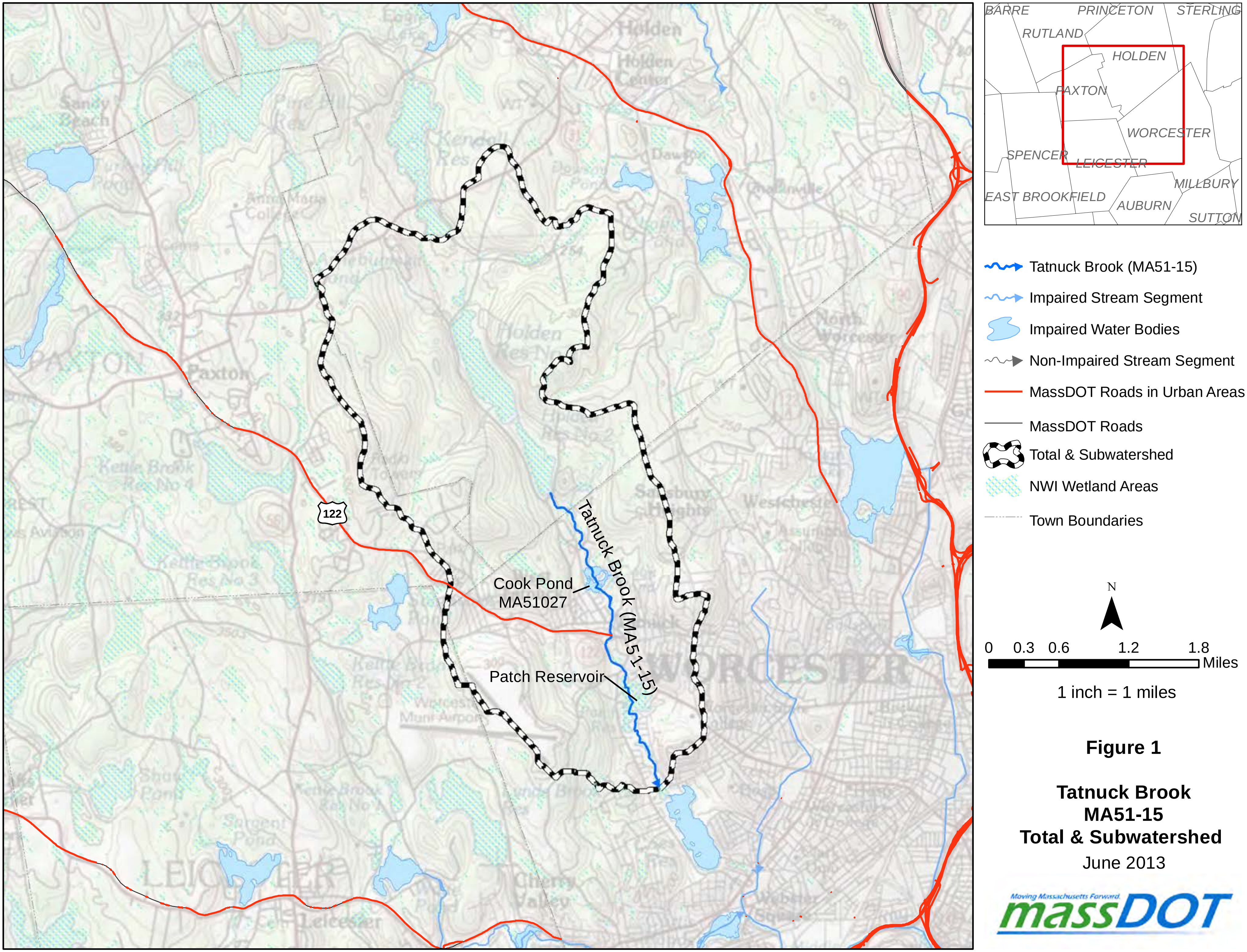

Figure 1

Tatnuck Brook
MA51-15
Total & Subwatershed
June 2013

Moving Massachusetts Forward.
massDOT

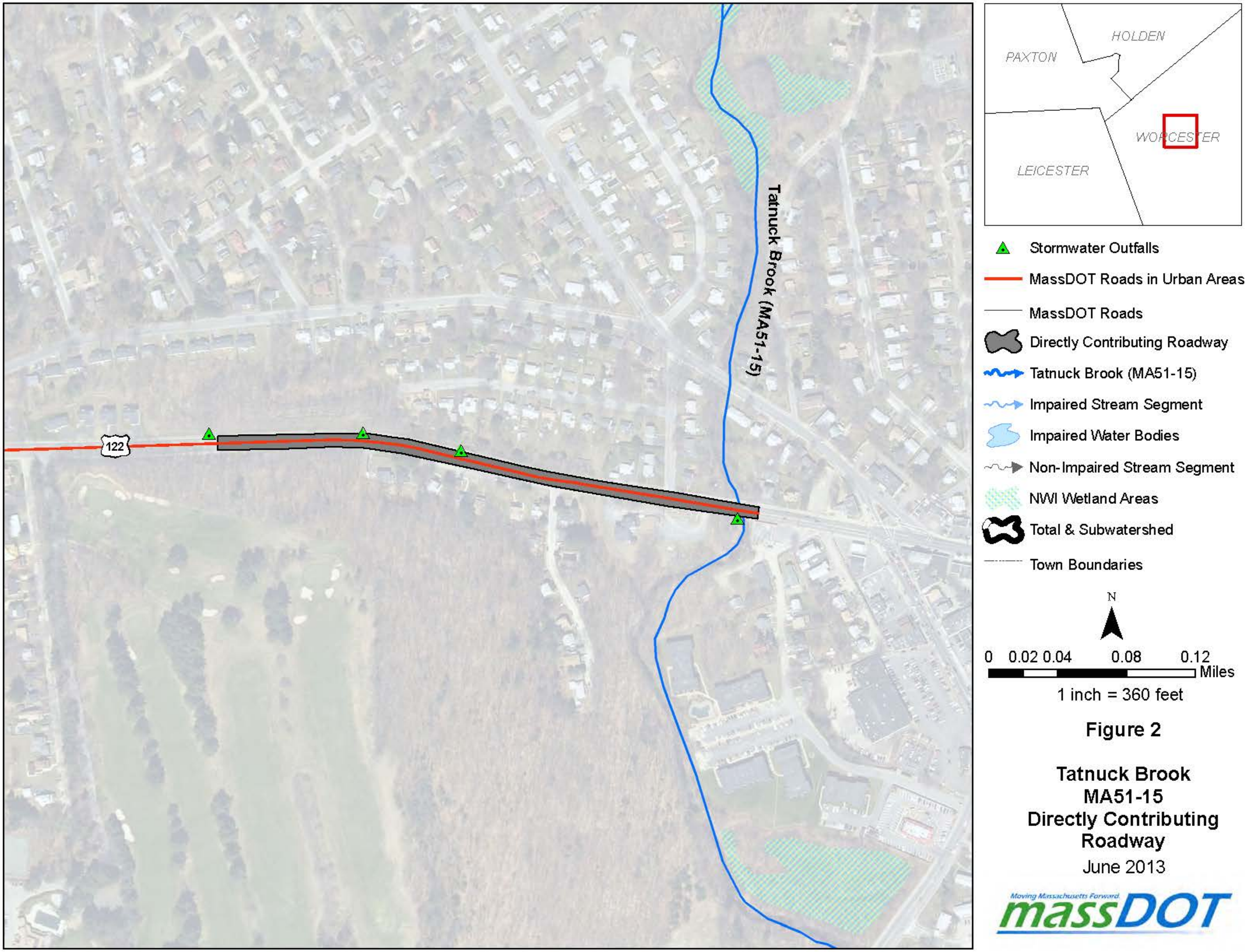

Figure 2

Tatnuck Brook MA51-15 Directly Contributing Roadway

June 2013

massDOT

Moving Massachusetts Forward.

i

Impaired Waters Assessment for Shirley Street Pond (MA51196) – Progress Report

Impaired Water Body

Name: Shirley Street Pond

Location: Shrewsbury, MA

Water Body ID: MA51196

Impairments

Shirley Street Pond (MA51196) is listed under Category 4a, "TMDL is Completed", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). Shirley Street Pond is impaired for aquatic plants (macrophytes) and has a TMDL for phosphorus (MassDEP, 2002). Shirley Street Pond was not assessed for any uses in MassDEP's *Blackstone River Watershed 2003-2007 Water Quality Assessment Report* (MassDEP, 2010).

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *314 CMR 4.05 (5) (c) Nutrients*. Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established by the Department pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.
- *314 CMR 4.05 (5) (a) Aesthetics*. All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.

Site Description

Shirley Street Pond (MA51196) lies in the town of Shrewsbury, MA and has a surface area of approximately 19 acres. The subwatershed of Shirley Street Pond has an area of about 9.1 square miles. The total watershed is the same as the subwatershed in the case of Shirley Street Pond. These are shown in Figure 1.

MassDOT owns several urban roadways within the subwatershed of segment MA51196, including Route 70, ramps to and from Interstate 190, and Interstate 290. The drainage along each roadway is briefly described below. The directly contributing MassDOT watershed areas are shown in Figure 2.

Interstate 190

The I-190 ramps are over 3 miles away from Shirley Street Pond. Discharge from these roadways does not directly discharge to the pond. See Figure 1.

Route 70

Stormwater from the southern portion of Route 70 discharges directly to Poor Farm Brook (MA51-17). Stormwater from the rest of the urban portion of Route 70 drains to wooded areas, wetland areas, ponds and non-impaired streams and therefore is not direct to Shirley Street Pond. See Figure 1.

Interstate 290 and Ramps

Stormwater from the ramps from I-290 east to Main Street in Shrewsbury and the ramps from Main Street to I-290 east is captured by a system of catch basins and pipes which drain it north up Main Street and outlet runoff directly to Shirley Street Pond. There are direct inlets in the grassy areas between these ramps and I-290 which also connect to this system of pipes. Therefore, runoff from the pervious areas between these ramps is also considered direct drainage to Shirley Pond.

Stormwater from the ramps from I-290 west to Main Street and the ramps from Main Street to I-290 west discharges to the inside cloverleaf of the ramp system and enters an open pipe which is part of a system that outlets directly to Shirley Street Pond. Stormwater from the area inside the cloverleaf also flows into the open pipe and also discharges directly to the pond.

Stormwater from the directly contributing portions of I-290 west and I-290 east is captured by catch basins and is conveyed through pipe systems which run north up Main Street and North Quinsigamond Avenue and outlet at Shirley Street Pond. Stormwater from the grassy median area is conveyed to direct inlets by a ditch along the median. These direct inlets are connected to the same drainage system which discharges to Shirley Street Pond. Stormwater from pervious outside the ramps and roadways also drains to Shirley Street Pond.

The directly contributing urban portions of I-290 are shown in Figure 2.

Assessment under BMP 7R

The TMDL for Shirley Street Pond addresses the impairment of phosphorus. Therefore, MassDOT assessed the contribution of phosphorus from MassDOT property directly draining to this water body to address the impairment of aquatic plants (macrophytes), which are directly related to phosphorus. The assessment was completed using the approach described in BMP 7R (TMDL Watershed Review).

TMDL

The Massachusetts Department of Environmental Protection's (MassDEP) TMDL report titled *Total Maximum Daily Loads of Phosphorus for Selected Northern Blackstone Lakes* [CN 70.1] (MassDEP, 2002) can be summarized as follows:

- Pollutant of Concern: Phosphorus
- Impairment for Shirley Street Pond Addressed in TMDL: phosphorus
- Applicable Waste Load Allocation (WLA): See Table 2p (p. 54) and Table 4p (p. 62) of TMDL Report.
  - Description of Associated Land Use: Commercial/Industrial
  - Commercial/Industrial Land Use Current Load (TP): 80 kg/yr (176 lbs/yr)
  - Commercial/ Industrial Land Use Target WLA (TP): 46 kg/yr (101 lbs/yr)
  - Commercial/Industrial Area in Watershed: 144 ha (355 acres)
  - Commercial/Industrial Land Use Target Areal WLA (TP): 0.32 kg/ha/yr (0.29 lb/acre/yr)

Estimated Loading from MassDOT

The loading of total phosphorus (TP) from MassDOT property directly contributing stormwater runoff to Shirley Street Pond was estimated using the following assumptions and calculations:

- MassDOT estimates the TP loading from its impervious areas as 1.60 lb/acre/yr. This loading rate is based on data collected in a study of stormwater runoff conducted by the United States Geological Survey (USGS) (Smith and Granato, 2010). The study analyzed stormwater samples from 12 sites located on highways operated by MassDOT across Massachusetts between September 2005 and September 2007. Samples were taken under a variety of weather conditions during this period.
- MassDOT estimates the TP loading from its pervious areas as 0.6 lb/acre/yr. This loading rate is based on the loading rate for hayland provided in the United States Environmental Protection Agency's (EPA) document EPA 440/5-80-011, "Modeling phosphorus loading and Pond response under uncertainty: a manual and compilation of export coefficients" (Reckhow, 1980). Hayland was chosen to represent the pervious right-of-way areas which are typically cleared areas that are mowed only once per year.
- MassDOT calculated its total estimated TP loading rate using the estimated loading rates listed above. MassDOT property contributing stormwater directly to Shirley Street Pond is 19.9 acres of impervious area and 35.5 acres of pervious area. The TP loading is 53 lb/yr without accounting for existing BMPs or treatment throughout the watershed.
- MassDOT calculated its target TP WLA using the TMDL target areal WLA of 0.29 lb/ac/yr and the total area of MassDOT property within the TMDL watershed directly draining to Shirley Street Pond (55.4 acres). The target TP WLA for MassDOT runoff is 16 lb/yr.

Assessment

MassDOT calculated its current TP loading rate (53 lb/yr) and its target TP WLA (16 lb/yr) using values provided in MassDEP's TMDL report. The difference between these two values represents the target reduction in TP that MassDOT will aim to achieve to comply with the WLA. For the watershed directly contributing to Shirley Street Pond, this target reduction is 37 lb/yr, or 70%. As explained in BMP 7R, MassDOT's pollutant loading analysis provides only a preliminary estimate of the level of pollutant reductions that may be recommended. In light of the variability of data on stormwater discharges, MassDOT will rely on a variety of other factors apart from numeric guidelines, including site constraints, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

During a site visit on November 29, 2012, no existing BMPs were identified in the DOT direct watershed to Shirley Street Pond. Thus, there is currently no TP reduction being provided.

Mitigation Plan

Because the total mitigation achieved by MassDOT's existing BMPs is less than the target reduction of 37 lb/yr, the implementation of additional BMPs will be considered by MassDOT.

Conclusions

MassDOT evaluated its property within the directly contributing watershed to Shirley Street Pond to identify existing BMPs. This assessment of Shirley Street Pond has shown that MassDOT has no existing BMPs in place, and therefore, discharges stormwater directly to Shirley Street Pond without providing treatment.

To meet the TMDL for phosphorus, MassDOT should reduce its TP loading within the directly contributing watershed by 37 lb/yr to achieve the targeted reduction. MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide the target load reduction or treatment to the maximum extent practicable. Once the design of proposed BMPs is finalized, MassDOT will develop a final assessment of this water body under the Impaired Waters program.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding the design progress made towards meeting the load reduction, plans for construction of the BMPs and finalized assessments. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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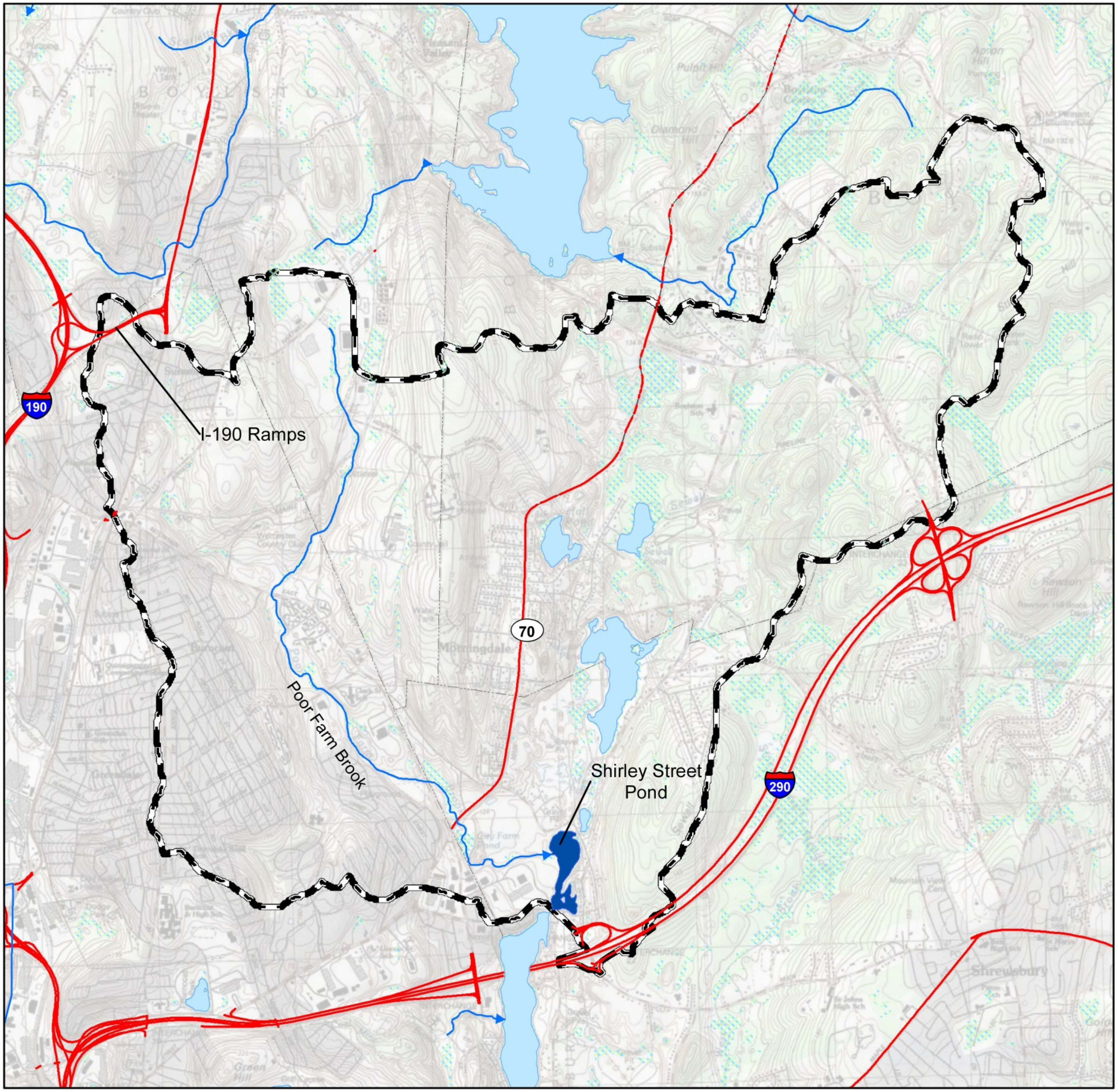
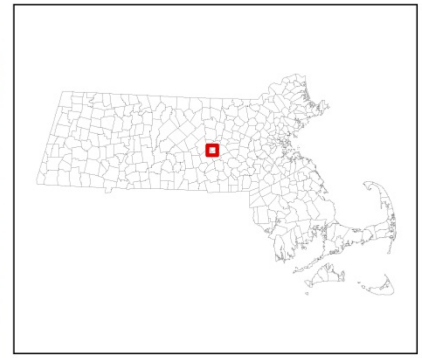




Impaired Stream Segment

Shirley Street Pond

Impaired Water Bodies

NWI Wetland Areas

MassDOT Roads in Urban Areas

MassDOT Roads

Town Boundaries

Subwatershed

Total Watershed

N

0 0.25 0.5 0.75 1 Miles

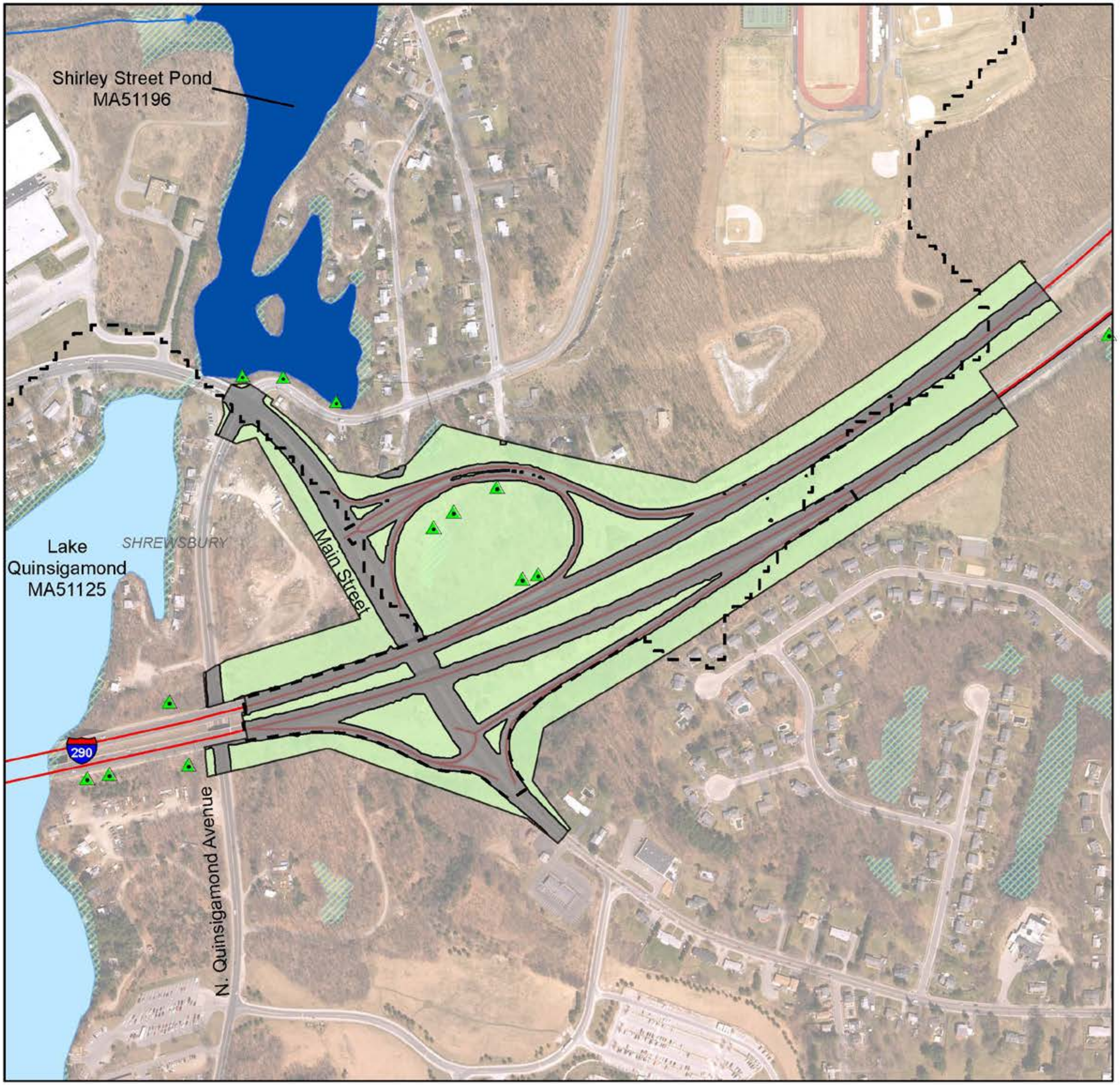
1 in = 3,250 feet

Figure 1

Shirley Street Pond Total Watershed and Subwatershed MA51196

March 2013

massDOT Massachusetts Department of Transportation Highway Division



Subwatershed
MassDOT Direct Impervious Watershed
MassDOT Direct Pervious Watershed
Stormwater Outfalls
Impaired Stream Segment
Shirley Street Pond
Impaired Water Bodies
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 250 500 750 1,000 ft

1 inch = 500 feet

Figure 2

Shirley Street Pond (MA51196) Directly Contributing MassDOT Watershed

March 2013

massDOT Massachusetts Department of Transportation Highway Division

Impaired Waters Assessment for Mount Hope Bay (MA61-06) – Progress Report

Impaired Water Body

Name: Mount Hope Bay

Location: Somerset and Fall River, MA

Water Body ID: MA61-06

Impairments

Mount Hope Bay (MA61-06) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). Mount Hope Bay is impaired for the following:

- chlorophyll-a
- fecal coliform
- fishes bioassessments
- total nitrogen
- water temperature

According to MassDEP's *Narragansett and Mount Hope Bay Watersheds 2004-2008 Water Quality Assessment Report* (MassDEP, 2009c), Mount Hope Bay (MA61-06) has been classified as impaired with respect to designated uses for Aquatic Life and Shellfish Harvesting. It has not yet been assessed for the Fish Consumption, Primary Contact, Secondary Contact, or Aesthetics. The report indicates that the Aquatic Life use impairment is caused by, "thermal modification contributing to collapse of fishery, elevated total nitrogen, [and] elevated chlorophyll a." The source is cited as, "industrial point source discharge, cooling water intake structures (impingement/entrainment), municipal point source discharge, [and] wet weather discharges—point source and combination of stormwater, SSO or CSO." The report includes specific recommendations targeting the once-through cooling system at the Brayton Point Station power point and the sewage conveyance and treatment system in the city of Fall River, which is a CSO (combined sewer overflow) system.

Relevant Water Quality Standards

Water Body Classification: Class SB, CSO

Applicable State Regulations:

- *314 CMR 4.05 (4) (b) 1 Dissolved Oxygen*. Shall not be less than 5.0 mg/l. Seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained. Where natural background conditions are lower, DO shall not be less than natural background.
- *314 CMR 4.05 (4) (b) 2 Temperature.*
  - a. Shall not exceed 85°F (29.4°C) nor a maximum daily mean of 80°0F (26.7°C), and the rise in temperature due to a discharge shall not exceed 1.5°F (0.8°C)

during the summer months (July through September) nor 4°0F (2.2°0C) during the winter months (October through June).

   - b. There shall be no changes from natural background that would impair any uses assigned to this class including those conditions necessary to protect normal species diversity, successful migration, reproductive functions or growth of aquatic organisms.

- *314 CMR 4.05 (4) (b) 3 pH.* Shall be in the range of 6.5 through 8.5 standard units and not more than 0.2 standard units outside of the natural background range. There shall be no change from natural background conditions that would impair any use assigned to this Class.
- *314 CMR 4.05 (4) (b) 4 Bacteria.*
   - a. Waters designated for shellfishing shall not exceed a fecal coliform median or geometric mean MPN of 88 organisms per 100 ml, nor shall more than 10% of the samples exceed an MPN of 260 per 100 ml or other values of equivalent protection based on sampling and analytical methods used by the Massachusetts Division of Marine Fisheries and approved by the National Shellfish Sanitation Program in the latest revision of the Guide For The Control of Molluscan Shellfish (more stringent regulations may apply, see 314 CMR 4.06(1)(d)(5)).
   - b. At bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010, no single enterococci sample taken during the bathing season shall exceed 104 colonies per 100 ml and the geometric mean of the five most recent samples taken within the same bathing season shall not exceed 35 enterococci colonies per 100 ml. In non bathing beach waters and bathing beach waters during the non bathing season, no single enterococci sample shall exceed 104 colonies per 100 ml and the geometric mean of all of the samples taken during the most recent six months typically based on a minimum of five samples shall not exceed 35 enterococci colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department.
- *314 CMR 4.05 (4) (b) 5 Solids*. These waters shall be free from floating, suspended and settleable solids in concentrations or combinations that would impair any use assigned to this class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.
- *314 CMR 4.05 (5) (b) Bottom Pollutants or Alterations*. All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.
- *314 CMR 4.05 (5) (c) Nutrients.* Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established by the Department pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.

- *314 CMR 4.05 (5) (e) Toxic Pollutants*. All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife. For pollutants not otherwise listed in 314 CMR 4.00, the National Recommended Water Quality Criteria: 2002, EPA 822R-02-047, November 2002 published by EPA pursuant to Section 304(a) of the Federal Water Pollution Control Act, are the allowable receiving water concentrations for the affected waters, unless the Department either establishes a site specific criterion or determines that naturally occurring background concentrations are higher. Where the Department determines that naturally occurring background concentrations are higher, those concentrations shall be the allowable receiving water concentrations. The Department shall use the water quality criteria for the protection of aquatic life expressed in terms of the dissolved fraction of metals when EPA's 304(a) recommended criteria provide for use of the dissolved fraction. The EPA recommended criteria based on total recoverable metals shall be converted to dissolved metals using EPA's published conversion factors. Permit limits will be written in terms of total recoverable metals. Translation from dissolved metals criteria to total recoverable metals permit limits will be based on EPA's conversion factors or other methods approved by the Department. The Department may establish site specific criteria for toxic pollutants based on site specific considerations.

Site Description

Mount Hope Bay (MA61-06) refers to the Massachusetts portion of Mount Hope Bay bounded by three linear demarcations. The upstream boundary is the I-195 Braga Bridge, where Taunton River (MA62-04) ends. The southern downstream boundary is the state border between Fall River, MA and Tiverton, RI. The western downstream boundary is a line from Brayton Point in Somerset, MA to the Rhode Island state border approximately ¾ of a mile due east of Spar Island, RI. The western downstream boundary of Mount Hope Bay (MA61-06) doubles as the eastern downstream boundary of Mount Hope Bay (MA61-07). The total area of segment MA61-06 is 2.29 sq. mi. (MassDEP, 2013)

The total watershed for Mount Hope Bay covers a large portion of the southeast area of the state. The subwatershed lies primarily within Fall River, Somerset, and Swansea. The areas in Fall River and Somerset are highly urbanized. In the city of Fall River, most stormwater enters a CSO system, which is designed to convey municipal wastewater and small to medium-sized storm events to a wastewater treatment plant at the southern tip of the segment. The plant discharges treated effluent directly into Mount Hope Bay. Because of this piped network, the subwatershed was delineated to include areas of the city that drain to CSOs. This information was provided directly by the city of Fall River, and is included in the Appendix of this report. The total watershed and subwatershed for Mount Hope Bay (MA61-06) are shown in Figures 1 and 2, respectively.

MassDOT's urban property directly contributing stormwater runoff to Mount Hope Bay (MA61-06) is comprised of a portion of I-195 southbound in Somerset and a MassDOT-owned bridge along Almond St. in Fall River. Additional portions of I-195 in Somerset and Fall River that pass adjacent to Mount Hope Bay (MA61-06) were found to contribute stormwater runoff to Taunton River (MA62-04). Those stormwater contributions are accounted for in the Impaired Waters Assessment for Taunton River (MA62-04). MassDOT's directly contributing property is shown in Figure 3.

Assessment under BMP 7U

Of the impairments listed for segment MA61-06 of Mount Hope Bay, four are potentially linked to stormwater runoff and have not been addressed by a TMDL. Therefore, MassDOT assessed these impairments using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of stormwater on many impairments. For this water body, MassDOT used the IC method to assess the following impairments:

- chlorophyll-a
- fishes bioassessments
- total nitrogen
- water temperature

The impairment for fecal coliform has been addressed by the *Final Pathogen TMDL for the Narragansett/Mt. Hope Bay Watershed* (MassDEP, 2010). MassDOT has assessed its contribution to this impairment and compliance with the corresponding TMDL separately in the section titled "Assessment under BMP 7R."

The following sections describe the methodology used by MassDOT to assess the four impairments potentially linked to stormwater that have not been addressed by a TMDL.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction necessary to attain the percent imperviousness in the watershed at which stormwater is not likely the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has the potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. IC data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer. In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's

Stormwater Best Management Practices (BMP) Performance Analysis report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for Mount Hope Bay (MA61-06):

Table 1. Site Parameters for Mount Hope Bay (MA61-06)

Total Watershed		
Watershed Area	361,000	acres
Impervious Cover (IC) Area	45,300	acres
Percent Impervious	12.6*	%
IC Area at 9% Goal	32,400	acres
Target Reduction % in IC	28.3*	%
Subwatershed		
Subwatershed Area	8,790	acres
Impervious Cover (IC) Area	3,280	acres
Percent Impervious	37.3	%
IC Area at 9% Goal	791	acres
Target Reduction % in IC	75.9	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	1.3	acres
MassDOT's Target Reduction in Effective IC (75.9% of DOT Directly Contributing IC)	1.0	acres

*Rounding accounts for differences in calculations.

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 75.9%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 1.0 acres.

Existing BMPs

Based on the site visit, there are no existing BMPs in the Mount Hope Bay (MA61-06) directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to Mount Hope Bay (MA61-06).

Mitigation Plan

Because there are currently no BMPs mitigating MassDOT's directly contributing impervious surface, MassDOT will consider implementing new BMPs to contribute to the target reduction of 1.0 acres.

Assessment under BMP 7R

MassDOT assessed the fecal coliform impairment using the approach described in BMP 7R of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which can be applied to water bodies covered by a final TMDL. Mount Hope Bay (MA61-06) is covered by the *Final Pathogen TMDL for the Narragansett/Mt. Hope Bay Watershed* (MassDEP, 2010).

The TMDL report does not specifically site highway stormwater as a pathogen source of primary concern. Repeated mention is made to the CSO system in the city of Fall River, which has seven CSO outfalls directly to Mount Hope Bay (MA61-06). "The TMDL analysis has determined that the most significant point source contributors of fecal coliform to the Massachusetts portions of Mount Hope Bay (all of MA 61-06, and the eastern portion of MA 61-07) include the direct pollution effects of the City of Fall River" (MassDEP, 2010). An abatement program is underway to increase the capacity of the city's wastewater treatment plant conveyance and treatment system. "The CSO system is designed to handle a 3 month storm (1.72 inches of precipitation in a 12 hour period). The Long Term CSO Control Plan (LTCP) and Facilities Management Plan, when completed, will reduce the untreated CSO discharges from 691 to less than 4 per year and the annual average CSO volume from 1508 to 116 million gallons per year" (MassDEP, 2010).

MassDOT currently ties into the Fall River CSO system at a few locations. Five catch basins along Rte. 79 tie into the President Ave. CSO system, contributing only approximately 0.3 lane miles of IC. MassDOT has a much more significant connection to the Alton St. CSO system. All of Rte. 79 between the N. Main St. interchange and the road's high point near Arthur St. in Fall River drain to the Alton St. CSO, for a total of approximately 5.1 lane miles of IC. Reducing the volume of stormwater entering the CSO system would help to reduce the number of overflow events, thus improving the water quality of Mount Hope Bay (MA61-06).

Fecal Coliform Impairment

Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by an order of magnitude within a given storm event at a single location (MassDEP, 2009b). Therefore, it is difficult to predict pathogen concentrations in stormwater with accuracy. Due to this difficulty, MassDOT generally will not conduct site specific assessments of loading at each location impaired for pathogens. Instead these sites will be assessed collectively based on available information on pathogen loading from highways, MassDOT actions, and information available from EPA and DEP. Based on this information MassDOT developed an approach to be consistent with relevant TMDL and permit condition requirements and an iterative adaptive management approach to stormwater management.

In addition, while there is a positive relationship between IC and pathogen loading, the relationship is not as direct as other impairments. According to the Center for Watershed Protection "…Other studies show that concentrations of bacteria are typically higher in urban areas than rural areas (USGS, 1999), but they are not always directly related to IC (CWP, 2003)." Therefore, DOT did not rely solely on the IC method to assess pathogen impairments. Instead, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

Pathogens in MassDOT Discharge

A study conducted on MassDOT's South East Expressway measured bacterial concentrations in stormwater runoff (Smith, 2002). This study found a geometric mean of 186 fecal coliforms/100 ml. Concentrations of pathogens in stormwater runoff from roadways can vary widely and pathogen concentrations in runoff across the state likely deviate significantly from this stretch of roadway's specific estimate. Event mean concentrations of fecal coliform bacteria in urban stormwater from other sources ranging between 14,000 and 17,000 fecal coliform organisms/100 mL have been reported (MassDEP, 2009b). These data suggest that pathogen loading from highways may be lower than other urban areas.

Consideration of the potential sources of pathogens supports the idea that pathogens are present in lower concentrations in highway runoff since potential pathogen sources are likely to be less prevalent in the highway environment than along other urban roadways:

- Illicit discharges: Due to the typical setback of highways from residential and commercial developments and the stand alone nature of the drainage system, the potential for illicit discharges (e.g. sewer connections, laundry tie-ins) is much lower than in other stormwater systems. This has been confirmed by MassDOT's illicit discharge detection on many miles of urban roadways within a broad range of areas across Massachusetts. After assessment of almost 140 miles, and investigation of more than 2,500 stormwater features, MassDOT's consultant performing the broad scope reviews has found no confirmed illicit discharges.
- Limited Sewer Utilities in Road Right of Ways: Since DOT does not provide sewer services, many MassDOT roads do not have sewer utilities within the road's right of way; thereby eliminating the chance of cross-connections or leaking pipes as a source of pathogens into the stormwater system.
- Pet waste: Pets are only present on highways in rare instances. In urban residential areas pets and their associated waste are much more common. MassDOT is aware that pet waste at road side rest stops may represent a potential source of pathogens to stormwater in certain situations.
- Wildlife: Highways are not generally an attractive place for wildlife. Wildlife generally avoids highways and only occasionally crosses them.

The dearth of pathogen sources on highways and the relatively low concentrations of pathogens measured in the South East Expressway study together suggest that pathogen loading from stormwater runoff from highways is lower than other urban sources.

Furthermore, in almost all cases the contribution of pathogens from MassDOT to a specific water body is likely to be very small relative to other sources of pathogens in the watershed. Since MassDOT urban roadways are linear and usually cross watersheds, they represent a small fraction of the receiving water body's watershed. The water quality within these water bodies is dependent on discharge from various sources, including discharges from other stormwater systems and a large number of other factors.

Assessment

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

TMDLs for pathogen impairments in Massachusetts recognize that pathogens are highly variable and difficult to address and emphasize the need for an iterative adaptive management approach to address pathogens. Examples of relevant language from these TMDLs are included below:

- "given the vast potential number of bacteria sources and the difficulty of identifying and removing them from some sources such as stormwater require an iterative process and will take some time to accomplish. While the stated goal in the TMDL is to meet the water quality standard at the point of discharge it also attempts to be clear that MassDEP's expectation is that for stormwater an iterative approach is needed…" (MassDEP, 2009a)

- “The NPDES permit does not, however, establish numeric effluent limitations for stormwater discharges. Maximum extent practicable (MEP) is the statutory standard that establishes the level of pollutant reductions that regulated municipalities must achieve. The MEP standard is a narrative effluent limitation that is satisfied through implementation of SWMPs and achievement of measurable goals.” (MassDEP, 2009b)
- “Although the TMDL presents quantified WLAs for stormwater that are set equivalent to the criteria in the Massachusetts Water Quality Standards, the Phase II NPDES permits will not include numeric effluent limitations. Phase II permits are intended to be BMP based permits that will require communities to develop and implement comprehensive stormwater management programs involving the use of BMPs. Massachusetts and EPA believe that BMP based Phase II permits involving comprehensive stormwater management together with specific emphasis on pollutants contributing to existing water quality problems can be consistent with the intent of the quantitative WLAs for stormwater discharges in TMDLs.” (MassDEP, 2002).

This language clearly indicates that an iterative adaptive management approach is the appropriate way to address discharges to pathogen impaired waters. The recommendations in pathogen TMDLs for waters in Massachusetts generally require development and implementation of stormwater management programs, illicit discharge detection and elimination efforts, and in some cases installing BMPs to the maximum extent practicable

The draft North Coastal Watershed General MS4 permit and the draft Interstate, Merrimack, and South Coastal (IMS) watershed permits contain specific requirements for compliance with pathogen TMDLs (in Appendix G). While these permits are still in draft form, MassDOT believes they represent the best available guidance on what EPA believes is appropriate for addressing stormwater discharges to pathogen-impaired waters. Section 2.2.1(c) of the permit states “For any discharge from its MS4 to impaired waters with an approved TMDL, the permittee shall comply with the specific terms of Part 2.1 of this permit. In addition, where an approved TMDL establishes a WLA that applies to its MS4 discharges, the permittee shall implement the specific BMPs and other permit requirements identified in Appendix G to achieve consistency with the WLA.” Appendix G references a number of programmatic BMPs that are necessary to address pathogen loading. These cover the following general topics:

- Residential educational program
- Illicit connection identification, tracking and removal
- Pet waste management

Mitigation Plan

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Stormwater Management Plan (SWMP) including educational programs, illicit connection review and source control. The specific BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In
- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System

- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

In addition, the structural BMPs that will be considered to reduce the IC will also have the effect of reducing pathogen loads.

MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations. MassDOT's existing stormwater management plan outlines BMPs that include education and illicit discharge detection and elimination. MassDOT will be implementing a pet waste management program at its rest stops that have discharges to pathogen impaired waters.

Conclusions

MassDOT used the IC Method to assess Mount Hope Bay (MA61-06) for the impairments identified in MassDEP's final *Massachusetts Year 2012 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed by 1.0 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Mount Hope Bay (MA61-06) to identify existing BMPs and found that existing BMPs provide 0% of the target reduction in effective IC. This information is summarized in Table 2 below.

Table 2. Effective IC Reductions under Existing & Proposed Conditions

IC in Directly Contributing Watershed	1.3	acres
Target Reduction in Effective IC	1.0	acres
IC Effectively Reduced by Existing BMPs	0	acres
IC Remaining to Mitigate with Proposed BMPs	**1.0**	**acres**

MassDOT should reduce its effective IC within the directly contributing watershed by 1.0 acres to achieve the targeted reduction in IC. MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs to treat directly contributing IC as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide the target IC reduction or treatment to the maximum extent practicable.

MassDOT has concluded based on review of the draft North Coastal Watershed General MS4 permit, the draft Interstate, Merrimack, and South Coastal watershed permits, and pathogen TMDLs for Massachusetts waters, that the BMPs outlined in the stormwater management plan and those under consideration for reducing effective IC from MassDOT areas are consistent with its existing permit requirements. MassDOT believes that these measures achieve pathogen reductions (including fecal coliform) to the maximum extent practicable and are consistent with the intent of its existing stormwater permit and the applicable Pathogen TMDLs.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of additional BMPs, and finalized assessments including reductions achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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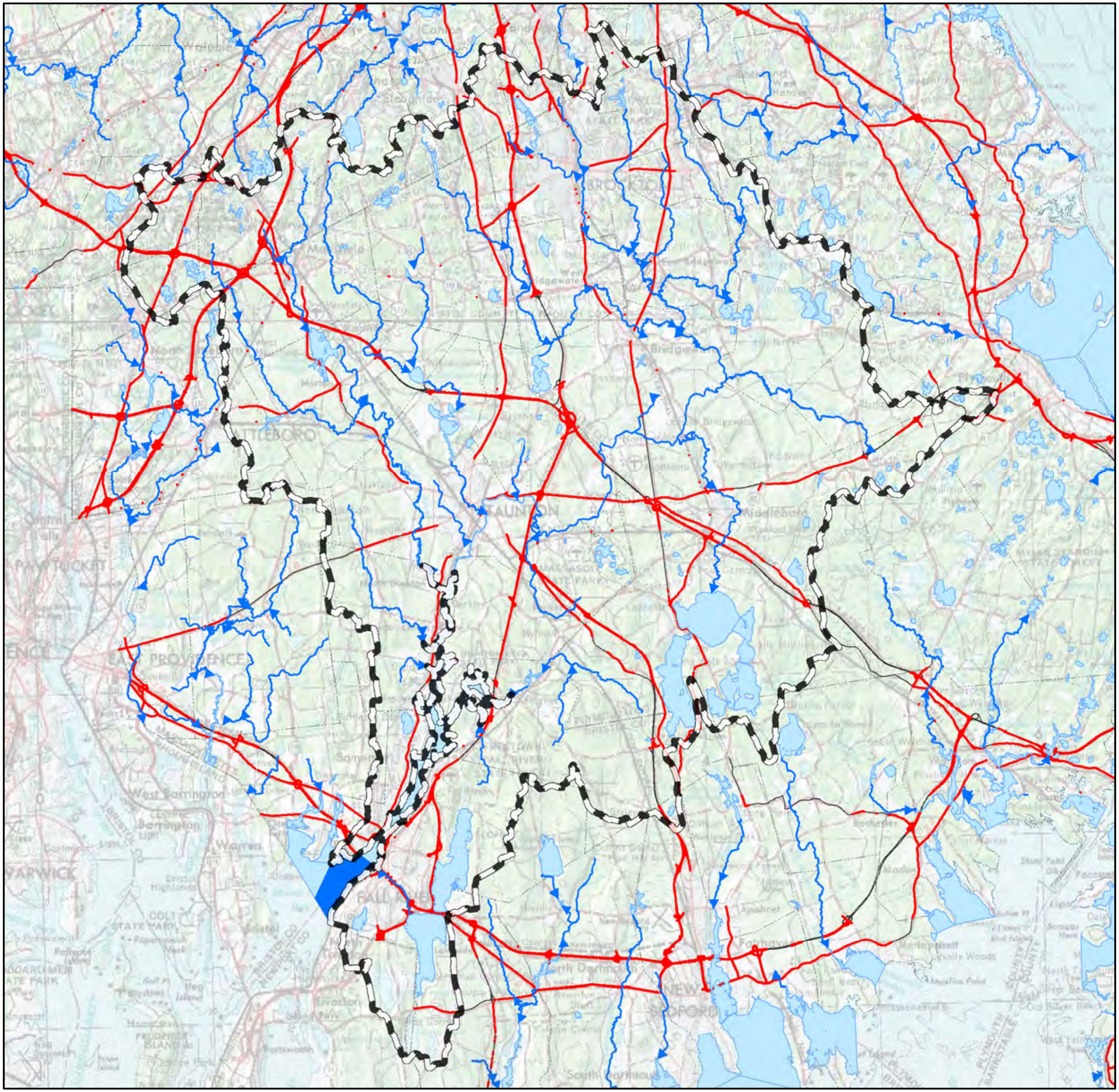
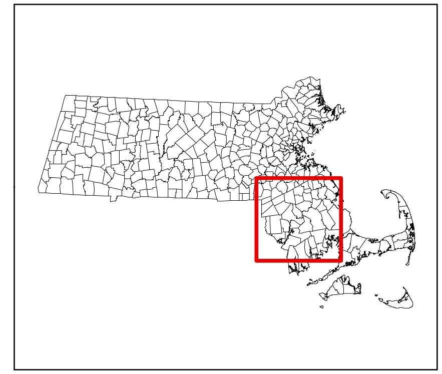




Total Watershed

Mount Hope Bay (MA61-06)

Impaired Stream Segment

Impaired Water Bodies

MassDOT Roads in Urban Areas

MassDOT Roads

Town Boundaries

N

0 1.25 2.5 5 7.5 10 Miles

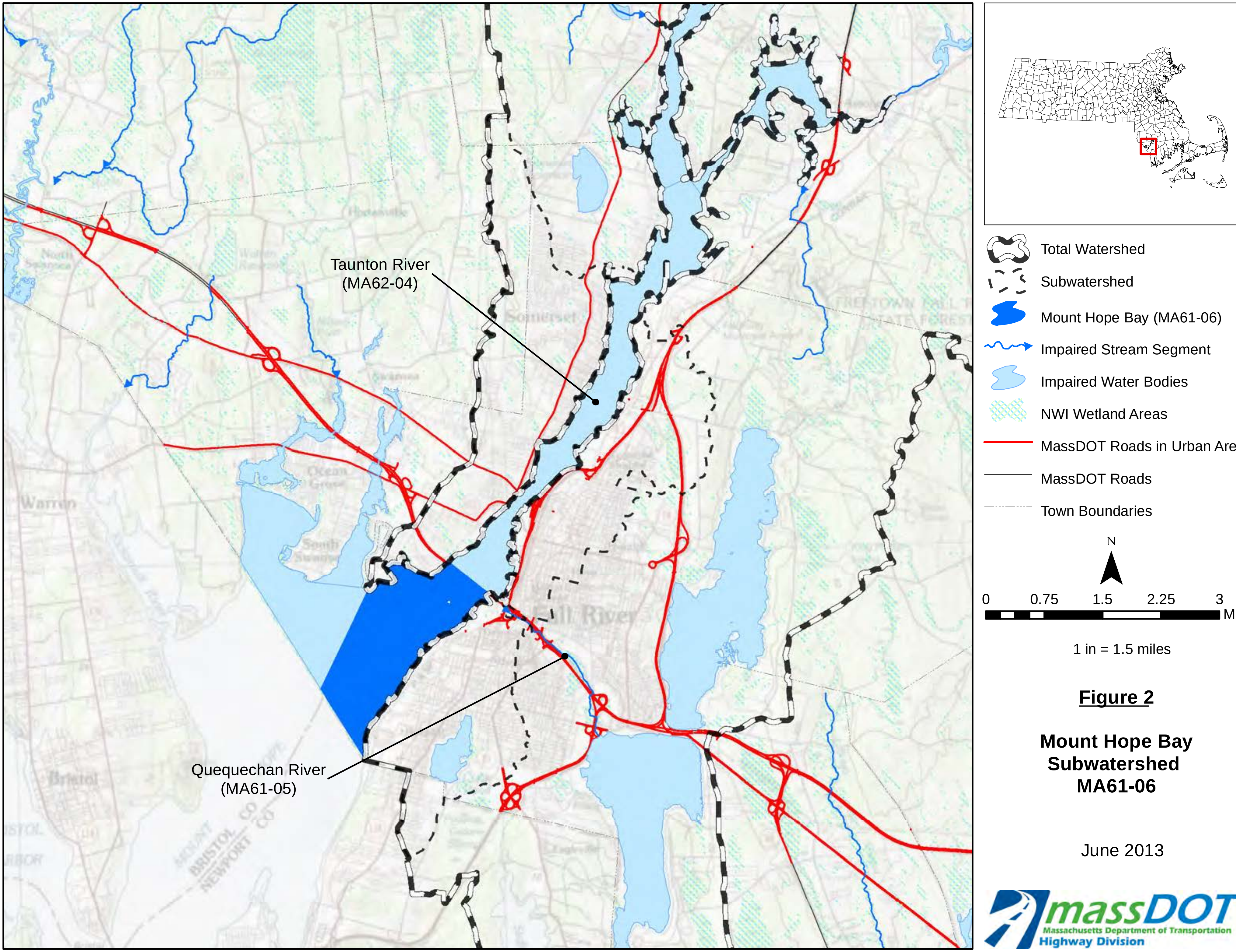
1 in = 5 miles

<u>Figure 1</u>

Mount Hope Bay
Total Watershed
MA61-06

June 2013

massDOT
Massachusetts Department of Transportation
Highway Division



Total Watershed

Subwatershed

Mount Hope Bay (MA61-06)

Impaired Stream Segment

Impaired Water Bodies

NWI Wetland Areas

MassDOT Roads in Urban Areas

MassDOT Roads

Town Boundaries

N

0 0.75 1.5 2.25 3 Miles

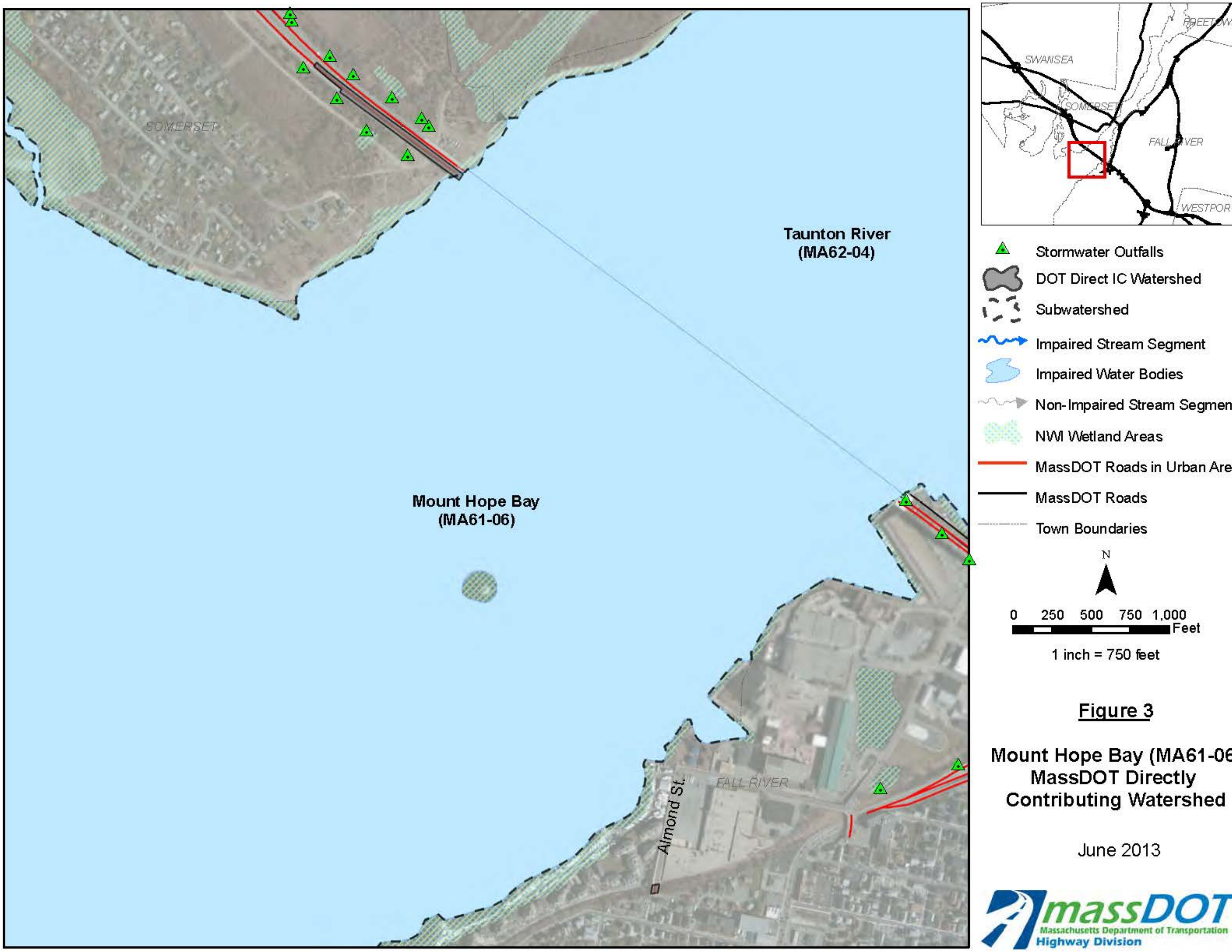
1 in = 1.5 miles

Figure 2

Mount Hope Bay Subwatershed MA61-06

June 2013

massDOT Massachusetts Department of Transportation Highway Division



Stormwater Outfalls
DOT Direct IC Watershed
Subwatershed
Impaired Stream Segment
Impaired Water Bodies
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 250 500 750 1,000 Feet

1 inch = 750 feet

Figure 3

Mount Hope Bay (MA61-06) MassDOT Directly Contributing Watershed

June 2013

massDOT
Massachusetts Department of Transportation
Highway Division

Impaired Waters Assessment for Taunton River (MA62-04) – Progress Report

Impaired Water Body

Name: Taunton River

Location: Somerset, Fall River, and Freetown, MA

Water Body ID: MA62-04

Impairments

Taunton River (MA62-04) is listed under Category 5, “Waters Requiring a TMDL”, on MassDEP’s final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). Taunton River (MA62-04) is impaired for the following:

- fecal coliform
- fishes bioassessments
- dissolved oxygen

According to MassDEP’s *Taunton River Watershed 2001 Water Quality Assessment Report*, Taunton River Watershed (MA62-04) has been classified as impaired with respect to designated uses for Aquatic Life and Shellfish Harvesting. It has not yet been assessed for Fish Consumption, Primary Contact, Secondary Contact, or Aesthetics. The report indicates that the Aquatic Life use impairment is caused by “reduced abundance and diversity of fish.” The suspected sources are cited as “cooling water intakes, industrial thermal discharges, municipal storm sewer systems, CSO, municipal point source discharges, and highway and bridge runoff.” Additionally, the report indicates that the Shellfish Harvesting use impairment is caused by “fecal coliform bacteria.” The suspected sources are cited as “discharges from municipal separate storm sewer systems, CSO, septic systems, and marina/boating pumpout releases.” (MassDEP, 2001)

Relevant Water Quality Standards

Water Body Classification: Class SB, Shellfishing (R), CSO

Applicable State Regulations:

- *314 CMR 4.05 (4) (b) 1 Dissolved Oxygen*. Shall not be less than 5.0 mg/l. Seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained. Where natural background conditions are lower, DO shall not be less than natural background.
- *314 CMR 4.05 (4) (b) 2 Temperature.*
    - a. Shall not exceed 85°F (29.4°C) nor a maximum daily mean of 80°0F (26.7°C), and the rise in temperature due to a discharge shall not exceed 1.5°F (0.8°C) during the summer months (July through September) nor 4°0F (2.2°0C) during the winter months (October through June).

  - b. There shall be no changes from natural background that would impair any uses assigned to this class including those conditions necessary to protect normal species diversity, successful migration, reproductive functions or growth of aquatic organisms.

- *314 CMR 4.05 (4) (b) 3 pH.* Shall be in the range of 6.5 through 8.5 standard units and not more than 0.2 standard units outside of the natural background range. There shall be no change from natural background conditions that would impair any use assigned to this Class.
- *314 CMR 4.05 (4) (b) 4 Bacteria.*
  - a. Waters designated for shellfishing shall not exceed a fecal coliform median or geometric mean MPN of 88 organisms per 100 ml, nor shall more than 10% of the samples exceed an MPN of 260 per 100 ml or other values of equivalent protection based on sampling and analytical methods used by the Massachusetts Division of Marine Fisheries and approved by the National Shellfish Sanitation Program in the latest revision of the Guide For The Control of Molluscan Shellfish (more stringent regulations may apply, see 314 CMR 4.06(1)(d)(5)).
  - b. At bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010, no single enterococci sample taken during the bathing season shall exceed 104 colonies per 100 ml and the geometric mean of the five most recent samples taken within the same bathing season shall not exceed 35 enterococci colonies per 100 ml. In non bathing beach waters and bathing beach waters during the non bathing season, no single enterococci sample shall exceed 104 colonies per 100 ml and the geometric mean of all of the samples taken during the most recent six months typically based on a minimum of five samples shall not exceed 35 enterococci colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department.
- *314 CMR 4.05 (4) (b) 5 Solids*. These waters shall be free from floating, suspended and settleable solids in concentrations or combinations that would impair any use assigned to this class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.
- *314 CMR 4.05 (5) (b) Bottom Pollutants or Alterations*. All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.
- *314 CMR 4.05 (5) (e) Toxic Pollutants*. All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife. For pollutants not otherwise listed in 314 CMR 4.00, the National Recommended Water Quality Criteria: 2002, EPA 822R-02-047, November 2002 published by EPA pursuant to Section 304(a) of the Federal Water Pollution Control Act, are the allowable receiving water concentrations for the affected waters, unless the Department either establishes a site specific criterion or determines that naturally occurring background concentrations are higher. Where the Department determines that naturally occurring background concentrations are higher, those concentrations shall be the allowable receiving water concentrations. The Department shall use the water quality criteria for the protection of aquatic life expressed in terms of the dissolved fraction of metals when EPA's 304(a) recommended criteria provide for use of the dissolved fraction. The EPA recommended criteria based on total recoverable metals shall be converted to dissolved metals using EPA's published conversion factors. Permit limits will be written in terms of total recoverable metals. Translation from dissolved metals criteria to total recoverable metals permit limits will be based on EPA's conversion factors or other methods approved by the

Department. The Department may establish site specific criteria for toxic pollutants based on site specific considerations.

Site Description

Taunton River (MA62-04) refers to the portion of the Taunton River beginning at its confluence with the Assonet River at a line from Sandy Point, Somerset, northeasterly to the southwestern tip of Assonet Neck, Berkley. The segment ends at the I-195 Braga Bridge, where the Taunton River empties into Mount Hope Bay (MA61-06). The total area of segment MA62-04 is 2.65 sq. mi. (MassDEP, 2013)

The total watershed for Taunton River covers a large portion of the southeast area of the state. The subwatershed lies primarily within Fall River, Somerset, Swansea, and Freetown. The areas in Fall River and Somerset are highly urbanized. In the city of Fall River, most stormwater enters a CSO system, which is designed to convey municipal wastewater and small to medium-sized storm events to a wastewater treatment plant at the southern tip of Mount Hope Bay (MA61-06). Because of this piped network, the subwatershed for Taunton River was delineated to exclude areas of the city that drain to CSOs and thus to Mount Hope Bay. This information was provided directly by the city of Fall River, and is included in the Appendix of this report. The total watershed and subwatershed for Taunton River (MA62-04) are shown in Figures 1 and 2, respectively.

MassDOT's urban property directly contributing stormwater runoff to Taunton River (MA62-04) is comprised of portions of Rte. 138, Rte. 6, Rte. 103, and I-195 in Somerset, MA and portions of Rte. 24, Rte. 79, and I-195 in Fall River, MA. MassDOT's directly contributing property is shown in Figures 3A through 3H.

Assessment under BMP 7U

Of the impairments listed for segment MA62-04 of Taunton River, two are potentially linked to stormwater runoff and have not been addressed by a TMDL. Therefore, MassDOT assessed these impairments using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of stormwater on many impairments. For this water body, MassDOT used the IC method to assess the following impairments:

- fishes bioassessments
- dissolved oxygen

The impairment for fecal coliform has been addressed by the *Final Pathogen TMDL for the Taunton River Watershed* (MassDEP, 2011). MassDOT has assessed its contribution to this impairment and compliance with the corresponding TMDL separately in the section titled "Assessment under BMP 7R."

The following sections describe the methodology used by MassDOT to assess the two impairments potentially linked to stormwater that have not been addressed by a TMDL.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction necessary to attain the percent imperviousness in the watershed at which stormwater is not likely the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has the potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. IC data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer. In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for the Taunton River (MA62-04).

Table 1. Site Parameters for Taunton River (MA62-04)

Total Watershed		
Watershed Area	358,000	acres
Impervious Cover (IC) Area	44,000	acres
Percent Impervious	12.3	%
IC Area at 9% Goal	32,200	acres
Target Reduction % in IC	26.8	%
Subwatershed		
Subwatershed Area	6,880	acres
Impervious Cover (IC) Area	1,760	acres
Percent Impervious	25.6	%
IC Area at 9% Goal	619	acres
Target Reduction % in IC	64.8	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	98.1	acres
MassDOT's Target Reduction in Effective IC (64.8% of DOT Directly Contributing IC)	63.6	acres

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 64.8%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 63.6 acres.

Existing BMPs

MassDOT has three existing BMPs in the Taunton River (MA62-04) directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to the Taunton River. The three BMPs are actually one long swale divided into three segments which act in series, thus they are identified as Ex-BMP-1A, Ex-BMP-1B, and Ex-BMP-1C. Figure 4 shows the BMP locations. In our analysis, existing BMPs receive credit for removing the effect of IC depending on their type, size relative to the IC that they process, and the local soil conditions. The soil in the area associated with the existing BMPs is characterized as hydrologic group C (silt loam).

Ex-BMP-1A, Ex-BMP-1B, and Ex-BMP-1C:

Rte. 6 in Somerset has been relocated to direct traffic over the newly constructed Veterans Memorial Bridge across the Taunton River. At the location where the new Rte. 6 diverges from Brightman St., an updated drainage system directs stormwater into a grass swale along the westbound shoulder. There are three outfalls at equal intervals along the swale. The area has no standing water and appears to infiltrate stormwater efficiently. The swale is approximately 2.5 ft wide at its bottom with side slopes of approximately 3:1. Three stone check dams, each approximately 1 ft high, were observed. The three swales operating in series receive stormwater from 1.46 acres of IC. They collectively provide 88% removal, resulting in an effective IC area reduction of 1.28 acres.

Flow that does not infiltrate enters a drop inlet at the end of the swale. The piped system is designed to send some flow through a wetland replication area and on to the Taunton River (MA62-

04), but high flows will bypass the wetland and outfall directly to the Taunton River. Because the wetland replication area seems to have a well-defined flow path, soils that are not intended to infiltrate, and lacks an outlet control structure, it was not given credit as an existing BMP.

Ex-BMP-1A. Infiltration swale facing east

Ex-BMP-1C. Infiltration swale facing west

Table 2. Summary of Existing BMPs

BMP Name	BMP Type	Soil Type	Depth of Runoff Treated (inches)	Effective IC Area Treated (acres)	Reduction of Effective IC* (%)	Reduction of Effective IC (acres)
Ex-BMP-1A	Infiltration Swale	C- Silt Loam 0.27 in/hr	0.4	0.9	50	0.4**
Ex-BMP-1B	Infiltration Swale	C- Silt Loam 0.27 in/hr	0.6	0.7	67	0.5
Ex-BMP-1C	Infiltration Swale	C- Silt Loam 0.27 in/hr	0.7	0.6	69	0.4
Total						1.3

*Description of MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011)
**Rounding accounts for differences in calculations.

Mitigation Plan

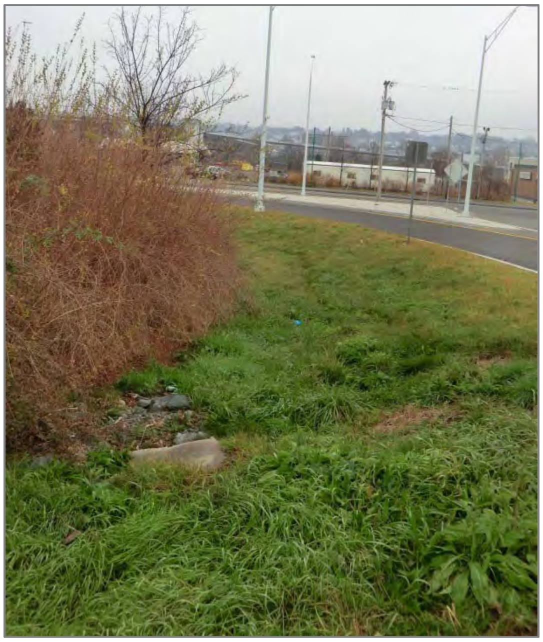
Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 63.6 acres, MassDOT will consider the implementation of additional BMPs.

Based on plan drawings for the relocated Rte. 6 and a site visit to the area, there are a few locations along MassDOT property that appear to be well-suited for additional BMPs. The first is at the location where the new Rte. 6 diverges from Brightman St., along the eastbound shoulder opposite Ex-BMP-1 (**Photo 1**). There is already an appropriately graded grass swale in this location that receives discharge from two catch basin outfalls; however there are no check dams to slow flow to the drop inlet at the end of the swale, near Brayton Ave. The addition of check dams could enable this swale to receive credit as a BMP.

Photo 1. Shoulder along Rte. 6 eastbound near Brayton Ave.

The second location is along the right shoulder of the Rte. 6 eastbound on-ramp at Riverside Ave. in Somerset (**Photo 2**). There is already a grass swale in this location that receives discharge from two catch basin outfalls along the ramp; however there are no check dams to slow flow to the drop inlet at the end of the swale. The addition of check dams could enable this swale to receive credit as a BMP.

Photo 2. Shoulder along Rte. 6
eastbound on-ramp at Riverside Ave.



The third location is along the right shoulder of the Rte. 79 northbound off-ramp to Rte. 6 westbound in Fall River (**Photo 3**). There is already a grass swale in this location that receives discharge from three outfalls along the ramp; however there are no check dams to slow flow to the drop inlet at the end of the swale. The addition of check dams could enable this swale to receive credit as a BMP, but the slope along the flow path of the swale may be too steep to meet regulations.

Photo 3. Shoulder along Rte. 79
northbound off-ramp to Rte. 6 westbound

Assessment under BMP 7R

MassDOT assessed the fecal coliform impairment using the approach described in BMP 7R of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which can be applied to water bodies covered by a final TMDL. The Taunton River (MA62-04) is covered by the *Final Pathogen TMDL for the Taunton River Watershed* (MassDEP, 2011).

In Appendix A of the TMDL report, MassDEP's response to a public comment pertaining to MassDOT is as follows:

> *Mass Highway is included in the Stormwater Phase II Program, and as such will be responsible for completing the six minimum controls mandated by that program, i.e., public education and outreach, public involvement and participation, illicit discharge detection and elimination, construction site stormwater runoff control, post construction stormwater management, and good housekeeping in operations.* (MassDEP, 2011)

Repeated mention is made to the CSO system in the city of Fall River, which has four CSO outfalls directly to the Taunton River (MA62-04). An abatement program is underway to increase the capacity of the city's wastewater treatment plant conveyance and treatment system. According to the *Final Pathogen TMDL for the Narragansett/Mt. Hope Bay Watershed,* "the CSO system is designed to handle a 3 month storm (1.72 inches of precipitation in a 12 hour period). The Long Term CSO Control Plan (LTCP) and Facilities Management Plan, when completed, will reduce the untreated CSO discharges from 691 to less than 4 per year and the annual average CSO volume from 1508 to 116 million gallons per year" (MassDEP, 2010).

MassDOT currently ties into the Fall River CSO system at a few locations. Five catch basins along Rte. 79 tie into the President Ave. CSO system, contributing only approximately 0.3 lane miles of IC. MassDOT has a much more significant connection to the Alton St. CSO system. All of Rte. 79 between the N. Main St. interchange and the road's high point near Arthur St. in Fall River drain to the Alton St. CSO, for a total of approximately 5.1 lane miles of IC. Reducing the volume of stormwater entering the CSO system would help to reduce the number of overflow events at the four CSOs along the Taunton River, thus improving the water quality of the Taunton River (MA62-04).

Fecal Coliform Impairment

Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by an order of magnitude within a given storm event at a single location (MassDEP, 2009b). Therefore, it is difficult to predict pathogen concentrations in stormwater with accuracy. Due to this difficulty, MassDOT generally will not conduct site specific assessments of loading at each location impaired for pathogens. Instead these sites will be assessed collectively based on available information on pathogen loading from highways, MassDOT actions, and information available from EPA and DEP. Based on this information MassDOT developed an approach to be consistent with relevant TMDL and permit condition requirements and an iterative adaptive management approach to stormwater management.

In addition, while there is a positive relationship between IC and pathogen loading, the relationship is not as direct as other impairments. According to the Center for Watershed Protection "…Other studies show that concentrations of bacteria are typically higher in urban areas than rural areas (USGS, 1999), but they are not always directly related to IC (CWP, 2003)." Therefore, DOT did not rely solely on the IC method to assess pathogen impairments. Instead, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

Pathogens in MassDOT Discharge

A study conducted on MassDOT's South East Expressway measured bacterial concentrations in stormwater runoff (Smith, 2002). This study found a geometric mean of 186 fecal coliforms/100 ml. Concentrations of pathogens in stormwater runoff from roadways can vary widely and pathogen concentrations in runoff across the state likely deviate significantly from this stretch of roadway's specific estimate. Event mean concentrations of fecal coliform bacteria in urban stormwater from other sources ranging between 14,000 and 17,000 fecal coliform organisms/100 mL have been reported (MassDEP, 2009b). These data suggest that pathogen loading from highways may be lower than other urban areas.

Consideration of the potential sources of pathogens supports the idea that pathogens are present in lower concentrations in highway runoff since potential pathogen sources are likely to be less prevalent in the highway environment than along other urban roadways:

- Illicit discharges: Due to the typical setback of highways from residential and commercial developments and the stand alone nature of the drainage system, the potential for illicit discharges (e.g. sewer connections, laundry tie-ins) is much lower than in other stormwater systems. This has been confirmed by MassDOT's illicit discharge detection on many miles of urban roadways within a broad range of areas across Massachusetts. After assessment of almost 140 miles, and investigation of more than 2,500 stormwater features, MassDOT's consultant performing the broad scope reviews has found no confirmed illicit discharges.
- Limited Sewer Utilities in Road Right of Ways: Since DOT does not provide sewer services, many MassDOT roads do not have sewer utilities within the road's right of way; thereby eliminating the chance of cross-connections or leaking pipes as a source of pathogens into the stormwater system.
- Pet waste: Pets are only present on highways in rare instances. In urban residential areas pets and their associated waste are much more common. MassDOT is aware that pet waste at road side rest stops may represent a potential source of pathogens to stormwater in certain situations.
- Wildlife: Highways are not generally an attractive place for wildlife. Wildlife generally avoids highways and only occasionally crosses them.

The dearth of pathogen sources on highways and the relatively low concentrations of pathogens measured in the South East Expressway study together suggest that pathogen loading from stormwater runoff from highways is lower than other urban sources.

Furthermore, in almost all cases the contribution of pathogens from MassDOT to a specific water body is likely to be very small relative to other sources of pathogens in the watershed. Since MassDOT urban roadways are linear and usually cross watersheds, they represent a small fraction of the receiving water body's watershed. The water quality within these water bodies is dependent on discharge from various sources, including discharges from other stormwater systems and a large number of other factors.

Assessment

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

TMDLs for pathogen impairments in Massachusetts recognize that pathogens are highly variable and difficult to address and emphasize the need for an iterative adaptive management approach to address pathogens. Examples of relevant language from these TMDLs are included below:

- "given the vast potential number of bacteria sources and the difficulty of identifying and removing them from some sources such as stormwater require an iterative process and will take some time to accomplish. While the stated goal in the TMDL is to meet the water quality standard at the point of discharge it also attempts to be clear that MassDEP's expectation is that for stormwater an iterative approach is needed…" (MassDEP, 2009a)
- "The NPDES permit does not, however, establish numeric effluent limitations for stormwater discharges. Maximum extent practicable (MEP) is the statutory standard that establishes the level of pollutant reductions that regulated municipalities must achieve. The MEP standard is a narrative effluent limitation that is satisfied through implementation of SWMPs and achievement of measurable goals." (MassDEP, 2009b)
- "Although the TMDL presents quantified WLAs for stormwater that are set equivalent to the criteria in the Massachusetts Water Quality Standards, the Phase II NPDES permits will not include numeric effluent limitations. Phase II permits are intended to be BMP based permits that will require communities to develop and implement comprehensive stormwater management programs involving the use of BMPs. Massachusetts and EPA believe that BMP based Phase II permits involving comprehensive stormwater management together with specific emphasis on pollutants contributing to existing water quality problems can be consistent with the intent of the quantitative WLAs for stormwater discharges in TMDLs." (MassDEP, 2002).

This language clearly indicates that an iterative adaptive management approach is the appropriate way to address discharges to pathogen impaired waters. The recommendations in pathogen TMDLs for waters in Massachusetts generally require development and implementation of stormwater management programs, illicit discharge detection and elimination efforts, and in some cases installing BMPs to the maximum extent practicable

The draft North Coastal Watershed General MS4 permit and the draft Interstate, Merrimack, and South Coastal (IMS) watershed permits contain specific requirements for compliance with pathogen TMDLs (in Appendix G). While these permits are still in draft form, MassDOT believes they represent the best available guidance on what EPA believes is appropriate for addressing stormwater discharges to pathogen-impaired waters. Section 2.2.1(c) of the permit states "For any discharge from its MS4 to impaired waters with an approved TMDL, the permittee shall comply with the specific terms of Part 2.1 of this permit. In addition, where an approved TMDL establishes a WLA that applies to its MS4 discharges, the permittee shall implement the specific BMPs and other permit requirements identified in Appendix G to achieve consistency with the WLA." Appendix G references a number of programmatic BMPs that are necessary to address pathogen loading. These cover the following general topics:

- Residential educational program
- Illicit connection identification, tracking and removal
- Pet waste management

Mitigation Plan

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Stormwater Management Plan (SWMP) including educational programs, illicit connection review and source control. The specific BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy

- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In
- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

In addition, the structural BMPs that will be considered to reduce the IC will also have the effect of reducing pathogen loads.

MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations. MassDOT's existing stormwater management plan outlines BMPs that include education and illicit discharge detection and elimination. MassDOT will be implementing a pet waste management program at its rest stops that have discharges to pathogen impaired waters.

Conclusions

MassDOT used the IC Method to assess the Taunton River (MA62-04) for the impairments identified in MassDEP's final *Massachusetts Year 2012 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed by 63.6 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Taunton River (MA62-04) to identify existing BMPs and found that existing BMPs provide 2% of the target reduction in effective IC. This information is summarized in Table 3 below.

Table 3. Effective IC Reductions under Existing & Proposed Conditions

IC in Directly Contributing Watershed	98.1	acres
Target Reduction in Effective IC	63.6	acres
IC Effectively Reduced by Existing BMPs	1.3	acres
IC Remaining to Mitigate with Proposed BMPs	**62.3**	**acres**

MassDOT should reduce its effective IC within the directly contributing watershed by an additional 62.3 acres to achieve the targeted reduction in IC. MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs to treat directly contributing IC as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide the target IC reduction or treatment to the maximum extent practicable.

MassDOT has concluded based on review of the draft North Coastal Watershed General MS4 permit, the draft Interstate, Merrimack, and South Coastal watershed permits, and pathogen TMDLs for Massachusetts waters, that the BMPs outlined in the stormwater management plan and those under consideration for reducing effective IC from MassDOT areas are consistent with its existing permit requirements. MassDOT believes that these measures achieve pathogen reductions (including fecal coliform) to the maximum extent practicable and are consistent with the intent of its existing stormwater permit and the applicable Pathogen TMDLs.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of additional BMPs, and finalized assessments including reductions achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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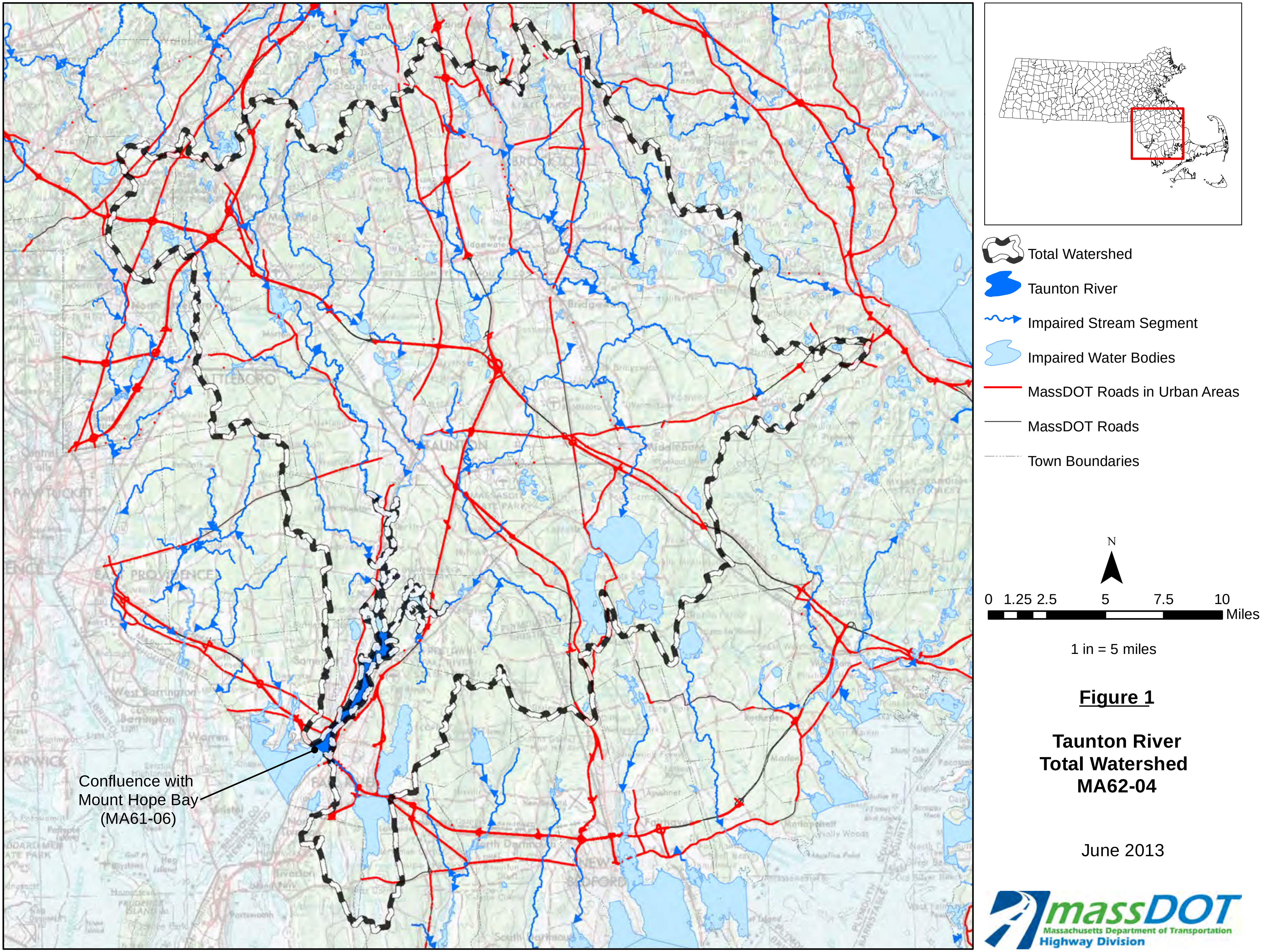
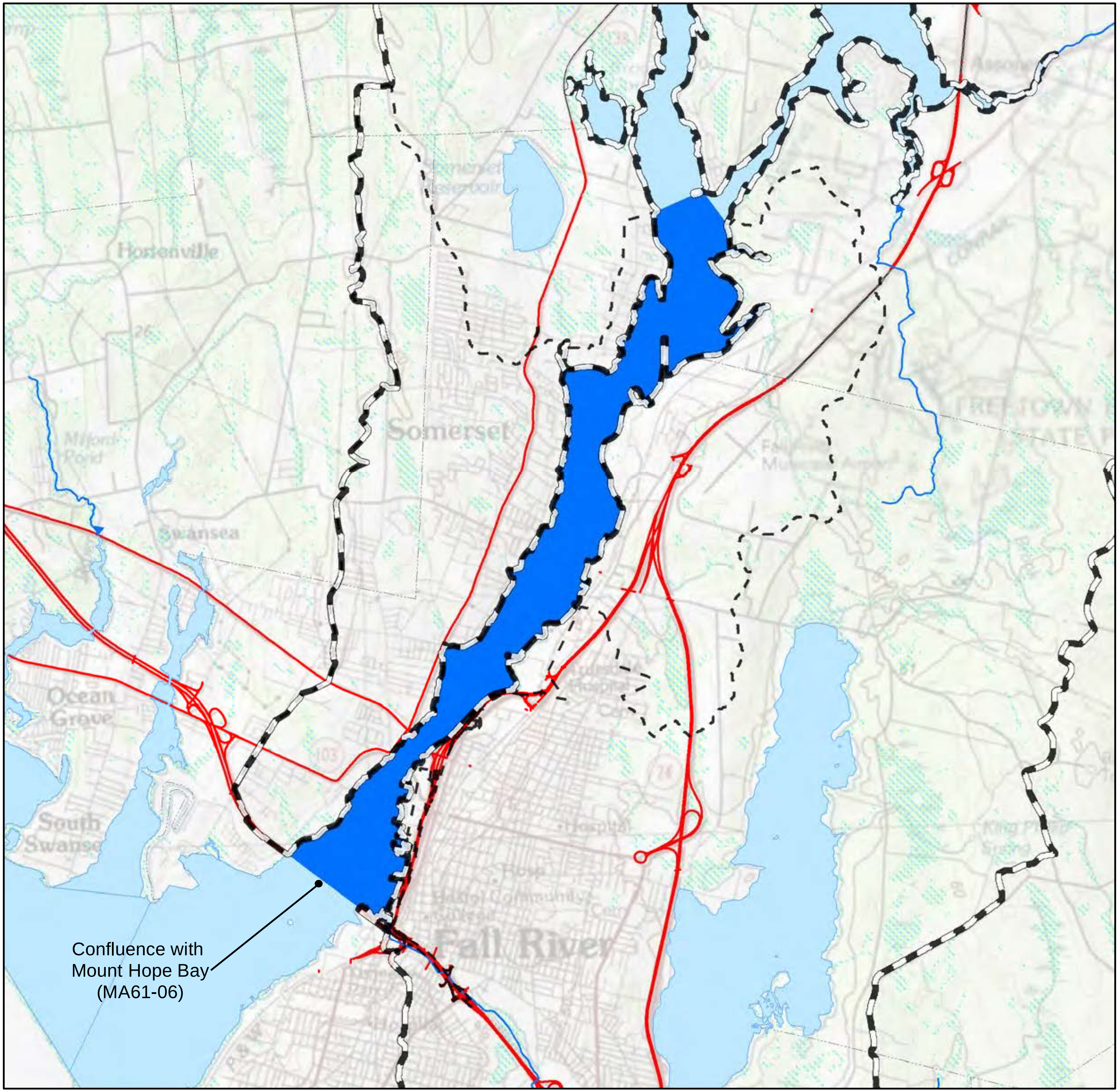


Figure 1

**Taunton River
Total Watershed
MA62-04**

June 2013



Total Watershed
Subwatershed
Taunton River
Impaired Stream Segment
Impaired Water Bodies
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 0.25 0.5 1 1.5 2 Miles

1 in = 1 miles

Figure 2

Taunton River Subwatershed MA62-04

June 2013

massDOT Massachusetts Department of Transportation Highway Division

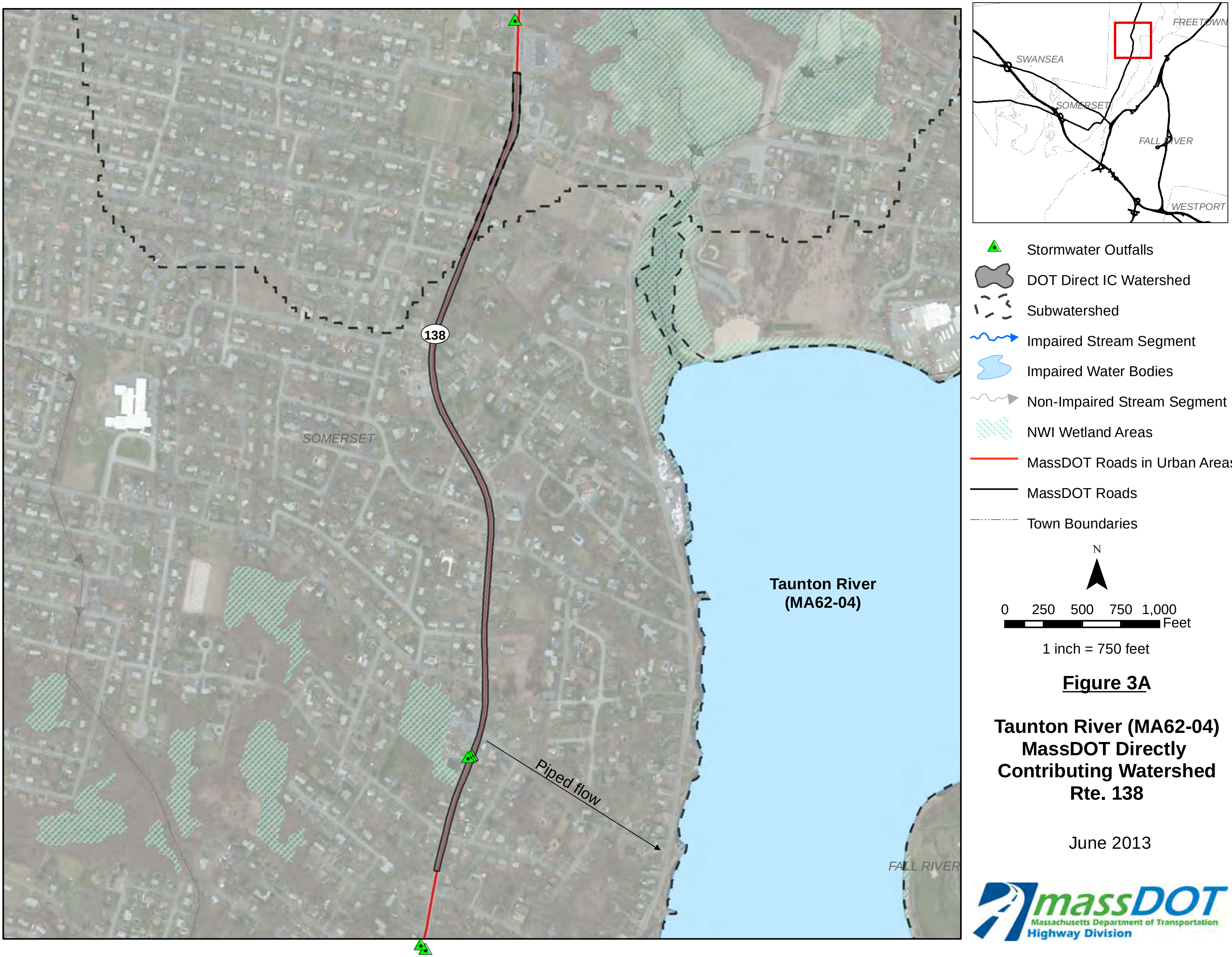
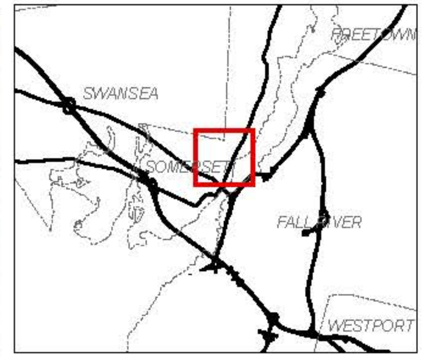


Figure 3A

Taunton River (MA62-04)
MassDOT Directly Contributing Watershed
Rte. 138

June 2013

massDOT
Massachusetts Department of Transportation
Highway Division



Stormwater Outfalls
DOT Direct IC Watershed
Subwatershed
Impaired Stream Segment
Impaired Water Bodies
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 250 500 750 1,000 Feet

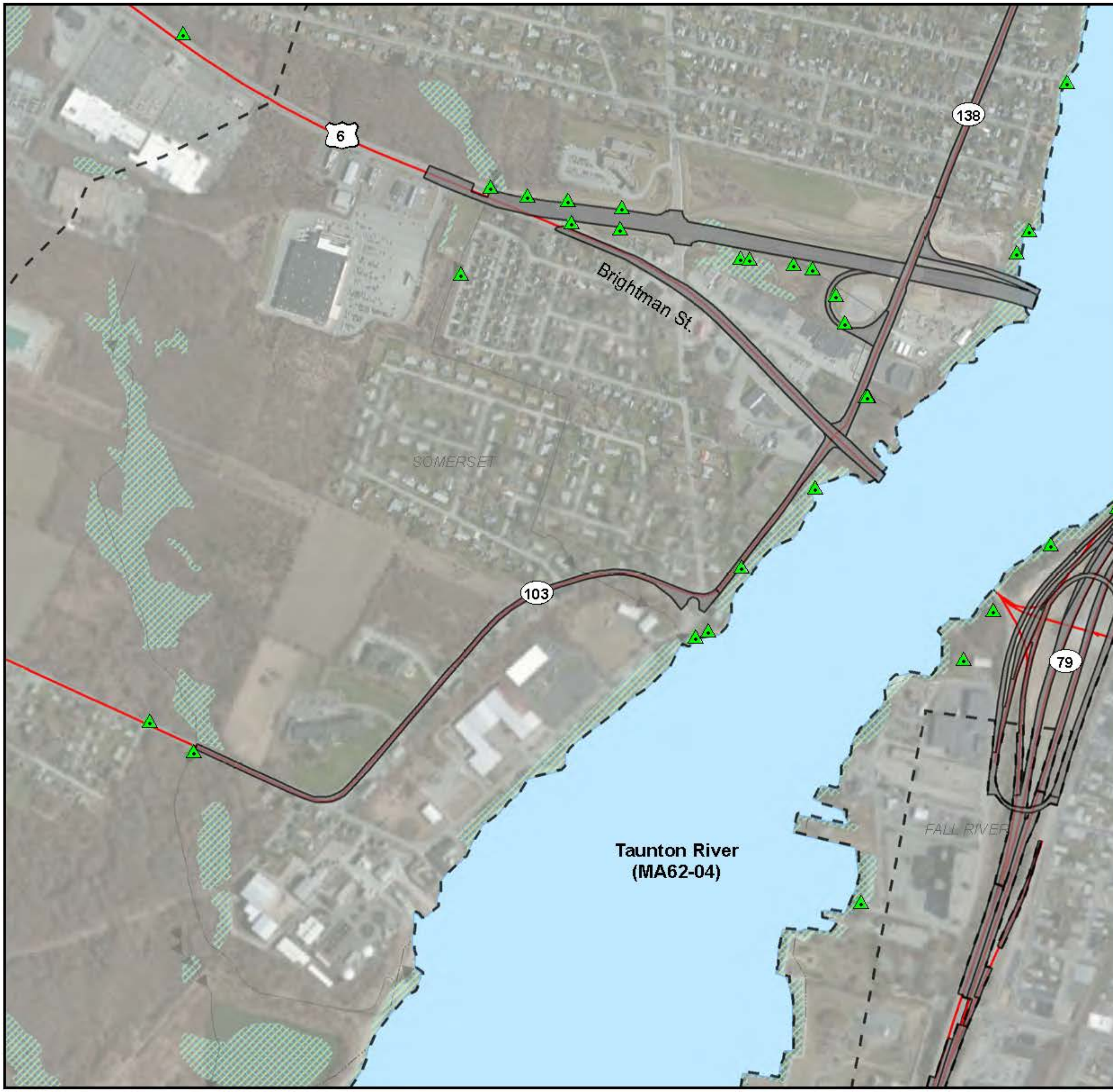
1 inch = 750 feet

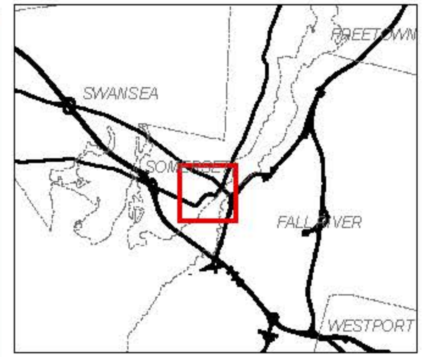
Figure 3B

Taunton River (MA62-04)
MassDOT Directly
Contributing Watershed
Rte. 138, Rte. 6

June 2013

massDOT
Massachusetts Department of Transportation
Highway Division





Stormwater Outfalls
DOT Direct IC Watershed
Subwatershed
Impaired Stream Segment
Impaired Water Bodies
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 250 500 750 1,000 Feet

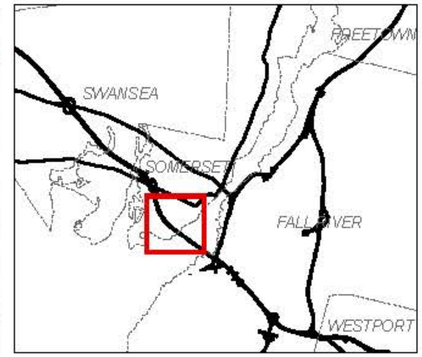
1 inch = 750 feet

Figure 3C

Taunton River (MA62-04)
MassDOT Directly Contributing Watershed
Rte. 6, Rte. 103

June 2013

massDOT
Massachusetts Department of Transportation
Highway Division



- Stormwater Outfalls
- DOT Direct IC Watershed
- Subwatershed
- Impaired Stream Segment
- Impaired Water Bodies
- Non-Impaired Stream Segment
- NWI Wetland Areas
- MassDOT Roads in Urban Areas
- MassDOT Roads
- Town Boundaries

N

0 250 500 750 1,000 Feet

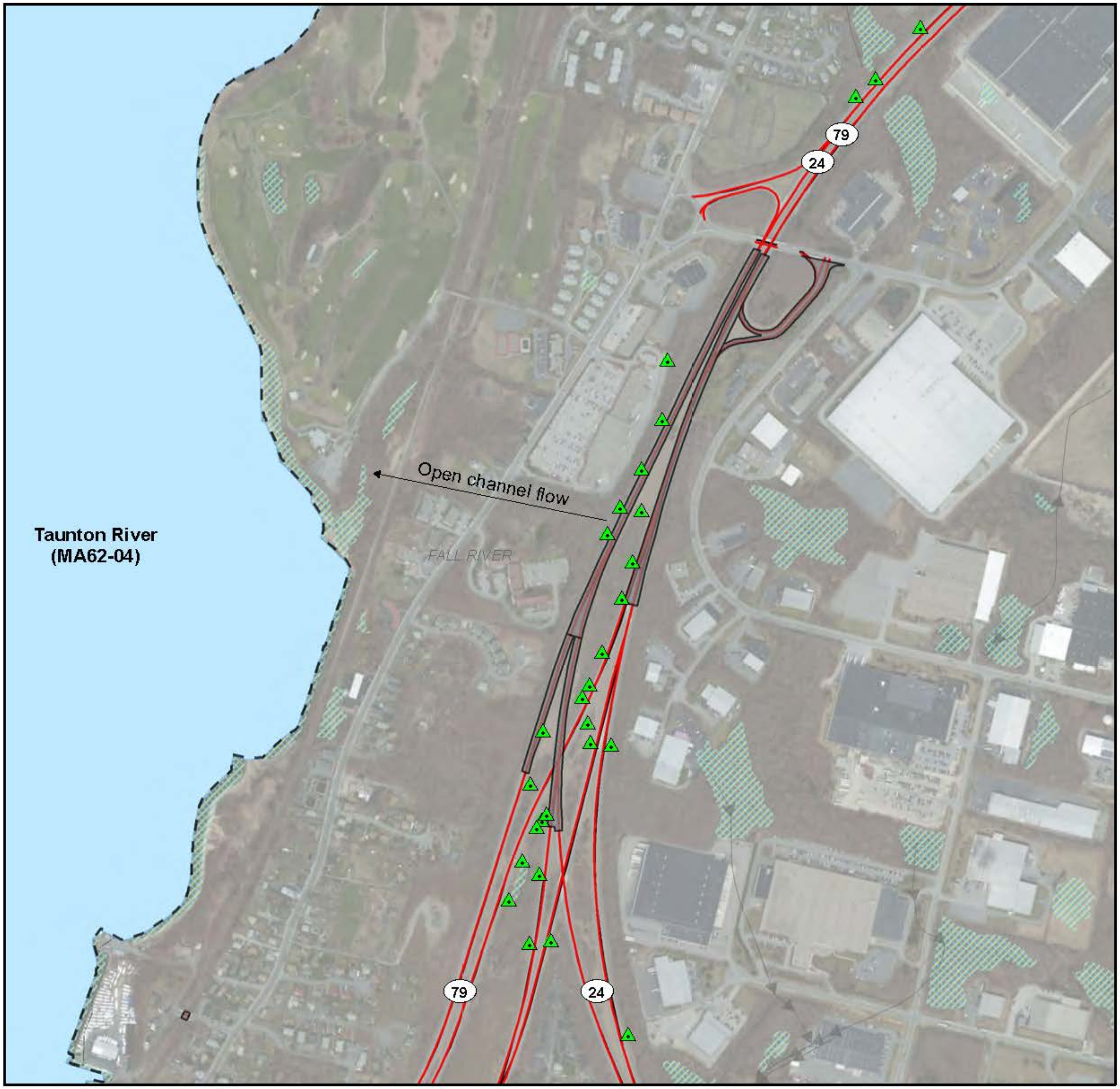
1 inch = 750 feet

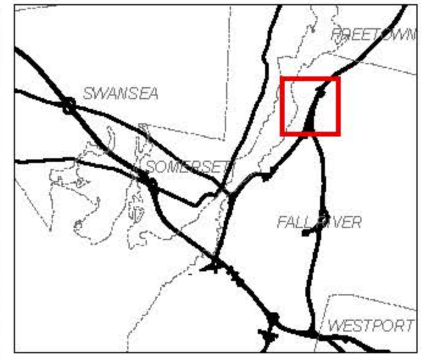
Figure 3D

Taunton River (MA62-04) MassDOT Directly Contributing Watershed I-195, Rte. 103

June 2013

massDOT
Massachusetts Department of Transportation
Highway Division





Stormwater Outfalls
DOT Direct IC Watershed
Subwatershed
Impaired Stream Segment
Impaired Water Bodies
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 250 500 750 1,000 Feet

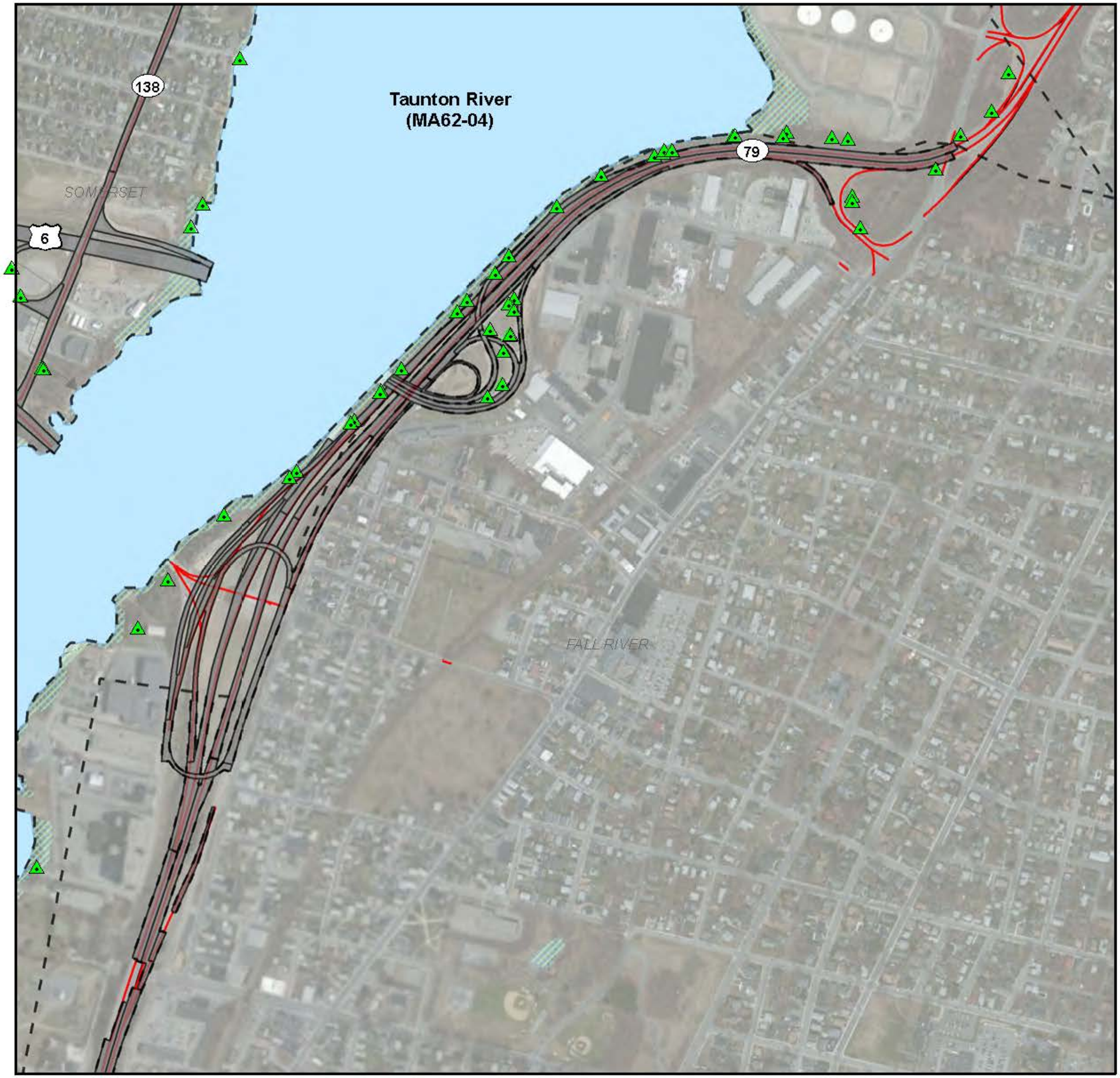
1 inch = 750 feet

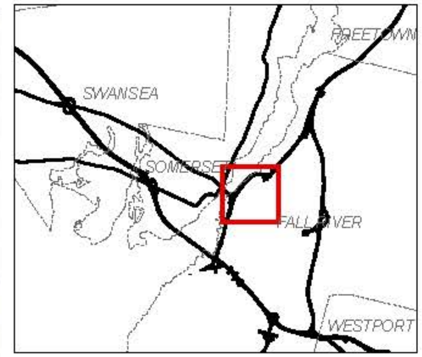
Figure 3E

Taunton River (MA62-04)
MassDOT Directly Contributing Watershed
Rte. 79, Rte. 24

June 2013

massDOT
Massachusetts Department of Transportation
Highway Division





Stormwater Outfalls
DOT Direct IC Watershed
Subwatershed
Impaired Stream Segment
Impaired Water Bodies
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 250 500 750 1,000 Feet

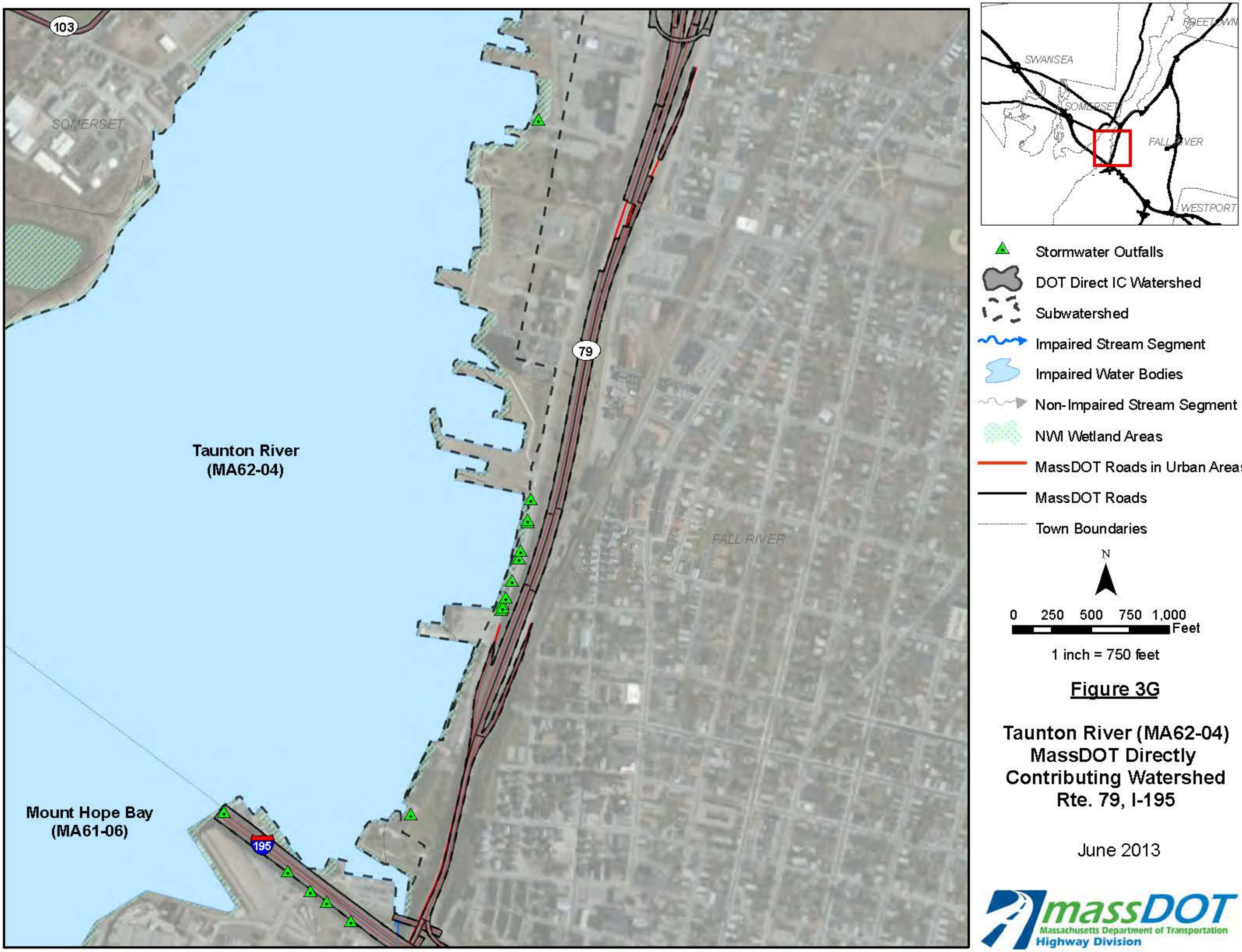
1 inch = 750 feet

Figure 3F

Taunton River (MA62-04) MassDOT Directly Contributing Watershed Rte. 79

June 2013

massDOT
Massachusetts Department of Transportation
Highway Division



Stormwater Outfalls
DOT Direct IC Watershed
Subwatershed
Impaired Stream Segment
Impaired Water Bodies
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 250 500 750 1,000 Feet

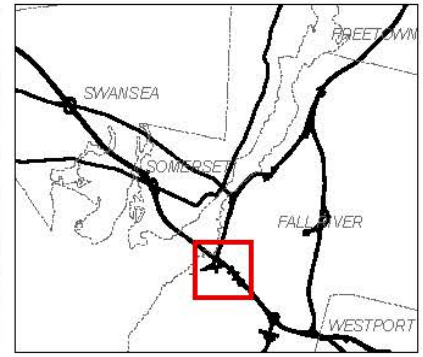
1 inch = 750 feet

Figure 3G

Taunton River (MA62-04)
MassDOT Directly Contributing Watershed
Rte. 79, I-195

June 2013

massDOT
Massachusetts Department of Transportation
Highway Division



Stormwater Outfalls
DOT Direct IC Watershed
Subwatershed
Impaired Stream Segment
Impaired Water Bodies
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 250 500 750 1,000 Feet

1 inch = 750 feet

Figure 3G

**Taunton River (MA62-04)
MassDOT Directly
Contributing Watershed
I-195**

June 2013

massDOT
Massachusetts Department of Transportation
Highway Division

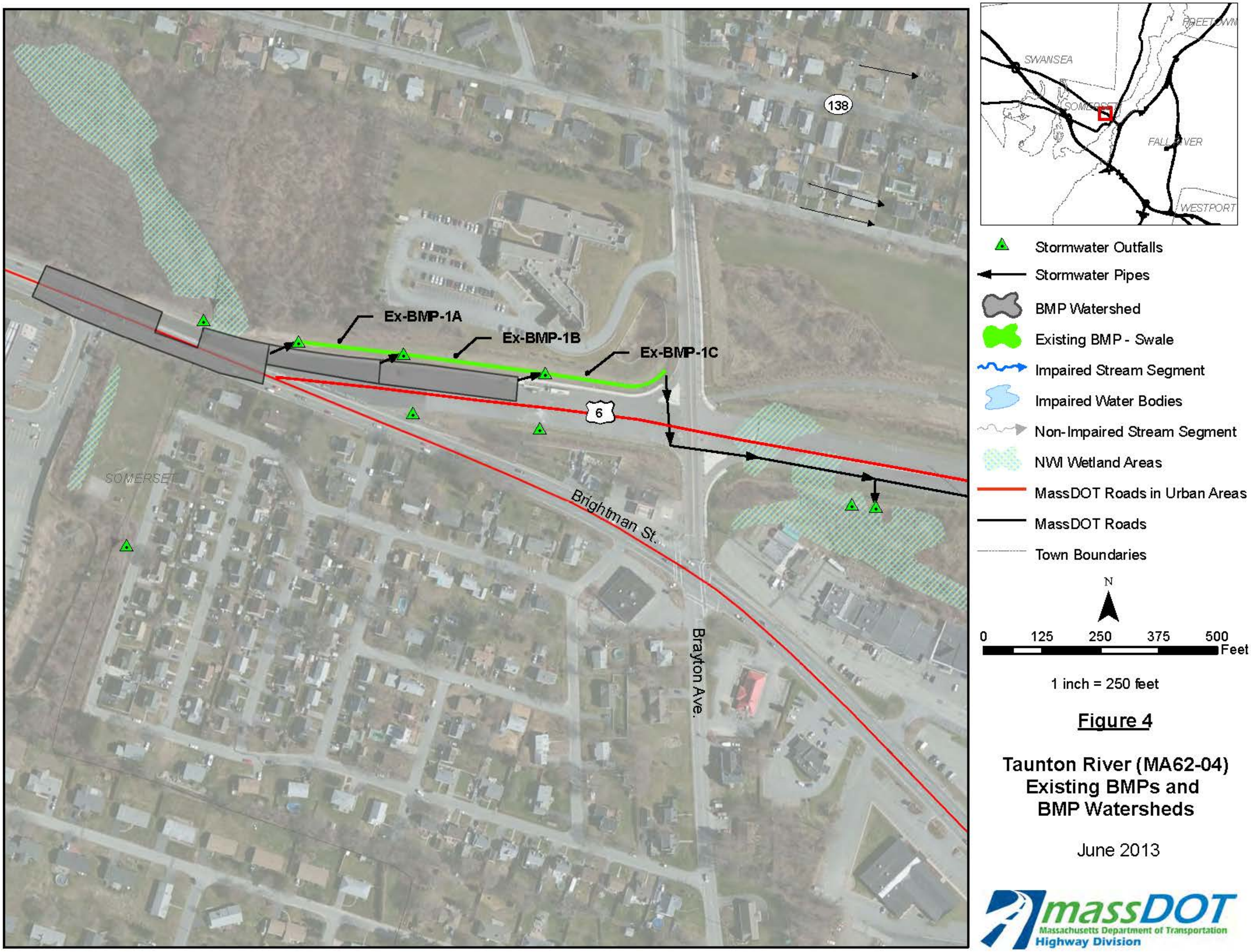
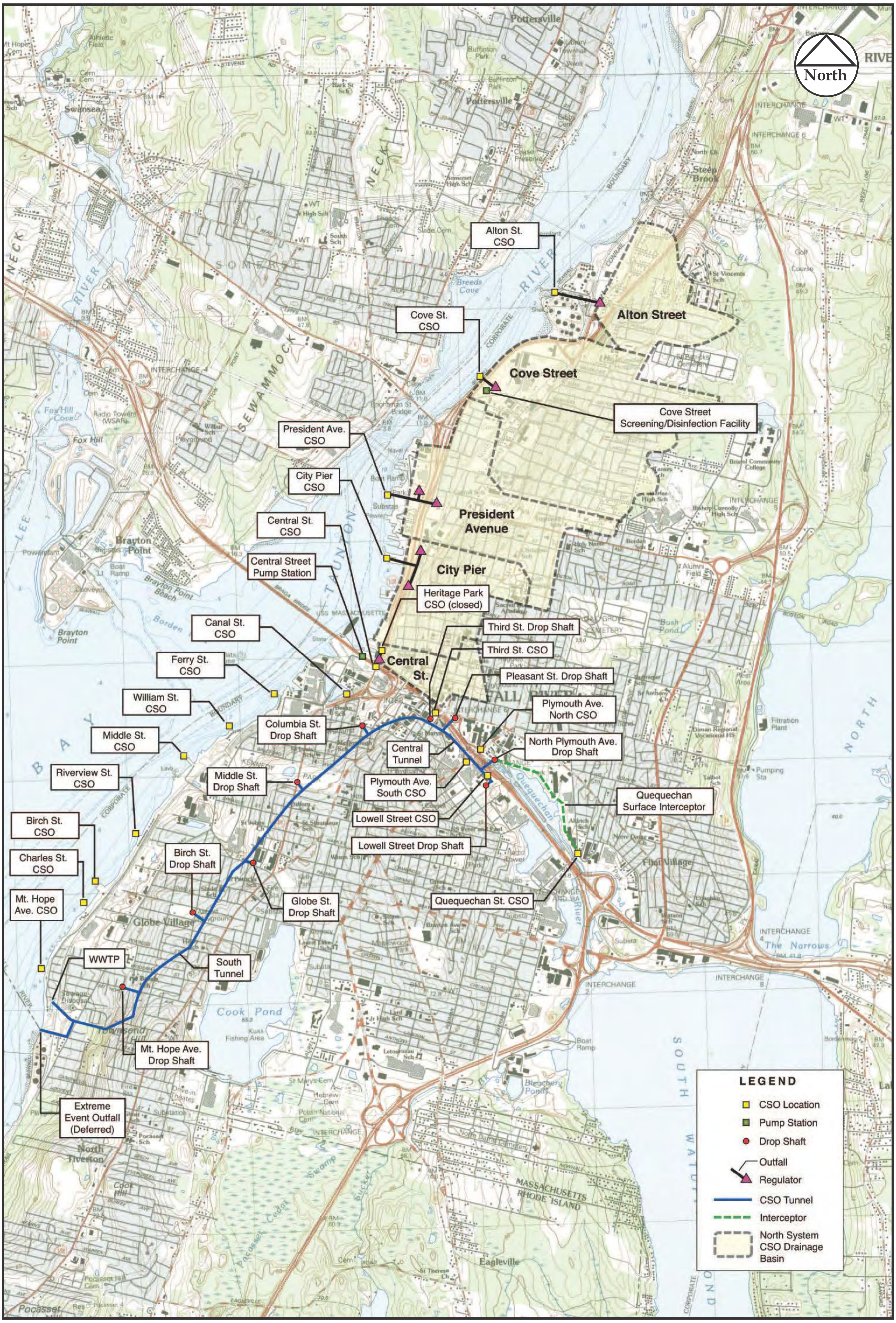


Figure 4

Taunton River (MA62-04) Existing BMPs and BMP Watersheds

June 2013

Appendix



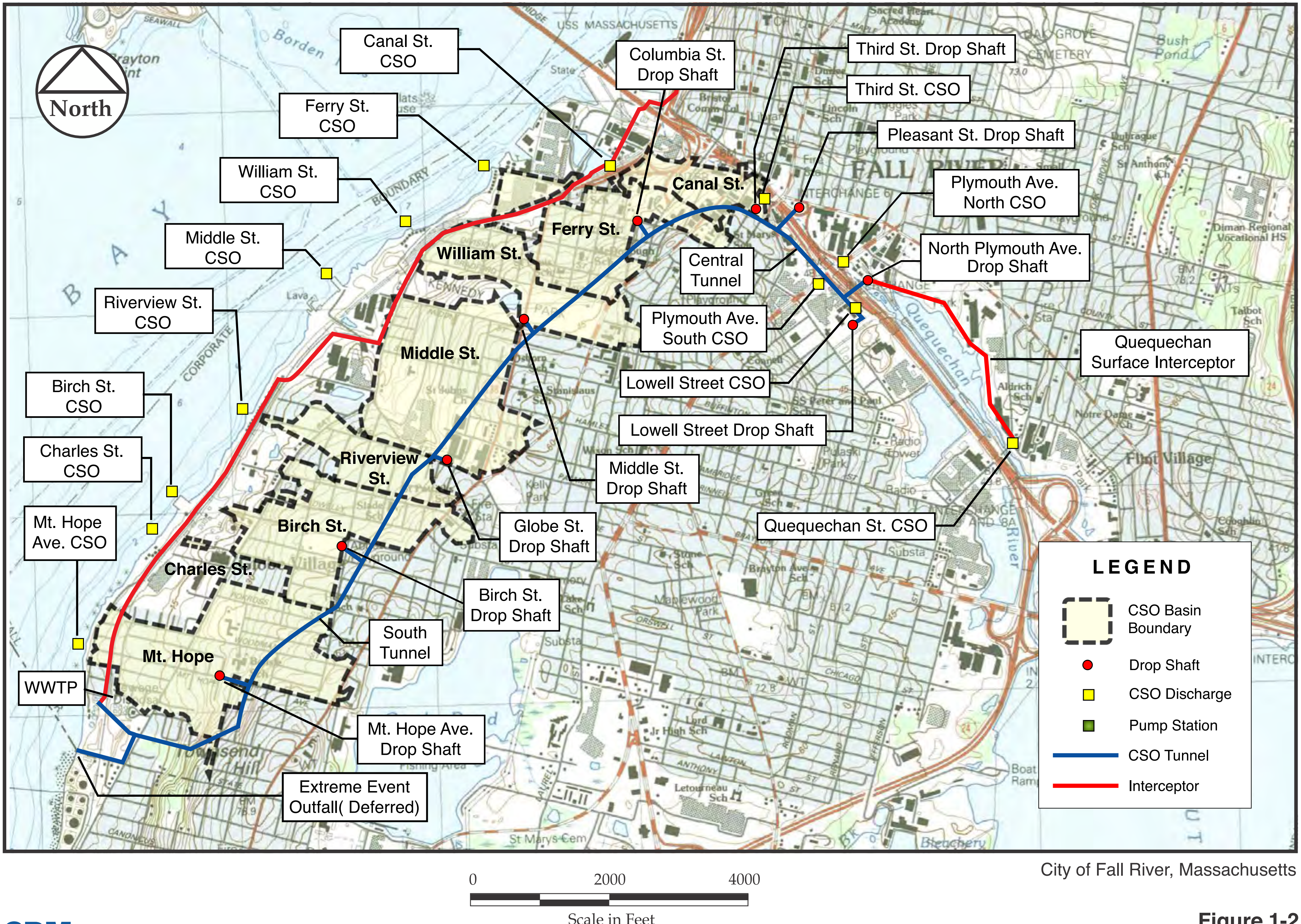
0 2000 4000

Scale in Feet

City of Fall River, Massachusetts

Figure 1-1
Fall River CSO Abatement Program
Modified Tunnel Plan

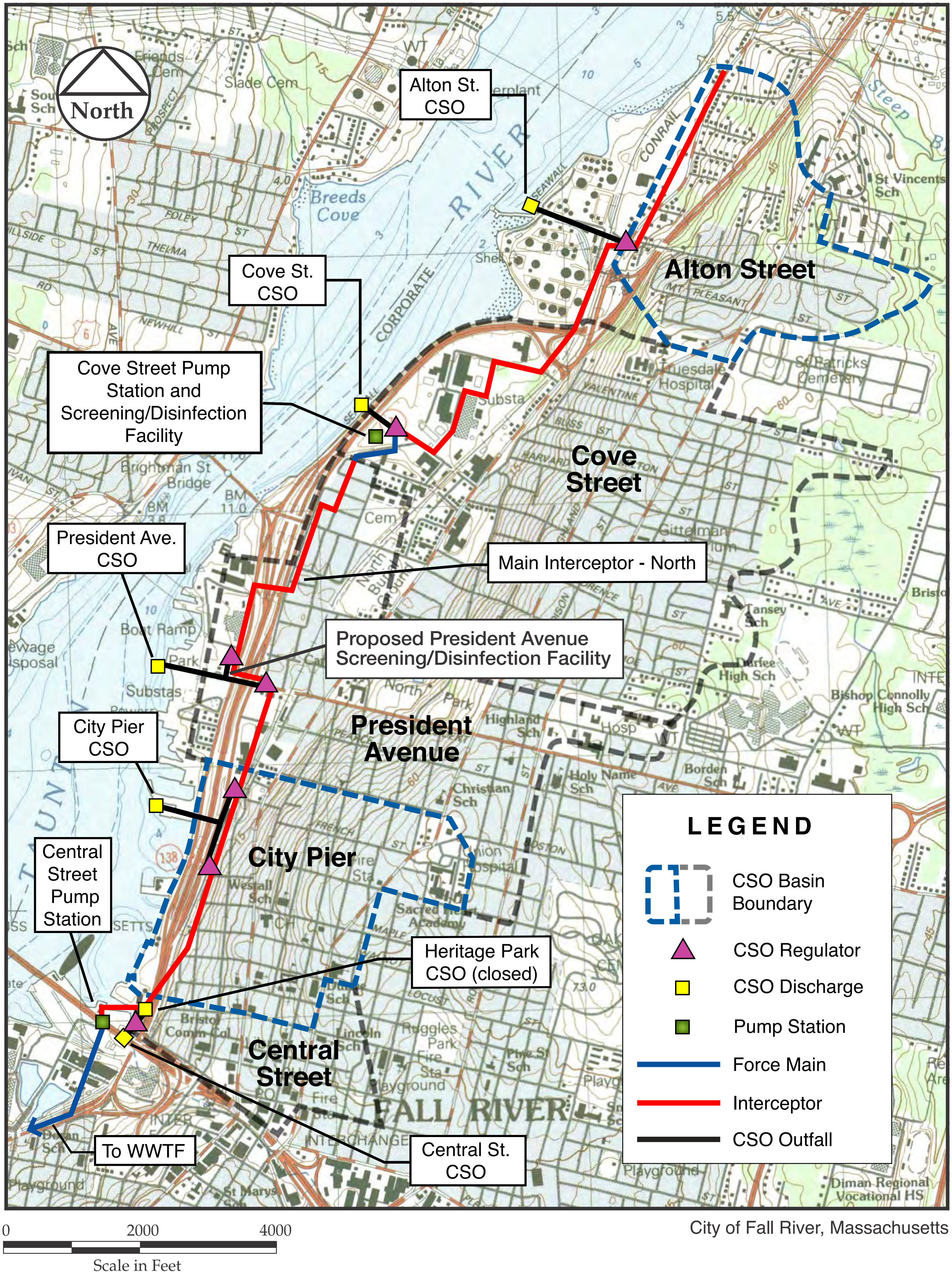
CDM Smith



City of Fall River, Massachusetts

Figure 1-2
South System Overview Plan

CDM Smith



City of Fall River, Massachusetts

CDM Smith

Figure 1-3
North System Overview Plan

Impaired Waters Assessment for Charles River (MA72-03)

Impaired Waterbody

Name: Charles River

Location: Hopedale and Mendon, Massachusetts

Water Body ID: MA72-03

Impairments

According to the MassDEP Final Year 2012 Integrated List of Waters, this segment is listed under Category 5 as impaired for DDT, dissolved oxygen saturation, Escherichia coli, excess algal growth, organic enrichment (sewage) biological indicators, and phosphorus. This assessment does not address the DDT impairment as DDT is not related to stormwater. In accordance to MassDOT's Impaired Waters Assessment for Impaired Waters with Impairments Unrelated to Stormwater in the December 8, 2012 EPA submittal, DDT impairment is not related to stormwater.

Two TMDL reports have been finalized that address the Charles River watershed, which includes this segment.

- *Final Pathogens TMDL for the Charles River Watershed (CN 156.0)* addressing Escherichia coli
- *TMDL for Nutrients in the Upper/Middle Charles River (CN 272.0)* addressing dissolved oxygen saturation, excess algal growth, organic enrichment (sewage) biological indicators, and total phosphorus.

The *Charles River Watershed 2002-2006 Water Quality Assessment Report* lists municipal point source discharge among the main sources of pollutants to this segment. Other causes of impairments in the subwatershed include urban runoff/stormwater and discharges from municipal separate from storm sewer systems.

Relevant Water Quality Standards

- Water Body Classification: B
- 301 CMR § 4.05 (3)(b) – *Class B. These waters are designed as habitat for fish, other aquatic life, and wildlife, including for their reproduction, migration, growth, and other critical functions, and for primary and secondary contact recreation. Where designated in 314 CMR 4.06, they shall be suitable as a source of public water supply with appropriate treatment ("Treated Water Supply"). Class B waters shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value.*
- 314 CMR § 4.05 (3)(b)(1) – *Dissolved Oxygen. a. Shall not be less than 6.0 mg/l in cold water fisheries and not less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.*

- 314 CMR § 4.05 (3)(b)(4) – *Bacteria.*
  a. At bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: where E. coli is the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml; alternatively, where enterococci are the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no single sample taken during the bathing season shall exceed 61 colonies per 100 ml;
  b. for other waters and, during the non bathing season, for waters at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: the geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml; alternatively, the geometric mean of all enterococci samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 61 colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department;
- 314 CMR § 4.05 (5)(a) – *Aesthetics. All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.*
- 314 CMR § 4.05 (5)(c) – *Nutrients. Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established by the Department pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.*
- 314 CMR § 4.05 (5)(e) - *Toxic Pollutants. All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife. For pollutants not otherwise listed in 314 CMR 4.00, the National Recommended Water Quality Criteria: 2002, EPA 822R-02-047, November 2002 published by EPA pursuant to Section 304(a) of the Federal Water Pollution Control Act, are the allowable receiving water concentrations for the affected waters, unless the Department either establishes a site specific criterion or determines that naturally occurring background concentrations are higher. Where the Department determines that naturally occurring background concentrations are higher, those concentrations shall be the allowable receiving water concentrations. The Department shall use the water quality criteria for the protection of aquatic life expressed in terms of the dissolved fraction of metals when EPA's 304(a) recommended criteria provide for use of the dissolved fraction. The EPA recommended criteria based on total recoverable metals shall be converted to dissolved metals using EPA's published conversion factors. Permit limits will be written in terms of total recoverable metals. Translation from dissolved metals criteria to total recoverable metals permit limits will be based on EPA's conversion factors or other methods approved by the Department. The Department may establish site specific criteria for toxic pollutants based on site specific considerations.*

Summary

MassDOT has assessed stormwater impacts from MassDOT properties discharging to the Charles River using BMP 7R to address the Phosphorus and Pathogen TMDLs. The following sections describe the methodology for these assessments. Based on this assessment, MassDOT determined that a 4.3-pound reduction in annual phosphorus loading would be needed to meet the targets for this watershed.

No existing stormwater best management practices (BMPs) are present to reduce annual phosphorus loads from MassDOT directly discharging properties. To reduce MassDOT's contribution to impairments within the Charles River watershed, MassDOT proposes 2 BMPs: one sedimentation basin and one leaching basin. These BMPs will provide 1.3 lbs/yr of phosphorus load reduction. Site constraints limit the areas available for constructing additional BMPs and therefore the target reduction could not be fully met.

See the **Proposed Mitigation Plan** section of this assessment for more information.

Reductions Applied to MassDOT Direct Watershed

	Phosphorus Load (Pounds/year)
MassDOT's Area Directly Contributing to Impaired Segment	5.6
Target Reduction	4.3
Reduction Provided in Proposed Conditions	1.3

Site Description

The Charles River Segment MA72-03 is located within the Towns of Hopedale, Milford, Bellingham, and Mendon, Massachusetts. The upstream end of Segment MA72-03 originates at the outlet of the Milford Wastewater Treatment Facility in Hopedale. The Charles River flows southeast 3.4 miles along the town boundaries of Milford and Hopedale, Hopedale and Bellingham, and Bellingham and Mendon to the outlet of Box Pond in Bellingham (see Figure 1). The river is impaired due to DDT, dissolved oxygen saturation, Escherichia coli, excess algal growth, organic enrichment sewage biological indicators, and total phosphorus. According to the 2006 Water Quality Assessment Report, the estimated percent impervious cover for this subwatershed is 14.4% and the primary land uses of the 14.7 square mile subwatershed (excluding water) are residential (36%), forest (43%), and open land (7%).

The only MassDOT owned property in the subwatershed to Segment MA72-03 is South Main Street/Cape Road (Route 140) (see Figure 1). Route 140 is west of and parallel to the Charles River in this area. Route 140 is an urban principal arterial which carries one travel lane in each direction. For the most part, Route 140 is curbed and stormwater flows into catch basins along the roadway to outfalls adjacent to the roadway. The extent of MassDOT right-of-way in this area is not known at this time, but abutting residential properties suggest the right-of-way is limited. Land uses along Route 140 are mostly residential with some retail and community related services. One large industrial facility, Copart's, is located along Route 140 toward the southern end of Segment MA72-03, in Bellingham.

Stormwater runoff from Route 140, from the beginning of Segment MA72-03 to approximately 2,000 feet south of the Hartford Avenue intersection and from the intersection of Bellingham Street to the segment end, was determined to not be directly discharging to the Charles River. Stormwater in this area is discharged to outfalls adjacent to the roadway which are approximately

2,000 feet from the Charles River and flows through wooded natural systems before reaching the Charles River. The intersection of Route 140 and Hartford Avenue was recently reconstructed (MassDOT Project# 603359). As a result of this project, all stormwater from Route 140 is conveyed to a plunge pool which flows to a wetland replication area along Hartford Avenue west of Route 140. This location is on the opposite side of Route 140 from the Charles River and the wetland replication area does not discharge to the Charles River.

South of this intersection, approximately 1,600 linear feet of roadway drains to an outfall just north of the Mendon Mennonite Church parking lot. The outfall is in poor condition and has collapsed. Erosion at this outfall has formed a small plunge pool at the headwall. Stormwater flows for approximately 500 feet down a steep wooded slope before reaching the Charles River.

South of this outfall, stormwater from another approximately 1,600 linear feet of roadway flows into a closed drainage system that outlets to the western side of the roadway. Stormwater then enters a pipe which likely carries the water under the roadway, then under the large Copart's facility, and to the Charles River. Figure 2 delineates the MassDOT directly discharging areas for this segment.

No existing BMPs treating stormwater from MassDOT properties were found.

Assessment under BMP 7R for Impairments Addressed by Phosphorus TMDL [CN 272.0]

The Total Maximum Daily Load (TMDL) for Nutrients in the Upper/Middle Charles River, Massachusetts (CN 272.0) addresses the dissolved oxygen, excessive algal growth, organic enrichment (sewage) biological indicators and total phosphorus impairments for this water body. Therefore, MassDOT assessed the contribution of phosphorus from MassDOT properties to this water body using the approach described in BMP 7R of MassDOT's Stormwater Management Plan (TMDL Watershed Review), which applies to impairments that have been addressed by a TMDL.

- Pollutant of Concern: Phosphorus
  - Impairment Addressed: dissolved oxygen, nutrient/eutrophication biological indicators , excessive algal growth, organic enrichment (sewage) biological indicators and total phosphorus
  - Applicable Waste Load Allocation (WLA): See Table ES-3 of the Nutrient TMDL.
    - Description of Associated Land Use: Transportation
    - Transportation Land Use Current Load (TP): 2,167 kilograms per year (kg/yr)
    - Transportation Land Use WLA (TP): 759 kg/yr
    - Commercial/Industrial/Transportation Area in Watershed: 15.9 sq miles or 5.9% (reported in Phase III Calibration Report Table 5. Transportation not separated from Commercial/Industrial during TMDL analysis)
    - Commercial/Industrial/Transportation Land Use Areal WLA: 0.72 kilograms per hectare per year (kg/ha/yr) (0.64 pounds per acre per year (lbs/ac/yr)) (calculated)
  - Applicable Recommendations: Section 7.2 Nutrient TMDL Final Report
    - Management of Stormwater Systems - Page 87 of the Nutrient TMDL

      "Comprehensive programs will be necessary to achieve the phosphorus reduction and water quality goals of this TMDL. Programs should build upon existing stormwater management to accomplish the following tasks:

- characterize the drainage areas that contribute to discharges requiring permit coverage under the Permittee's jurisdiction
- implement a comprehensive Illicit Discharge Detection and Elimination (IDDE) program (where appropriate)
- prioritize source areas for stormwater management and control
- identify site-specific and regional opportunities for implementation of BMPs
- include the necessary structural and non-structural BMPs that, upon implementation, will achieve reductions in phosphorus loadings from the NPDES covered drainage areas that are consistent with the phosphorus load reductions identified in this TMDL."

To complete the BMP 7R Phosphorus Assessment, MassDOT used a site-specific, continuous, long-term hydrologic and pollutant simulation model (the assessment model) to estimate annual median pollutant loads from its property and treatment through both existing and proposed BMPs, if present. The assessment model was run for a 10-year period using hourly Boston rainfall data to capture a range of meteorological conditions and estimate annual median pollutant loads. The pollutant loading portion of the assessment model was calibrated to match pollutant runoff data from the USGS Highway-Runoff Database (Version 1.0, September 2009). The assessment model directly evaluates BMP effects on hydrology (detention, infiltration) and pollutant loads (losses through infiltration, settling, filtration, and biological treatment). For a more detailed description of this approach, see Long-Term Continuous Simulation for Pollutant Loading and Treatment for MassDOT Impaired Waters Program (MassDOT, June 2012).

The following table summarizes the assessment model results for the MassDOT directly contributing watershed to the Charles River for existing conditions.

Annual Watershed Phosphorus Loading under Existing Conditions

Watershed/ BMP ID	Watershed Size (Acres)	Pre- BMP Annual Load (pounds/year)	Post-BMP Annual Load (pounds/year)	Estimated Annual Removal Efficiency
Total Directly Contributing MassDOT Watershed	2.0	5.6	5.6	0%

The assessment model predicts that the existing annual median phosphorus load from the MassDOT directly contributing watershed is approximately 5.6 pounds. Based on the TMDL, MassDOT's WLA target should be 0.72 kg/ha/yr (0.64 lbs/ac/yr) or 1.3 pounds of phosphorus per year for MassDOT's directly contributing watershed.

BMP 7R Phosphorus Mitigation Plan

Under existing conditions, MassDOT's estimated directly contributing annual phosphorus load exceeds the TMDL WLA. To mitigate this load, MassDOT will implement stormwater BMPs to the maximum extent given the site constraints.

This assessment has identified locations for potential stormwater BMPs and estimated their potential annual phosphorus removal performance. The Proposed Mitigation Plan section of this assessment describes the BMPs and their estimated annual load reduction performance.

Assessment under BMP 7R for Pathogens

The *Pathogen Total Maximum Daily Load (TMDL) for the Charles River Watershed (CN 0156.0)* covers the Charles River. The TMDL states that sources of indicator bacteria in the Charles River Watershed were found to be many and varied. The TMDL lists sources as including failing septic systems, combined sewer overflows (CSO), sanitary sewer overflows (SSO), sewer pipes connected to storm drains, certain recreational activities, wildlife including birds along with domestic pets and animals, and direct overland stormwater runoff.

In addition, as stated on page 12 of the TMDL, *Many of the impacts associated with increased impervious surface area also result in changes in pathogen loading (e.g., increased sediment loading can result in increased pathogen loading). In addition to increased impervious surface impacts, increased human and pet densities in developed areas increase potential fecal contamination. Furthermore, stormwater drainage systems and associated stormwater culverts and outfall pipes often result in the channelization of streams which leads to less attenuation of pathogen pollution.*

Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by orders of magnitude within a given storm event (MassDEP, 2009). Therefore, it is difficult to predict stormwater pathogen concentrations with accuracy. Due to this difficulty, MassDOT is not conducting site specific assessments of loading at each location impaired for pathogens as part of this Retrofit Program. However, MassDOT recognizes that its roadways, especially in urbanized areas, contribute to the pathogen impairment of the Charles River Watershed and has performed a general assessment and developed a mitigation plan as described below.

BMP 7R Pathogens Assessment

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT has reviewed its existing programs and their consistency with the Pathogen TMDL for the Charles River Watershed recommendations as well as the draft EPA National Pollution Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit requirements for the North Coastal Watershed.

The Pathogen TMDL for the Charles River Watershed recognizes that mitigation for pathogen impairments is difficult to address and emphasizes the need for an iterative adaptive management approach. The Executive Summary of the TMDL, page xi, states:

> *TMDL implementation to achieve [the pathogen reduction goals] should be an iterative process with selection and implementation of mitigation measures followed by monitoring to determine the extent of water quality improvement realized. Recommended TMDL implementation measures include identification and elimination of prohibited sources such as leaky or improperly connected sanitary sewer flows and best management practices to mitigate stormwater runoff volume.*

The existing NPDES MS4 permit that covers MassDOT stormwater discharges does not provide guidance on what measures are necessary to comply with the Pathogen TMDL for the Charles River Watershed. The fact sheet for the draft permit for MS4 stormwater discharges for the North Coastal Watershed contains some guidance on what measures EPA has determined necessary to be consistent with the Pathogen TMDL for the Charles River Watershed. Page 36 of the fact sheet states:

> *Instead of a numeric limitation for bacteria, the draft permit includes requirements for MS4s to provide education to pet owners and owners of septic systems, to implement a comprehensive illicit discharge detection and elimination program that addresses not only sources of pathogens but also sources of phosphorus,*

> *and to implement programs to address water fowl. In addition, although entitled "Phosphorus Control Plan" most of the actions needed to develop and implement a successful PCP are also effective in supporting the achievement of the WLA for the Charles River pathogen TMDL.*

As discussed above, both the Pathogen TMDL for the Charles River Watershed and the draft North Coastal Watershed MS4 permit state that identification of illicit discharges and addressing stormwater volumes and pollutants, such as phosphorus, are the best approaches to mitigate the pathogen impairments. MassDOT has developed a mitigation plan, described below, to address the pathogen impairments using guidance from these two documents.

BMP 7R Pathogens Mitigation Plan

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Storm Water Management Plan (SWMP) including educational programs, illicit connection review and source control. The specific non-structural BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In
- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

MassDOT will be implementing a pet waste management program at its rest stops, including those that have discharges to pathogen impaired waters. In addition, MassDOT has requested to be covered under an Individual MS4 permit for the next permit term. A future individual permit may contain additional programmatic BMPs to address pathogens.

The structural BMPs that will be considered to reduce phosphorus loading and the effects of IC would also reduce pathogen loads. See the Proposed Mitigation Plan section of this assessment for more information on specific BMPs proposed as part of this assessment. MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations.

Proposed Mitigation Plan to Address Phosphorus

MassDOT is reviewing the Charles River Basin as an entire watershed and has committed to constructing stormwater BMP retrofit projects to address impaired waters. During this assessment phase of the Impaired Waters Program, MassDOT has focused on directly contributing areas and identified BMPs that can be constructed entirely on MassDOT property without resulting in substantial wetland impacts or result in an adverse impact on historical or archeological resources. Projects that meet these requirements can utilize the Federal Highway Administration's Alternative Contracting mechanism (SEP-14) created for this program. MassDOT will advance designs for BMPs where practicable in the watershed above and beyond the target mitigation to compensate for areas where site constraints prohibit the construction of stormwater BMPs.

As an overall program, MassDOT will re-evaluate the potential need for structural BMPs to address pollutant loading when roadwork is conducted for programmed projects in the area. Further work by MassDOT on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. During this assessment analysis, potential BMPs beyond the scope of the impaired waters program were identified and can be reviewed during future projects.

In this assessment, MassDOT has identified 2 stormwater BMPs that may be implemented on MassDOT property to reduce annual phosphorus loads. These BMPs include one sedimentation basin and one leaching basin, shown with their estimated contributing drainage areas in Figure 3. These locations were chosen based on a cursory review of the drainage systems, topography, property lines, and other site constraints. Detailed survey, complete utility location information, official property ownership, and soils evaluation information will influence the final selection and design of BMPs. Below is a description of these potential proposed BMPs.

PR-BMP 1
Proposed BMP 1 is a sedimentation basin at the collapsed outfall on the eastern side of Route 140 in Mendon. From preliminary review of the site, the outfall could be repaired and a sedimentation basin could be constructed at the outfall. The basin would slow stormwater flow, allow sediments to fall out, and promote some infiltration before stormwater flows down the wooded slope to the Charles River. The limits MassDOT right-of-way at this location will need to be investigated to determine the feasibility of this BMP.

PR-BMP-2
Proposed BMP 2 is a leaching catch basin on the eastern side of Route 140, in front of the Copart facility in Mendon. Route 140 runoff from the location of BMP 1 south flows down a steep hill to existing catch basins along Route 140. The existing catch basins could be retrofitted to divert water to a leaching basin in the shoulder of the roadway to promote infiltration.

The existing conditions assessment was modified to develop a proposed conditions simulation including proposed BMPs, estimated potential contributing drainage areas and rough sizing of the proposed BMPs. The following table shows the proposed BMPs, their MassDOT drainage areas, and estimated phosphorus reductions. The assessment model identifies each BMP by unique ID, which is included in the table below.

Proposed Mitigation

Watershed / BMP ID	BMP Type	Estimated Contributing Watershed Phosphorus Load Pre-BMP (lbs/yr)	Estimated Percent Reduction of Phosphorus	Estimated Reduction of Phosphorus (lbs/yr)
PR 01 (1.7)	Sedimentation Basin	2.9	32%	0.9
PR 02 (2.7)	Leaching Basin	2.7	15%	0.4
Total			**24%**	**1.3**

The proposed BMPs would result in an estimated 1.3 pounds phosphorus reduction on an annual median basis resulting in a total load of 4.3 pounds per year, compared to the WLA of 1.3 pounds per year.

The amount of BMPs proposed is limited due to the right-of-way area owned by MassDOT within the MassDOT directly discharging area to the Charles River. Through the retrofit program, construction of BMPs can only be proposed within MassDOTs right-of-way, and the existing right of way area is not suitable for the conditions needed for BMP installation. MassDOT will continue to ensure proper non-structural BMPs are being implemented within the watershed of the Charles River, including regular roadway and drainage system maintenance, erosion and sedimentation control, and outreach and education.

In addition, BMP implementation through MassDOT's programmed projects are carefully evaluated and implemented where practicable, and documented through the MassDOT Water Quality Data Form. The potential for BMPs outside of MassDOT property will be reviewed during the design phase of these projects and through ongoing partnerships with other state and local entities.

Conclusions

MassDOT has assessed stormwater impacts from MassDOT properties directly discharging to the Charles River using BMP 7R to address the Phosphorus and Pathogen TMDLs. This assessment found that no existing BMPs treat stormwater discharges from MassDOT properties. MassDOT proposes to install 2 BMPs to reduce MassDOT's contribution to impairments within the Charles River watershed.

The following table summarizes the total phosphorus reductions proposed in Charles River's watershed.

Reductions Applied to MassDOT Direct Watershed

	Phosphorus Load (lbs/yr)
MassDOT's Area Directly Contributing to Impaired Segment	5.6
Target Reduction	4.3
Reduction Provided in Proposed Conditions	1.3

The proposed BMPs would reduce phosphorus loads by 1.3 lbs/yr, which is less than the target but reflects the maximum amount practical given the limited undeveloped MassDOT right-of-way within the Charles River directly discharging area.

MassDOT will proceed to the design phase to develop design and construction plans for the proposed BMPs as part of the MassDOT Impaired Waters Program. The project designers will gather additional information in this phase, such as soil data and site survey to further refine the proposed BMPs.

As an overall program, MassDOT will re-evaluate the potential need for structural BMPs to address pollutant loading when roadwork is conducted as programmed projects for the area. Further work by MassDOT on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to address impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting targets, plans for construction of proposed BMPs and finalized assessments including reduction achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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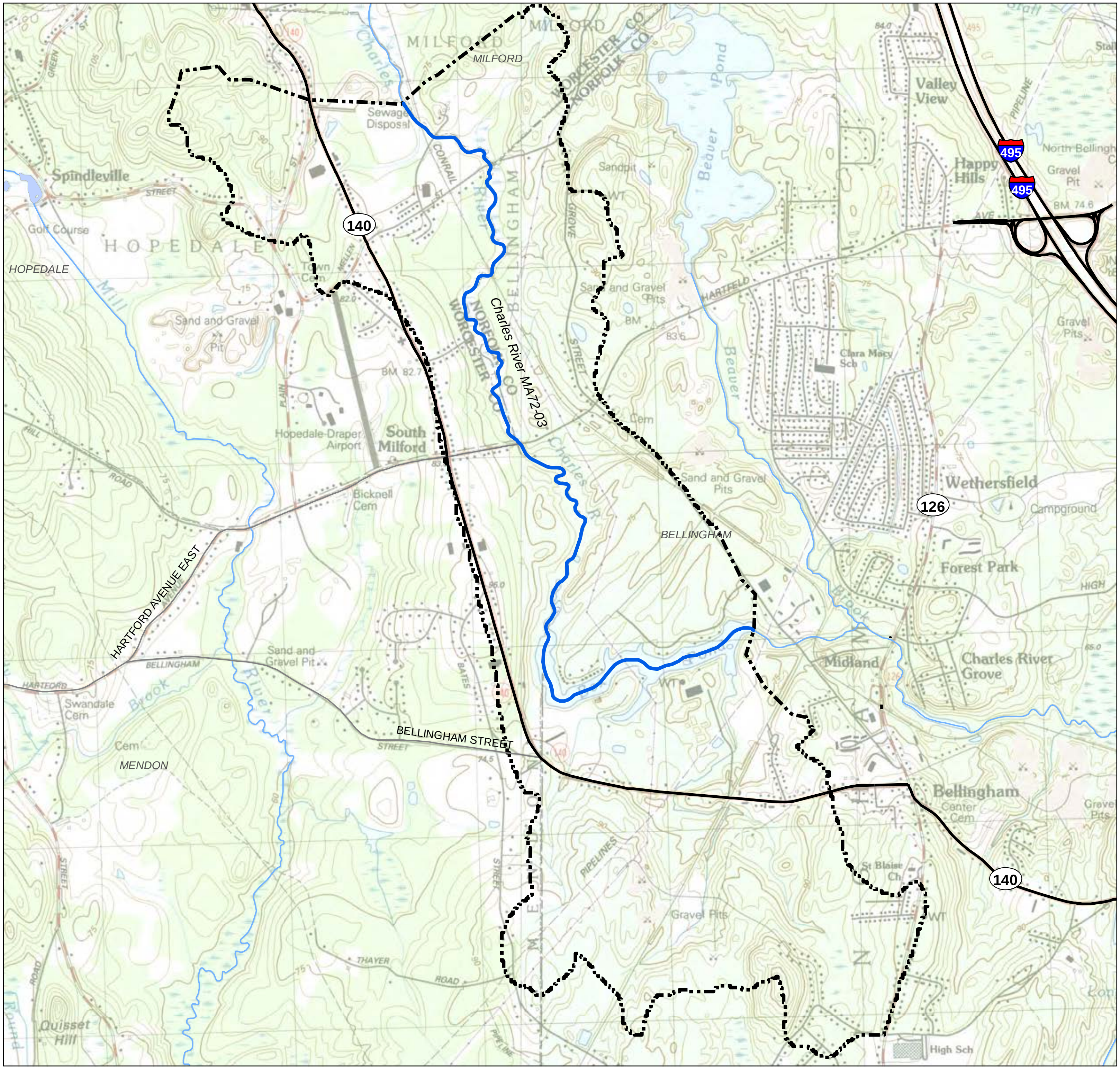

Figure 1

Charles River (MA72-03) Watersheds

June 2013

massDOT Massachusetts Department of Transportation Highway Division

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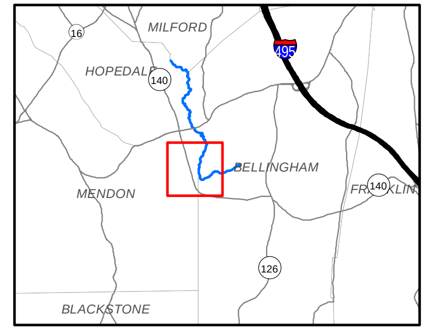

MassDOT Roadways

Assessed Segment

MassDOT Directly Discharging Watershed

N

0 500 1,000 Feet

Figure 2

Charles River (MA72-03) Directly Contributing MassDOT Watershed

June 2013

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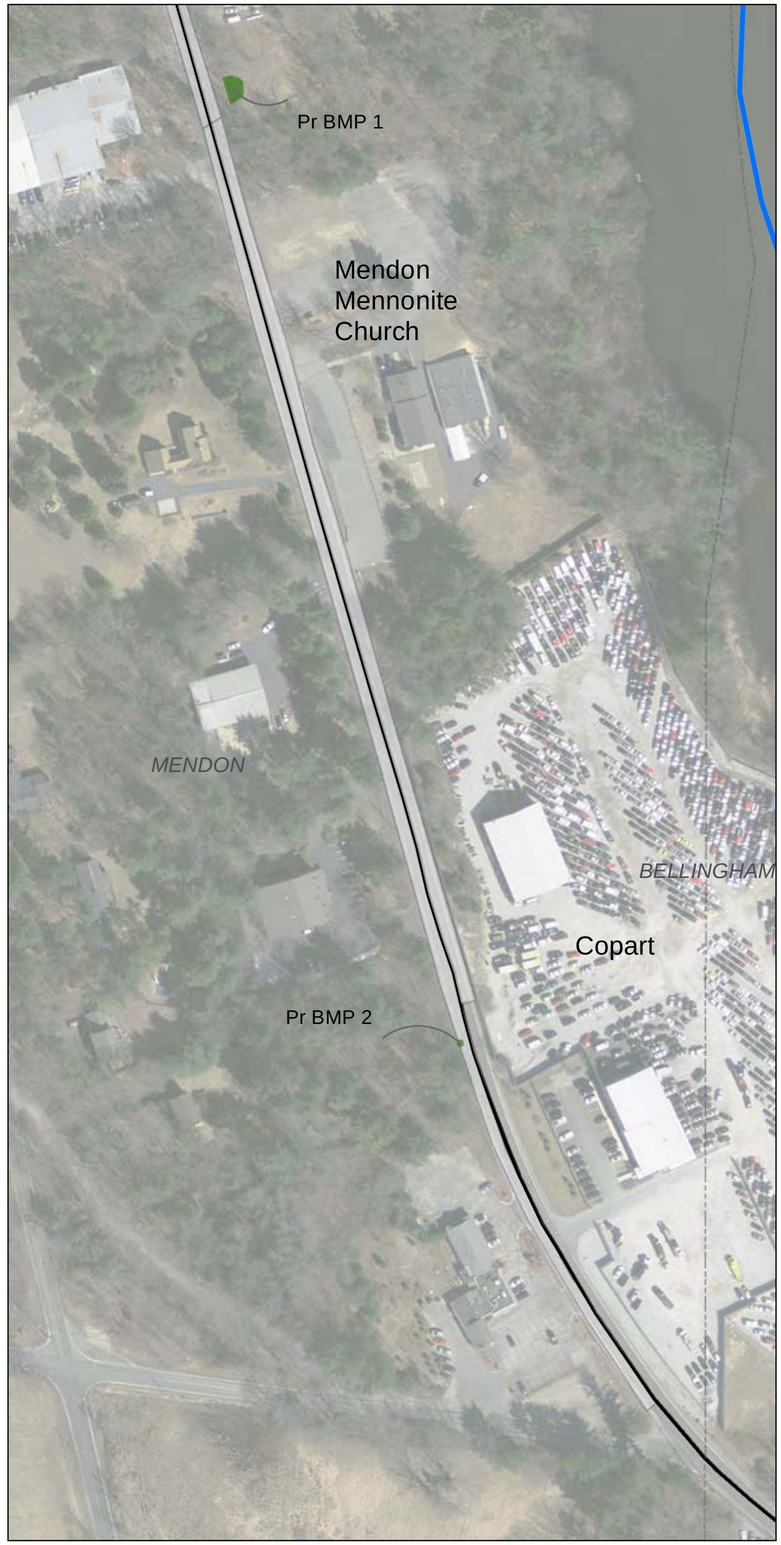

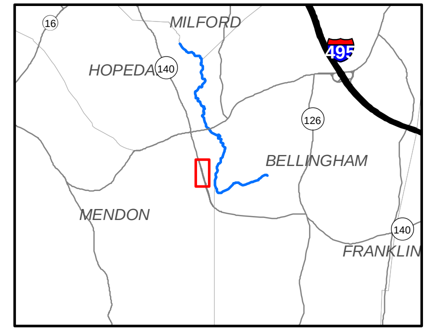

MassDOT Roadways

Proposed BMPs

Proposed BMP Watersheds

N

0 200 400 Feet

Figure 3

Charles River (MA72-03) Proposed BMPs

June 2013

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Impaired Waters Assessment for Beaver Brook (MA72-28)

Impaired Waterbody

Name: Beaver Brook

Location: Lexington, Belmont, and Waltham, MA

Water Body ID: MA72-28

Impairments

According to the MassDEP Final Year 2012 Integrated List of Waters, this segment is listed under Category 5 as impaired for non-native aquatic plants, other flow regime alterations, other anthropogenic substrate alterations, excess algal growth, turbidity, organic enrichment (sewage) biological indicators, dissolved oxygen, total phosphorus, sedimentation/siltation, taste and odor, and Escherichia coli. In accordance to MassDOT's Impaired Waters Assessment for Impaired Waters with Impairments Unrelated to Stormwater in the December 8, 2012 EPA submittal, this assessment does not address the non-pollutant impairments such as non-native aquatic plants, other flow regime alterations, and other anthropogenic substrate alterations.

Two TMDL reports have been finalized that address the Charles River watershed, which includes this segment.

- *Final Pathogens TMDL for the Charles River Watershed (CN 156.0)* addressing Escherichia coli.
- *TMDL for Nutrients in the Upper/Middle Charles River (CN 272.0)* addressing dissolved oxygen, excess algal growth, turbidity, organic enrichment (sewage) biological indicators, and total phosphorus.

The *Charles River Watershed 2002-2006 Water Quality Assessment Report* lists unspecified urban stormwater and illicit connections among the main causes of impairments to this segment. Other causes of the impairments in the subwatershed include the introduction of non-native organisms, channelization, and waterfowl.

Relevant Water Quality Standards

- Water Body Classification: B
- 301 CMR § 4.05 (3)(b) – *Class B. These waters are designed as habitat for fish, other aquatic life, and wildlife, including for their reproduction, migration, growth, and other critical functions, and for primary and secondary contact recreation. Where designated in 314 CMR 4.06, they shall be suitable as a source of public water supply with appropriate treatment ("Treated Water Supply"). Class B waters shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value.*
- 314 CMR § 4.05 (3)(b)(1) – *Dissolved Oxygen. a. Shall not be less than 6.0 mg/l in cold water fisheries and not less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions.*

Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.

- 314 CMR § 4.05 (3)(b)(4) – *Bacteria.*
  a. At bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: where E. coli is the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml; alternatively, where enterococci are the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no single sample taken during the bathing season shall exceed 61 colonies per 100 ml;
  b. for other waters and, during the non bathing season, for waters at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: the geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml; alternatively, the geometric mean of all enterococci samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 61 colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department;
- 314 CMR § 4.05 (3)(b)(5) – *Solids. These waters shall be free from floating, suspended and settleable solids in concentrations or combinations that would impair any use assigned to this class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.*
- 314 CMR § 4.05 (3)(b)(6) – *Color and Turbidity. These waters shall be free from color and turbidity in concentrations or combinations that are aesthetically objectionable or would impair any use assigned to this class.*
- 314 CMR § 4.05 (3)(b)(8) – *Taste and Odor. None in such concentrations or combinations that are aesthetically objectionable, that would impair any use assigned to this Class, or that would cause tainting or undesirable flavors in the edible portions of aquatic life.*
- 314 CMR § 4.05 (5)(a) – *Aesthetics. All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.*
- 314 CMR § 4.05 (5)(b) - *Bottom Pollutants or Alterations. All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.*
- 314 CMR § 4.05 (5)(c) – *Nutrients. Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established by the Department pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.*

Summary

MassDOT has assessed stormwater impacts from MassDOT properties discharging to Beaver Brook using BMP 7R to address the Phosphorus and Pathogen TMDLs and BMP 7U to address impairments not addressed by a TMDL. The following sections describe the methodology for these assessments. Based on this assessment, MassDOT determined that a 42.4-pound reduction in annual phosphorus loading and an 18.5-acre reduction in effective impervious cover (IC) would be needed to meet the targets for this watershed.

MassDOT has concluded that no existing stormwater best management practices (BMPs) are in place to treat stormwater runoff from MassDOT properties before entering Beaver Brook. To reduce MassDOT's contribution to impairments within the Beaver Brook watershed, MassDOT proposes 18 BMPs. These BMPs will provide an 51.0 lbs/yr of phosphorus load reduction and 32.9 acres of effective IC reduction. During the design phase, MassDOT will collect additional information on the soils, property ownership, wetlands and other site conditions which may limit the potential for stormwater BMPs. Therefore, MassDOT has proposed additional BMPs in this assessment phase which show the phosphorus and effective IC reduction targets being exceeded.

See the **Proposed Mitigation Plan** section of this assessment for more information.

Reductions Applied to MassDOT Direct Watershed

	Effective IC (Acres)	Phosphorus Load (Pounds/year)
MassDOT's Area Directly Contributing to Impaired Segment	28.3	55.6
Target Reduction	19.8	22.8
Reduction Provided in Proposed Conditions	32.9	51.0

Site Description

The Beaver Brook (Segment MA72-28) is within the Towns of Lexington, Waltham, and Belmont in Massachusetts. The headwaters of Beaver Brook are just south of the Bowman School, north of Route 2 in Lexington. Beaver Brook crosses under Route 2 at Interchange 55 and continues south through the Beaver Brook Reservation along the Belmont/Waltham town line and eventually converging with the Charles River at Newton Street in Waltham (see Figure 1). North of the Beaver Brook Reservation, the brook flows through mostly open, forested land. However, south of the Beaver Brook Reservation, Beaver Brook flows through a highly urban residential area and is channelized in an underground culvert for much of its stretch in Waltham. According to the 2006 Water Quality Assessment Report, the primary land uses of the 11.4 square mile subwatershed are residential (47%), forest (22%), and open land (17%).

Beaver Brook is impaired due to non-native aquatic plants, other flow regime alterations, other anthropogenic substrate alterations, excess algal growth, turbidity, organic enrichment (sewage) biological indicators, dissolved oxygen, total phosphorus, sedimentation/siltation, taste and odor, and Escherichia coli. Sources for the impairments as listed in the Water Quality Assessment Report include loss of riparian habitat, unspecified urban stormwater, illicit connections, waterfowl, the introduction of non-native organisms, and the channelization of the segment.

MassDOT-owned properties within the subwatershed of MA72-28 include Route 2 in Lexington and Arlington, portions of Route 2A in Lexington, and the Route 20 Bridge over Beaver Brook and the MBTA rail line in Waltham. Stormwater from Route 2A in Lexington flows into surrounding wetlands north of Beaver Brook and is not considered a direct discharge to Beaver Brook. Approximately 7,000 feet of Route 2 in the vicinity of Interchange 55, 56, and 57 in Lexington and Arlington discharge stormwater runoff directly into Beaver Brook via a closed system of catch basins and subsurface pipes. The MassDOT-owned Route 20 (Main Street) Bridge over Beaver Brook and the MBTA rail line also contributes stormwater directly into the river. Stormwater west of the MBTA Railway discharges into Waltham's municipal stormwater system. Route 20 east of Beaver Brook from the bridge on slopes away from the river. Runoff from the end of the bridge west of Beaver Brook does not discharge to Beaver Brook. Direct discharge watersheds are delineated in Figure 2 and 3.

Assessment under BMP 7R for Impairments Addressed by Phosphorus TMDL (CN 272.0)

The Total Maximum Daily Load for Nutrients in the Upper/Middle Charles River, Massachusetts (CN 272.0) addresses the dissolved oxygen, organic enrichment (sewage) biological indicators, turbidity, excess algal growth, and phosphorous impairments for this water body. Therefore, MassDOT assessed the contribution of phosphorus from MassDOT properties to this water body using the approach described in BMP 7R of MassDOT's Stormwater Management Plan (TMDL Watershed Review), which applies to impairments that have been addressed by a TMDL.

- Pollutant of Concern: Phosphorus
  - Impairment Addressed: dissolved oxygen, organic enrichment (sewage) biological indicators, turbidity, excess algal growth, and phosphorous
  - Applicable Waste Load Allocation: See Table ES-3 of the Nutrient TMDL
    - Description of Associated Land Use: Transportation
    - Transportation Land Use Current Load (TP): 2,167 kg/yr
    - Transportation Land Use WLA (TP): 759 kg/yr
    - Commercial/Industrial/Transportation Area in Watershed: 15.9 sq miles or 5.9% (reported in Phase III Calibration Report Table 5. Transportation not separated from Commercial/Industrial during TMDL analysis)
    - Commercial/Industrial/Transportation Land Use Areal WLA: 0.72 kg/ha/yr (calculated)
  - Applicable Recommendations: Section 7.2 of the Final Nutrient TMDL
    - Management of Stormwater systems - Page 87 Phase III Final Report
      - "Comprehensive programs will be necessary to achieve the phosphorus reduction and water quality goals of this TMDL. Programs should build upon existing stormwater management accomplish the following tasks:
        - characterize the drainage areas that contribute to discharges requiring permit coverage under the Permittee's jurisdiction
        - implement a comprehensive Illicit Discharge Detection and Elimination (IDDE) program
        - prioritize source areas for stormwater management and control
        - identify site-specific and regional opportunities for implementation of BMPs

- include the necessary structural and non-structural best management practices (BMPs) that, upon implementation, will achieve reductions in phosphorus loadings from the NPDES covered drainage areas that are consistent with the phosphorus load reductions identified in this TMDL)

To complete the BMP 7R Phosphorus Assessment, MassDOT used a site-specific, continuous, long-term hydrologic and pollutant simulation model (the assessment model) to estimate annual median pollutant loads from its property and treatment through both existing and proposed BMPs, if present. The assessment model was run for a 10-year period using hourly Boston rainfall data to capture a range of meteorological conditions and estimate annual median pollutant loads. The pollutant loading portion of the assessment model was calibrated to match pollutant runoff data from the USGS Highway-Runoff Database (Version 1.0, September 2009). The assessment model directly evaluates BMP effects on hydrology (detention, infiltration) and pollutant loads (losses through infiltration, settling, filtration, and biological treatment). For a more detailed description of this approach, see Long-Term Continuous Simulation for Pollutant Loading and Treatment for MassDOT Impaired Waters Program.

MassDOT has concluded that no existing stormwater BMPs are in place to provide effective IC reduction from properties discharging directly to Beaver Brook. To reduce MassDOT's contribution to impairments within the Beaver Brook watershed, MassDOT proposes 18 BMPs, discussed in the Proposed Mitigation Plan section of this assessment.

The following table summarizes the assessment model results for the MassDOT directly contributing watershed to the Charles River for existing conditions.

Annual Watershed Phosphorus Loading under Existing Conditions

Watershed/ BMP ID	Watershed Size (Acres)	Pre- BMP Annual Load (pounds/year)	Post-BMP Annual Load (pounds/year)	Estimated Annual Removal Efficiency
Total Directly Contributing MassDOT Watershed	56.9	55.6	55.6	0%

The assessment model predicts that the annual median phosphorus load from the MassDOT directly contributing watershed is approximately 55.6 pounds. Based on the TMDL, MassDOT's WLA is 0.72 kg/ha/yr (0.64 lbs/ac/yr). For the 56.9 acres of directly contributing MassDOT watershed, this equates to 36.4 pounds of phosphorus per year.

BMP 7R Phosphorus Mitigation Plan

Under existing conditions, MassDOT's estimated directly contributing annual phosphorus load exceeds the TMDL WLA. To mitigate this load, MassDOT will implement stormwater BMPs to the maximum extent given the site constraints.

This assessment has identified locations for potential stormwater BMPs and estimated their potential annual phosphorus removal performance. The Proposed Mitigation Plan section of this assessment describes the BMPs and their estimated annual load reduction performance.

Assessment under BMP 7R for Pathogens

The Pathogen Total Maximum Daily Load (TMDL) for the Charles River Watershed (CN 0156.0) covers the Beaver Brook. The TMDL states that sources of indicator bacteria in the Charles River Watershed were found to be many and varied. The TMDL lists sources as including failing septic systems, combined sewer overflows (CSO), sanitary sewer overflows (SSO), sewer pipes connected to storm drains, certain recreational activities, wildlife including birds along with domestic pets and animals and direct overland stormwater runoff.

In addition, as page 12 of the TMDL states, *Many of the impacts associated with increased impervious surface area also result in changes in pathogen loading (e.g., increased sediment loading can result in increased pathogen loading). In addition to increased impervious surface impacts, increased human and pet densities in developed areas increase potential fecal contamination. Furthermore, stormwater drainage systems and associated stormwater culverts and outfall pipes often result in the channelization of streams which leads to less attenuation of pathogen pollution.*

Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by orders of magnitude within a given storm event (Mass DEP, 2009). Therefore, it is difficult to predict stormwater pathogen concentrations with accuracy. Due to this difficulty, MassDOT is not conducting site specific assessments of loading at each location impaired for pathogens as part of this Retrofit Program. However, MassDOT recognizes that its roadways, especially in urbanized areas, contribute to the pathogen impairment of the Charles River Watershed and has performed a general assessment and developed a mitigation plan as described below.

BMP 7R Pathogens Assessment

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT has reviewed its existing programs and their consistency with the Pathogen TMDL for the Charles River Watershed recommendations as well as the draft EPA National Pollution Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit requirements for the North Coastal Watershed.

The Pathogen TMDL for the Charles River Watershed recognizes that mitigation for pathogen impairments is difficult to address and emphasizes the need for an iterative adaptive management approach. The Executive Summary of the TMDL, page xi, states:

> *TMDL implementation to achieve [the pathogen reduction goals] should be an iterative process with selection and implementation of mitigation measures followed by monitoring to determine the extent of water quality improvement realized. Recommended TMDL implementation measures include identification and elimination of prohibited sources such as leaky or improperly connected sanitary sewer flows and best management practices to mitigate stormwater runoff volume.*

The existing NPDES MS4 permit that covers MassDOT stormwater discharges does not provide guidance on what measures are necessary to comply with the Pathogen TMDL for the Charles River Watershed. The fact sheet for the draft permit for MS4 stormwater discharges for the North Coastal Watershed contains some guidance on what measures EPA has determined necessary to be consistent with the Pathogen TMDL for the Charles River Watershed. Page 36 of the fact sheet states:

> *Instead of a numeric limitation for bacteria, the draft permit includes requirements for MS4s to provide education to pet owners and owners of septic systems, to implement a comprehensive illicit discharge detection and elimination program that addresses not only sources of pathogens but also sources of phosphorus,*

> *and to implement programs to address water fowl. In addition, although entitled "Phosphorus Control Plan" most of the actions needed to develop and implement a successful PCP are also effective in supporting the achievement of the WLA for the Charles River pathogen TMDL.*

As discussed above, both the Pathogen TMDL for the Charles River Watershed and the draft North Coastal Watershed MS4 permit state that identification of illicit discharges and addressing stormwater volumes and pollutants, such as phosphorus, are the best approaches to mitigate the pathogen impairments. MassDOT has developed a mitigation plan, described below, to address the pathogen impairments using guidance from these two documents.

BMP 7R Pathogens Mitigation Plan

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Storm Water Management Plan (SWMP) including educational programs, illicit connection review, and source control. The specific non-structural BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In
- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

Although not included in this permit term, MassDOT will be implementing a pet waste management program at its rest stops, including those that have discharges to pathogen impaired waters. In addition, MassDOT has requested to be covered under an Individual MS4 permit for the next permit term. A future individual permit may contain additional programmatic BMPs to address pathogens.

The structural BMPs that will be considered to reduce phosphorus loading and the effects of IC would also reduce pathogen loads. See the Proposed Mitigation Plan section of this assessment for more information on specific BMPs proposed as part of this assessment. MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations.

Assessment for Sedimentation/Siltation and Taste and Odor Under BMP 7U

The Charles River Phosphorus and Pathogen TMDLs do not address all of the impairments for the Beaver Brook, including sedimentation/siltation and taste and odor. Therefore, MassDOT assessed this impairments using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (Water Quality Impaired Waters Assessment and Mitigation Plan), which applies to impairments that have not been addressed by a TMDL.

MassDOT has identified a subset of water body impairments in the Charles River Watershed which are not related to stormwater runoff. Specific impairments unrelated to stormwater for the Beaver Brook include non-native aquatic plants, other flow regime alterations, and other anthropogenic substrate alterations. MassDOT is not including these impairments in this assessment as they are not caused by stormwater runoff.

For the stormwater-related impairments for this water body not covered by a TMDL, MassDOT used an application of EPA Region I's Impervious Cover (IC) Method described in EPA's Stormwater TMDL Implementation Support Manual (ENSR 2006). MassDOT used this method to assess potential stormwater impacts on the impaired water and develop the target IC to ensure that stormwater is not the cause of the impairments. The IC Method relates an aquatic system's health (i.e., state of impairment) to the percentage of IC in its contributing watershed. This method is largely based on the work of the Center for Watershed Protection, which has compiled and evaluated extensive data relating watershed IC to the hydrologic, physical, water quality, and biological conditions of aquatic systems (Schueler, 2003). Water quality in tributary streams, rivers, lakes and ponds is a direct reflection of loading from the watershed (Wetzel, 2001); therefore, the IC method can be used as a surrogate for pollutant loading when evaluating water quality impairments and their causes. Consistent with the findings of EPA and others, MassDOT concluded that when a watershed had less than 9% IC, stormwater was not the likely cause of the impairment.

MassDOT developed the target IC reduction using the approach outlined in *Description of MassDOT's Application of Impervious Cover Method in BMP 7U* (MassDOT, 2011). Since the development of the MassDOT Application of IC Method, MassDOT has further refined its approach to evaluate MassDOT's effective IC and BMP performance. For the Beaver Brook, MassDOT used a long-term continuous simulation model (the assessment model) to estimate effective IC.

MassDOT estimated the effective IC of its contributing drainage area with existing and proposed stormwater BMPs by comparing the runoff and pollutant response of its drainage area to the response of simulated watersheds with equivalent area, but varying IC from 0 to 100% (benchmark watersheds). The IC percentage of the watershed that produces a similar response to MassDOT's watershed was determined to be the effective IC of MassDOT's watershed. For a more detailed description of this approach, see the Long-Term Continuous Simulation for Pollutant Loading and Treatment for MassDOT Impaired Waters Program.

The MassDOT IC method for the impaired waters of the Charles River basin includes the following steps:

1. Calculate the percent IC of the water body's entire contributing watershed (total watershed to downstream end of impaired segment) and that of the local watershed contributing directly to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body.
2. For subwatersheds with greater than 9% IC, calculate the amount of IC reduction needed to achieve 9%. For subwatersheds with less and 9% IC, perform no further analysis under BMP 7U.
3. Calculate percentage of IC in the MassDOT directly contributing drainage area.
4. Apply reduction of IC necessary for the subwatershed to achieve 9% to MassDOT contributing drainage area as a target to address the stormwater impairments. Calculate resulting target IC for MassDOT drainage area.
5. In the case where BMPs are in place or where BMPs are proposed, derive IC reduction rates for the BMPs using MassDOT's assessment model based on size, function, and

contributing watersheds of the BMPs. See the Long-Term Continuous Simulation for Pollutant Loading and Treatment for MassDOT Impaired Waters Program for a more detailed description of this approach.

BMP 7U Assessment

Using the approach described above, MassDOT calculated the following values for the total contributing watershed of the impaired water (Beaver Brook) to determine the IC target (see Figure 1). For the Beaver Brook, MassDOT determined that the total watershed (total watershed upstream of the downstream end of the impaired segment) and the subwatershed (local watershed contributing directly to the impaired segment) were the same.

Watershed Impervious Cover

	Total Watershed
Watershed Area	7,323 acres
Impervious Cover (IC) Area	2,223 acres
Percent Impervious	30%
IC Area at 9% Goal	659 acres
Target Reduction % in IC	70%

The watershed is greater than 9% impervious which indicates that stormwater is a likely contributor to the impairment. To meet the 9% effective IC target, the effective IC within the watershed will need to be reduced by 70%. Therefore, the effective IC of MassDOT's directly contributing area should also be reduced by the same percentage to meet the target. The following table shows the resulting targets for MassDOT's contributing property.

Reductions Applied to DOT Direct Watershed

MassDOT's Area Directly Contributing to Impaired Segment	56.9 acres
MassDOT's IC Area Directly Contributing to Impaired Segment	28.3 acres
MassDOT's Percent Impervious	50%
MassDOT's Target Reduction in Effective IC (70% of DOT Directly Contributing IC)	19.8 acres
Target Effective IC	15%

MassDOT's directly contributing area includes 28.3 acres of IC. To meet the target reduction of effective IC, MassDOT should mitigate the effect of 19.8 acres of IC. Equivalently, MassDOT's contributing drainage area should act as a watershed of 15% IC.

BMP 7U Mitigation Plan

Under existing conditions, MassDOT's estimated effective IC exceeds the target as described above. To mitigate the effects of IC, MassDOT will implement stormwater BMPs to the maximum extent practicable.

This assessment has identified locations for potential stormwater BMPs and estimated their potential annual effective IC removal performance. The Proposed Mitigation Plan section of this assessment describes the BMPs and their estimated effective IC reduction performance.

Proposed Mitigation Plan to Address Phosphorus and Impervious Cover

MassDOT is reviewing the Charles River Basin as an entire watershed and has committed to constructing stormwater BMP retrofit projects to address impaired waters. During this assessment phase of the Impaired Waters Program, MassDOT has focused on directly contributing areas and identified BMPs that can be constructed entirely on MassDOT property without resulting in substantial wetland impacts or result in an adverse impact on historical or archeological resources. Projects that meet these requirements can utilize the Federal Highway Administration's Alternative Contracting mechanism (SEP-14) created for this program. MassDOT will advance designs for BMPs where practicable in the watershed above and beyond the target mitigation to compensate for areas where site constraints prohibit the construction of stormwater BMPs.

In this assessment, MassDOT has identified 18 stormwater BMPs that may be implemented on MassDOT property to reduce annual phosphorus loads. These BMPs include 2 infiltration basins, 15 water quality swales and 1 rain garden, shown with their estimated contributing drainage areas in Figures 4-6. The locations assessed for the potential BMPs proposed in this assessment comprise if interconnected existing stormwater conveyance systems such as drainage ditches, culverts, and paved swales. This allows for several situations where BMPs can be proposed in series. These locations were chosen based on a cursory review of the drainage systems, topography, property lines, and other site constraints. Detailed survey, complete utility location information, official property ownership, and soils evaluation information will influence the final selection and design of BMPs. Below is a description of these potential proposed BMPs.

PR BMP 1
Proposed BMP 1 is a water quality swale on the shoulder of Route 2 west, just west of the on ramp from Pleasant St in Lexington. Currently, stormwater from Route 2 west and the on ramp from Pleasant Street is collected in catch basins in the shoulders and is discharged to an existing drainage ditch in the pervious area adjacent to the shoulder of Route 2 west and the on ramp from Pleasant St. Overflow from the area proposed for PR BMP 5 would outlet to PR BMP 1 as well. PR BMP 1 would retrofit the current drainage ditch with check dams to increase storage and improve infiltration before PR BMP 1 discharges to Beaver Brook.

PR BMP 2
Proposed BMP 2 is a water quality swale in the median of Route 2, directly west of Pleasant Street. The section of Route 2 that is under investigation in this assessment consists of three lanes that crest in the middle of the highway. PR BMP 2 collects stormwater runoff from one and a half lanes from Route 2 west and one and a half lanes from Route 2 east. The current drainage system consists of paved waterways along the shoulders of Route 2 east and west which discharge stormwater into the median before drop inlets in the median outlet the stormwater to the shoulder of Route 2 east, the area where PR BMP 3 is proposed to be located. Check dams could be added to the median to promote infiltration and the existing drop inlet could be raised to allow for more storage before the stormwater is discharged to PR BMP 3.

PR BMP 3
Proposed BMP 3 is a water quality swale in the shoulder of Route 2 east, just east of the off ramp to Pleasant Street in Lexington. Currently stormwater is caught in a closed drainage system and is discharged into a drainage ditch in the pervious area adjacent to the shoulder of Route 2 east and the off ramp to Pleasant Street. Stormwater that is currently collected in the median, which is proposed as PR BMP 2 in this assessment, overflows to PR BMP 3 as well. The drainage ditch outlets to a headwall at the end of the ditch which carries the flow under Route 2 and outlets to the proposed location of PR BMP 4, the area between Route 2 west and the on ramp from Pleasant Street to Route 2 west. Check dams could be added to the existing drainage ditch to promote infiltration before discharging to PR BMP 4.

PR BMP 4
Proposed BMP 4 is a water quality swale located between the on ramp from Pleasant Street on to Route 2 west and Route 2 west. Currently, there is a paved water way that collects stormwater from three existing drainage ditches and catch basins on Route 2 west that collects stormwater from the shoulder and one and a half lanes. The paved waterway drains directly into Beaver Brook. The paved waterway could be removed and check dams could be installed to help promote infiltration before stormwater is discharged into Beaver Brook. The three existing drainage ditches that currently outlet to the location of PR BMP 4 are in the locations of PR BMP 2, PR BMP 3 and PR BMP 6.

PR BMP 5
Proposed BMP 5 is a water quality swale located in the median between Route 2 west and Route 2 east just west of Pleasant Street. The existing drainage system consists of paved waterways that collect stormwater from a total of two shoulders and 3 lanes from Route 2. A drop inlet in the median drains the stormwater into the existing drainage ditch in the location of PR BMP 1. To increase infiltration, check dams could be added within the swale and the existing drop inlet could be raised to increase storage of stormwater.

PR BMP 6
Proposed BMP 6 is a water quality swale located between the off ramp from Route 2 east to Pleasant Street and Route 2 east. The stormwater that currently drains to a ditch in this area via catch basins on the shoulder of Route 2 east catch approximately one and a half lanes and the shoulder from Route 2 east and outlets to the paved waterway proposed as PR BMP 4. Infiltration could be promoted by adding check dams to the ditch as well as raising the drop inlet to allow for more storage of stormwater.

PR BMP 7
Proposed BMP 7 is a water quality swale located in the median between Route 2 east and Route 2 west directly east of Pleasant Street. The median currently collects stormwater via paved waterways from a total of four lanes and two shoulders from Route 2 east and Route 2 west. Once in the median, the stormwater drains into a drop inlet, which outlets into the culverted portion of Beaver Brook. The median could be retrofitted to contain check dams as well as to raise the drop inlet to help promote infiltration before the stormwater reaches Beaver Brook.

PR BMP 8
Proposed BMP 8 is a water quality swale adjacent to Route 2 east between Pleasant Street and Beaver Brook. Stormwater from catch basins in the shoulder collect stormwater from one and a half lanes of Route 2 east as well as the shoulder and outlet into this pervious area. The existing area could be retrofitted into a swale with check dams to help infiltrate water before discharging into Beaver Brook at the end of the swale.

PR BMP 9
Proposed BMP 9 is a water quality swale located in the pervious area on the northern side of Route 2 west directly east of the Beaver Brook crossing. The existing pervious area collects stormwater from paved waterways from the shoulder and one and a half lanes of Route 2 east. An existing drainage ditch carries the stormwater directly to Beaver Brook. By adding check dams to this area and creating opportunities for infiltration, stormwater could be treated before draining to Beaver Brook.

PR BMP 10
Proposed BMP 10 is a long water quality swale located in the median between Route 2 west and Route 2 east. Stormwater from a total of two shoulders and three lanes from Route 2 drain into the median via paved waterways. The drop inlets within the median collect the stormwater and outlet it to the pervious area on the side of Route 2 east where it then drains into wetlands

surrounding Beaver Brook. Curb cuts or small paved waterways could be installed to increase the amount of stormwater entering the swale. Check dams could also be added to the median and the drop inlet could be raised to increase the amount of storage for stormwater to infiltrate before it is discharged to the area proposed as PR BMP 11.

PR BMP 11
Proposed BMP 11 is a water quality swale located in the pervious area on the side of Route 2 east before the off ramp to Winter Street. Currently, stormwater from the shoulder and three lanes from Route 2 east, and the shoulder and three lanes from Route 2 west, outlet to the large wetland system south of PR BMP 11. Under proposed conditions, the closed drainage system would be daylighted into a swale and check dams could be added to promote infiltration in the pervious area proposed for PR BMP 11 before discharging to the wetland. Overflow from PR BMP 10 would flow to PR BMP 11 as well.

PR BMP 12
Proposed BMP 12 is an infiltration basin proposed in the pervious interchange island between Route 2 east and Winter Street. Currently, this area only treats stormwater runoff from pervious area. The existing Route 2 drainage system includes pipes from several catch basins that originate in different areas of Route 2 that connect to one manhole located within the pervious island. Stormwater that enters this manhole outlets to wetlands surrounding Beaver Brook. The stormwater that flows into the manhole could be daylighted to create an infiltration basin, and the overflow from the basin could connect back into the existing manhole to outlet into the wetlands surrounding Beaver Brook. If the connections to the manhole could be diverted into the basin, stormwater from a total of two shoulders and six lanes from Route 2 could be treated.

PR BMP 13
Proposed BMP 13 is an infiltration basin located within the wooded, pervious interchange area between Route 2 east and Winter Street. Currently, this area has a web of paved waterways that flow to a headwall which outlets to the wetlands surrounding Beaver Brook. Under proposed conditions, PR BMP 13 would collect untreated stormwater from roughly 0.1 miles of Route 2 roadway consisting of 6 lanes and 2 shoulders, approximately 1,000feet from Winter Street consisting of two lanes and two shoulders, as well as the on ramp from Winter Street to Route 2 east and the on ramp from Winter Street to Route 2 east. It could also collect overflow stormwater from PR BMP 14, PR BMP 15 and PR BMP 17.

PR BMP 14
Proposed BMP 14 is a water quality swale located adjacent to the on ramp from Winter Street to Route 2 west. Currently, stormwater from a MassDOT maintenance lot sheet flows into an existing drainage ditch with a drop inlet to the Route 2 drainage system which outlets to the area proposed as PR BMP 13. By retrofitting the existing drainage ditch into a water quality swale by adding check dams and raising the drop inlet there is potential for stormwater to infiltrate.

PR BMP 15
Proposed BMP 15 is a water quality swale located off the shoulder of the on ramp from Winter Street to Route 2 West. Currently, only runoff from pervious areas drains to this area. Under proposed conditions, a catch basin on the shoulder that collects stormwater from the on ramp from Winter Street to Route 2 could be retrofitted to outlet to the proposed swale and the curb along the shoulder could be removed to promote sheet flow to the swale. Adding check dams and raising the existing drop inlet will help promote infiltration.

PR BMP 16
Proposed BMP 16 is a water quality swale aimed to reduce the amount of impervious cover within MassDOT's directly contributing watershed area to Beaver Brook. PR BMP 16 can divert roughly 5 acres of runoff to areas outside of the Beaver Brook watershed. The area proposed for PR BMP 16 is located between Route 2 west and the off ramp from Route 2 west to Winter Street.

Currently, the area does not receive any runoff from impervious cover. By diverting the outlets of surrounding catch basins and manholes, runoff from the shoulder, one and a half lanes from Route 2 west, the off ramp from Route 2 west to Winter Street, portions of Wadsworth Road and part of the MassDOT District 4 office's parking lot can be collected in PR BMP 16. By adding check dams to the existing drainage ditch and raising the existing drop inlet, stormwater can be infiltrated and outfall to the wetland system within the on and off ramp cloverleaf, outside of the Beaver Brook watershed. With the implementation of PR BMP 16, the stormwater would drain to the Mystic River Watershed.

PR BMP 17

Proposed BMP 17 is a water quality swale located in the grass strip between Route 2 east and MassDOT's Pilgrim Road. Currently, a drainage mainline runs under this grass strip that collects water from catch basins along the left shoulder of Route 2 west, the right shoulder of Route 2 east, the left shoulder of Route 2 east and the catch basins along Pilgrim Road. The water currently drains to the area proposed as PR BMP 13. The area proposed for PR BMP 17 would need to be graded into a swale to allow for storage of stormwater. By day lighting the pipes into the proposed water quality swale before they enter the mainline drain runoff from, three shoulders from Route 2, four and a half lanes from Route 2 and two lanes from Pilgrim Road could be treated before entering PR BMP 13.

PR BMP 18

Proposed BMP 18 is a rain garden located in a pervious island between Route 20 east and Massasoit Street just east of the Main Street Bridge in Waltham (shown in Figure 6). The roadway peaks at its highpoint in the center of the bridge, therefore stormwater that runs off two lanes from half the bridge could be collected in the rain garden by creating curb cuts into the island. The soils and vegetation could be retrofitted to promote infiltration. It is unknown of MassDOT owns this island.

The existing conditions assessment was modified to develop a proposed conditions simulation including proposed BMPs, estimated potential contributing drainage areas and rough sizing of the proposed BMPs. The table below shows the proposed BMPs, their MassDOT drainage areas, and estimated phosphorus and effective IC reductions. The assessment model identifies each BMP by unique ID, which is included in the table below.

MassDOT used the assessment model to simulate the MassDOT directly contributing watershed and proposed BMPs for Beaver Brook. The assessment model also simulated watersheds with the same area as the MassDOT watershed but with varying percentages of IC from 0 to 100% (simulated IC watersheds). The results of the simulated IC watersheds are used as "benchmarks" to determine effective IC of the MassDOT directly contributing watershed. The annual median runoff volume, phosphorus and total suspended solids (TSS) loads, and flow duration for the MassDOT watershed were compared to those results for the simulated IC watersheds to determine (based on similar runoff and load responses) the equivalent or effective impervious cover of the MassDOT watershed with BMPs treating a portion of the runoff. The graph and table below summarize assessment model results for the MassDOT directly contributing drainage area including the impacts of the proposed BMPs, along with the simulated IC watersheds.

Proposed Mitigation

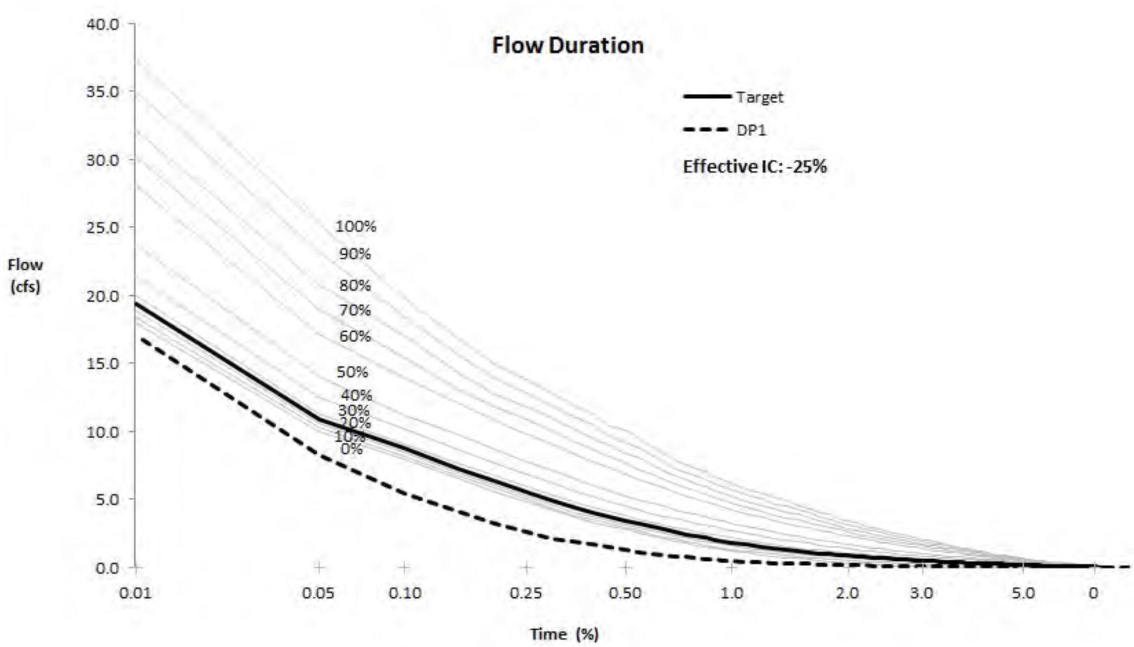
Watershed / BMP ID	BMP Type	Estimated Contributing Watershed Load Pre-BMP		Estimated Percent Reduction		Estimated Reduction	
		Effective IC Acres	Phosphorus Pounds/year	Effective IC	Phosphorus	Effective IC Acres	Phosphorus Pounds/year
PR 01 (7.6)	Water Quality Swale	2.0	4.1	121%	97%	2.5	4.0
PR 02 (14.6)	Water Quality Swale	0.7	1.4	129%	98%	0.9	1.4
PR 03 (8.6)	Water Quality Swale	1.5	3.0	129%	98%	1.9	2.9
PR 04 (6.6)	Water Quality Swale	2.9	5.6	107%	90%	3.1	5.0
PR 05 (13.6)	Water Quality Swale	0.9	1.8	117%	97%	1.0	1.7
PR 06 (9.6)	Water Quality Swale	0.2	0.5	157%	94%	0.3	0.4
PR 07 (15.6)	Water Quality Swale	0.6	1.2	113%	96%	0.7	1.1
PR 08 (3.6)	Water Quality Swale	0.4	0.8	161%	99%	0.6	0.8
PR 09 (16.6)	Water Quality Swale	0.2	0.5	150%	99%	0.4	0.5
PR 10 (5.6)	Water Quality Swale	1.5	3.1	124%	98%	1.9	3.0
PR 11 (10.6)	Water Quality Swale	2.7	5.5	102%	92%	2.8	5.1
PR 12 (2.7)	Infiltration Basin	2.1	4.2	145%	100%	3.1	4.2
PR 13 (3.7)	Infiltration Basin	12.4	24.2	137%	98.8%	17.0	23.9
PR 14 (4.6)	Water Quality Swale	0.8	1.5	53%	65%	0.4	1.0
PR 15 (1.6)	Water Quality Swale	0.3	0.5	140%	99%	0.4	0.5
PR 16	Water Quality Swale			BMP Watershed redirected to Mystic River Watershed			
PR 17 (11.6)	Water Quality Swale	5.3	10.2	76%	86%	4.0	8.8
PR 18 (1.7)	Rain Garden	0.5	1.0	48%	64%	0.2	0.6
Total*		**28.3**	**55.6**	**116%**	**92%**	**32.9**	**51**

* Total Effective IC and phosphorus load reduction based on the assessment model results for the total MassDOT directly discharging drainage area to the receiving water (not sum of individual BMP reductions).

Note: The predicted effective IC is determined by comparing the BMP's calculated median annual discharge volume, runoff flow/duration relationship, median annual phosphorus load and median annual total suspended solids load to predicted discharge values for benchmark watersheds with the same size and varying percent IC. In cases where analysis predicts that BMPs would discharges less runoff volume and pollutant mass than those predicted for a 0% IC (pervious, woods in good condition) benchmark watershed, then the predicted effective IC removal would be greater than 100% and reduction of effective IC area will be greater than the BMP contributing IC area. The Total Effective IC reduction is based on the assessment model results for the total MassDOT directly discharging drainage area to the receiving water (not sum of individual BMP reductions).

Proposed Median Annual Load Comparisons

Simulated IC Watersheds	Runoff (ac-ft)	P (lb.)	TSS (lb.)
0% IC	37.5	2.7	183
5% IC	44.3	4.3	900
10% IC	50.8	6.4	1,909
Target 15% IC	**56.8**	**9.4**	**3,450**
20% IC	63.8	13.1	5,273
30% IC	76.8	23.2	10,759
40% IC	89.7	36.5	18,162
50% IC	102.2	52.5	27,209
60% IC	114.7	69.6	37,102
70% IC	127.2	87.3	47,093
80% IC	139.7	105.0	57,053
90% IC	152.5	122.1	66,765
100% IC	165.0	139.6	76,643
Existing Conditions	113.5	55.61	28,861
Proposed Conditions	22.7	4.61	3450
Reduction %	**80%**	**92%**	**88%**
Effective IC	**-19%**	**6%**	**12%**



Effective IC Results

Existing Estimated Effective IC	28.3 ac
Proposed Estimated Effective IC	-4.6 ac
IC Reduction % with Proposed BMPs	116%
Estimated Effective IC*	-9%

*Average of estimated Effective IC for annual median runoff volume, phosphorus and TSS loads, and flow duration

MassDOT estimated the effective IC under proposed conditions as -9% by comparing the annual median runoff volume, phosphorus and TSS loads, and flow distribution statistics (flow duration) from MassDOT drainage area to the receiving water to those results for simulated IC watersheds. The proposed BMPs mitigate an estimated 32.9 acres of IC. In cases where analysis predicts that BMPs would discharges less runoff volume and pollutant mass than those predicted for a 0% IC (pervious, woods in good condition) benchmark watershed, then the predicted effective IC removal would be greater than 100% and reduction of effective IC area will be greater than the contributing IC area.

MassDOT will continue to ensure proper non-structural BMPs are being implemented within the watershed of the Charles River, including regular roadway and drainage system maintenance, erosion and sedimentation control, and outreach and education.

In addition, BMP implementation through MassDOT's programmed projects are carefully evaluated and implemented where practicable, and documented through the MassDOT Water Quality Data Form. The potential for BMPs outside of MassDOT property will be reviewed during the design phase of these projects and through ongoing partnerships with other state and local entities.

Conclusions

MassDOT has assessed stormwater impacts from MassDOT properties directly discharging to the Charles River using BMP 7R to address the Phosphorus and Pathogen TMDLs and BMP 7U for impairments not addressed by a TMDL. This assessment found that no existing BMPs treat stormwater discharges from MassDOT properties. MassDOT proposes to install 18 BMPs to reduce MassDOT's contribution to impairments within the Beaver Brook watershed.

The following table summarizes the total phosphorus and effective IC reductions proposed in Beaver Brook's watershed.

Reductions Applied to MassDOT Direct Watershed

	Effective IC (Acres)	Phosphorus Load (lbs/yr)
MassDOT's Area Directly Contributing to Impaired Segment	28.3	55.6
Target Reduction	19.5	22.8
Reduction Provided in Proposed Conditions	32.9	51.0

The proposed BMPs would reduce phosphorus loads by 51.0 lbs/yr and would reduce effective IC by 32.9 acres. These removal rates are greater than the target but constraints due to soil conditions, right-of-way ownership, and other unforeseen conditions may limit the practicality of these BMPs in the design phase.

MassDOT will proceed to the design phase to develop design and construction plans for the proposed BMPs as part of the MassDOT Impaired Waters Program. The project designers will gather additional information in this phase, such as soil data and site survey to further refine the proposed BMPs. Once the design of the proposed BMPs is finalized, MassDOT will provide an update with additional information and summarize the final phosphorus and effective IC reduction based on the as-built condition. MassDOT will continue to implement non-structural BMPs that reduce potential nutrient and sediment loading.

As an overall program, MassDOT will re-evaluate the potential need for structural BMPs to address pollutant loading when roadwork is conducted as programmed projects for the area. Further work by MassDOT on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to address impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of proposed BMPs and finalized assessments including reduction achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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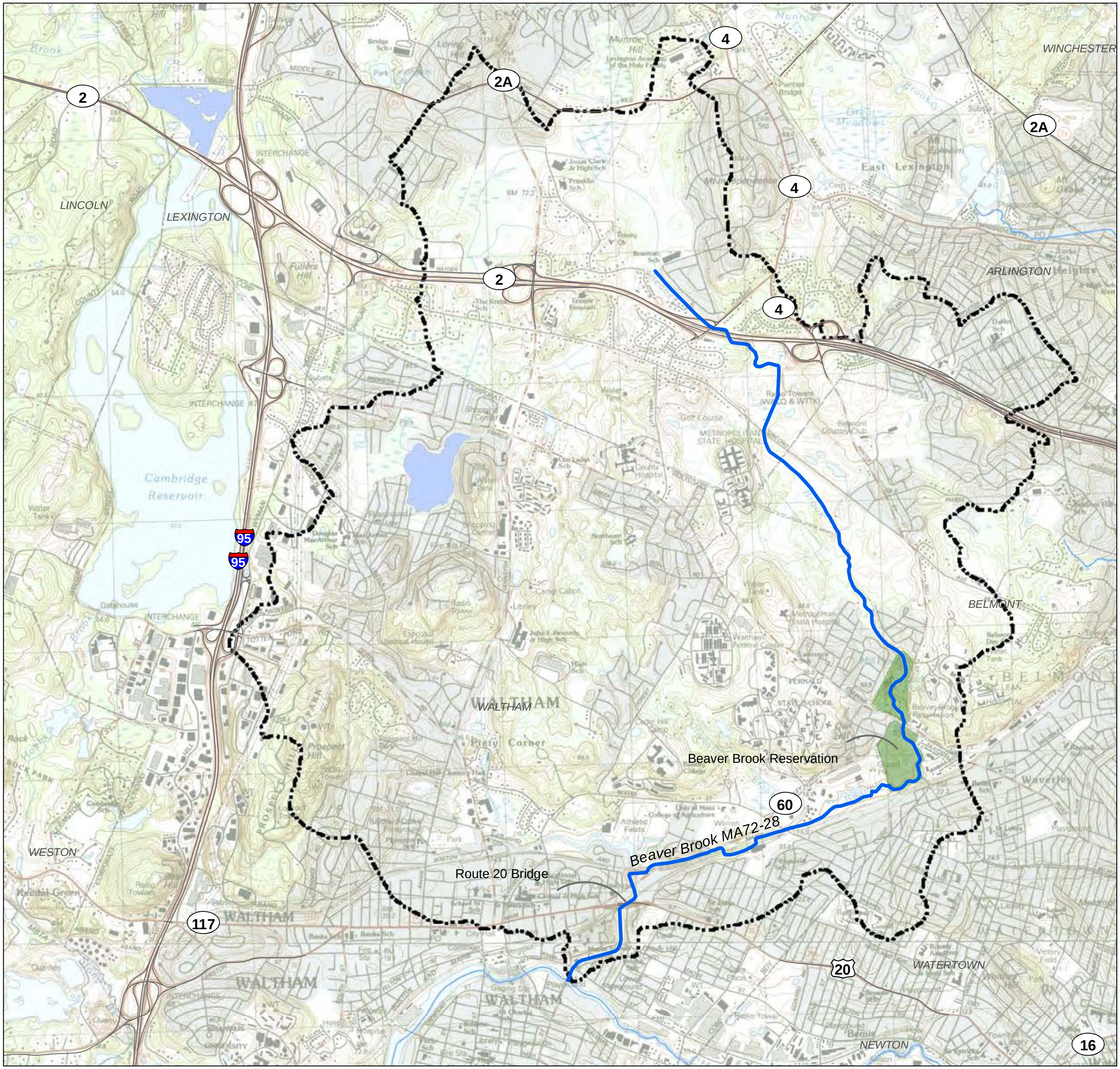

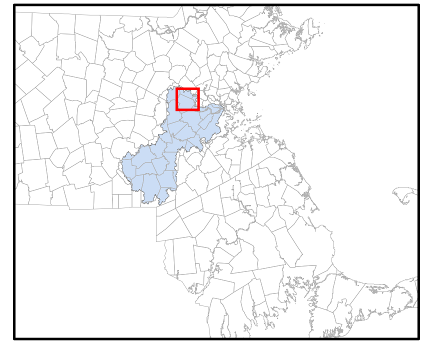

Assessed Segment
Impaired Lakes
Impaired Streams
MassDOT Roadways
Watershed

N

0 0.5 1 Miles

Figure 1

Beaver Brook (MA72-28) Watersheds

June 2013

massDOT
Massachusetts Department of Transportation
Highway Division

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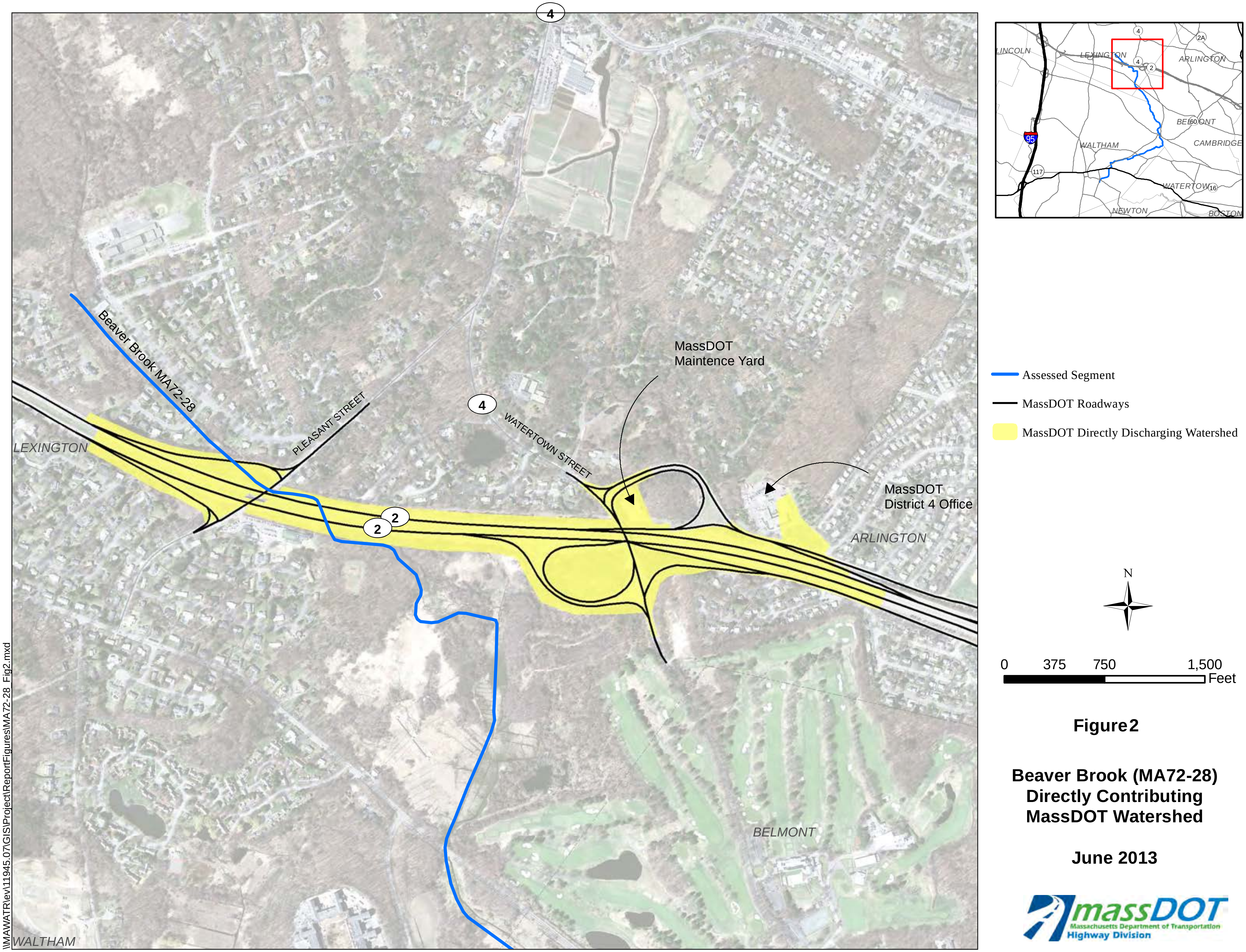
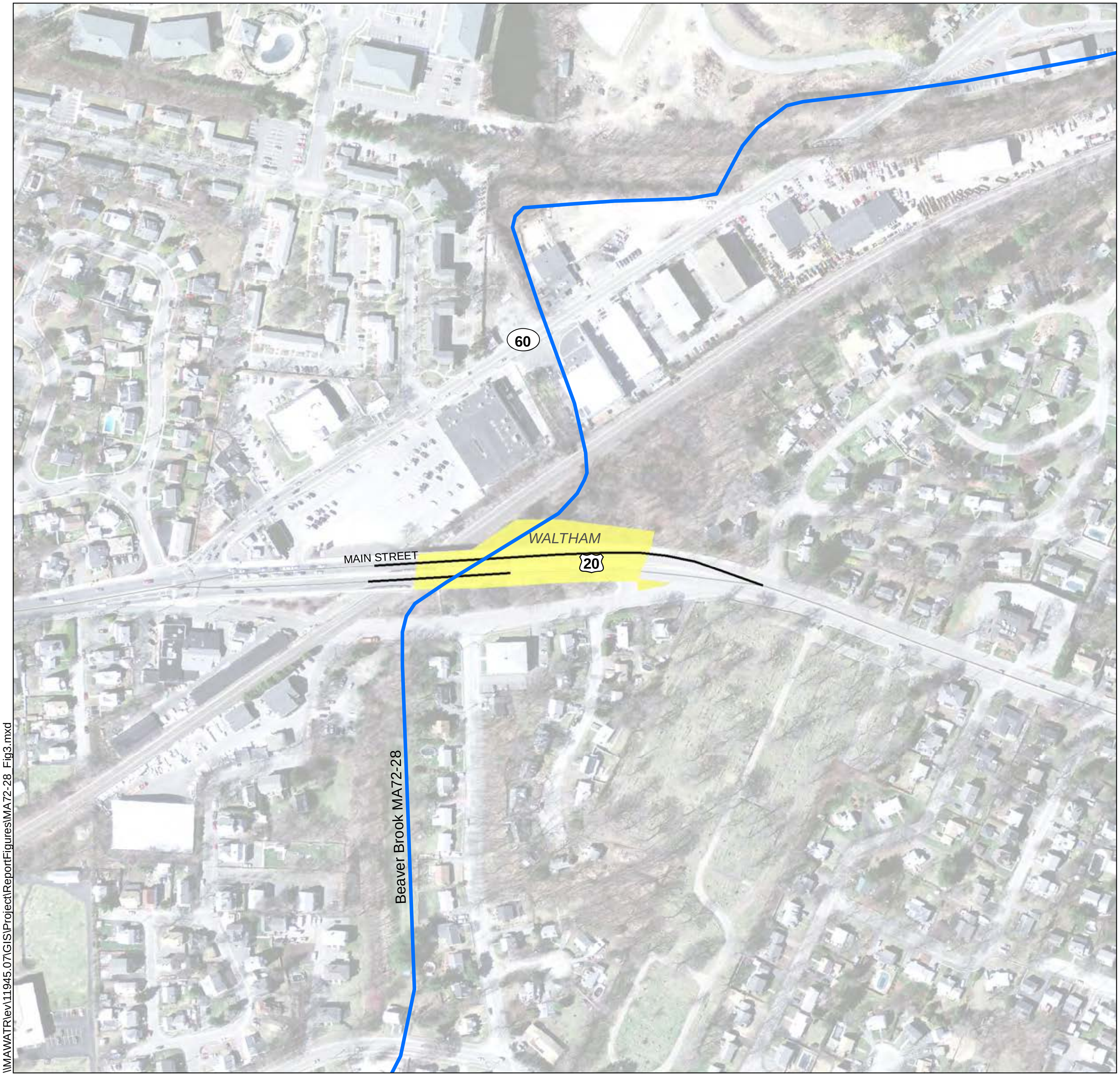


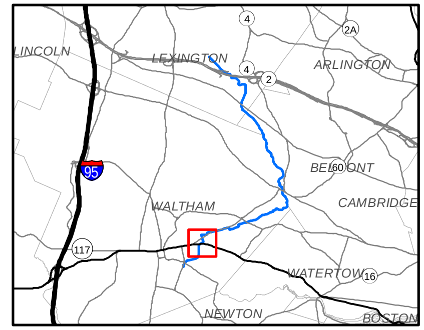
Figure 2

Beaver Brook (MA72-28) Directly Contributing MassDOT Watershed

June 2013

massDOT
Massachusetts Department of Transportation
Highway Division





Assessed Segment

MassDOT Roadways

MassDOT Directly Discharging Watershed

N

0 125 250 500 Feet

Figure 3

Beaver Brook (MA72-28) Directly Contributing MassDOT Watershed

June 2013

massDOT Massachusetts Department of Transportation Highway Division

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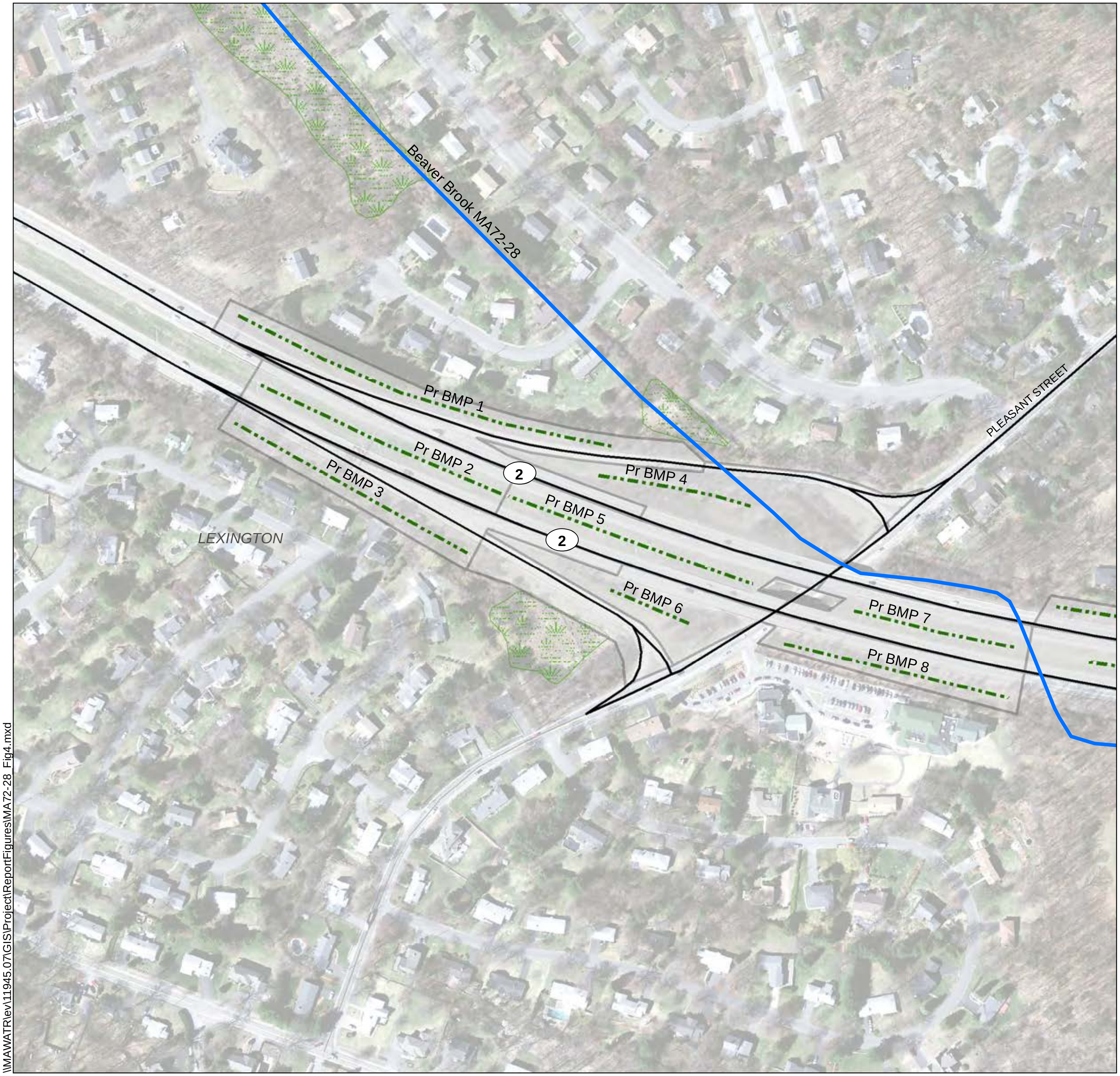

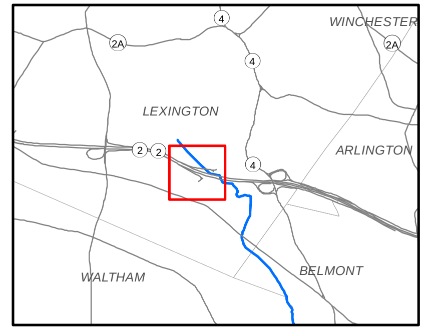

Assessed Segment
MassDOT Roadways
Proposed BMP Watersheds
Proposed Basins
Proposed Swales
DEP Wetlands

N

0 250 500 Feet

Figure 4

Beaver Brook (MA72-28)
Proposed BMPs

June 2013

massDOT
Massachusetts Department of Transportation
Highway Division

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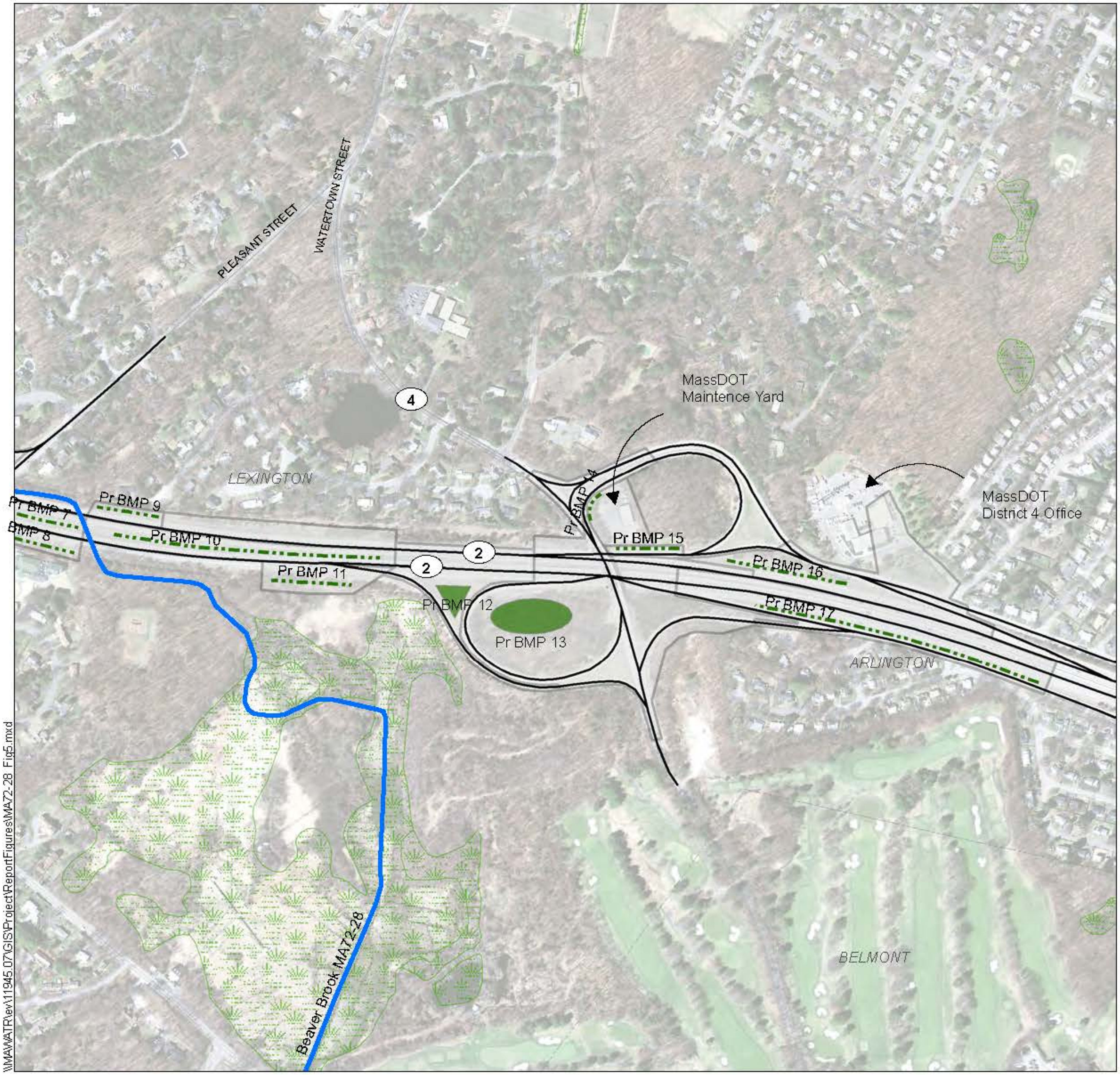

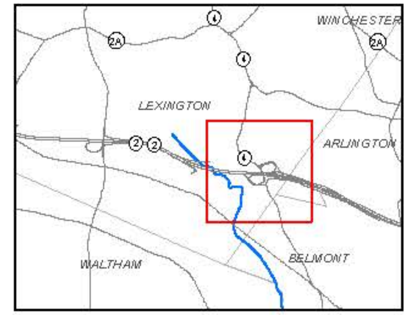

Assessed Segment

MassDOT Roadways

Proposed BMP Watersheds

Proposed Basins

Proposed Swales

DEP Wetlands

N

0 500 1,000 Feet

Figure5

Beaver Brook (MA72-28)
Proposed BMPs

June 2013

massDOT Massachusetts Department of Transportation Highway Division

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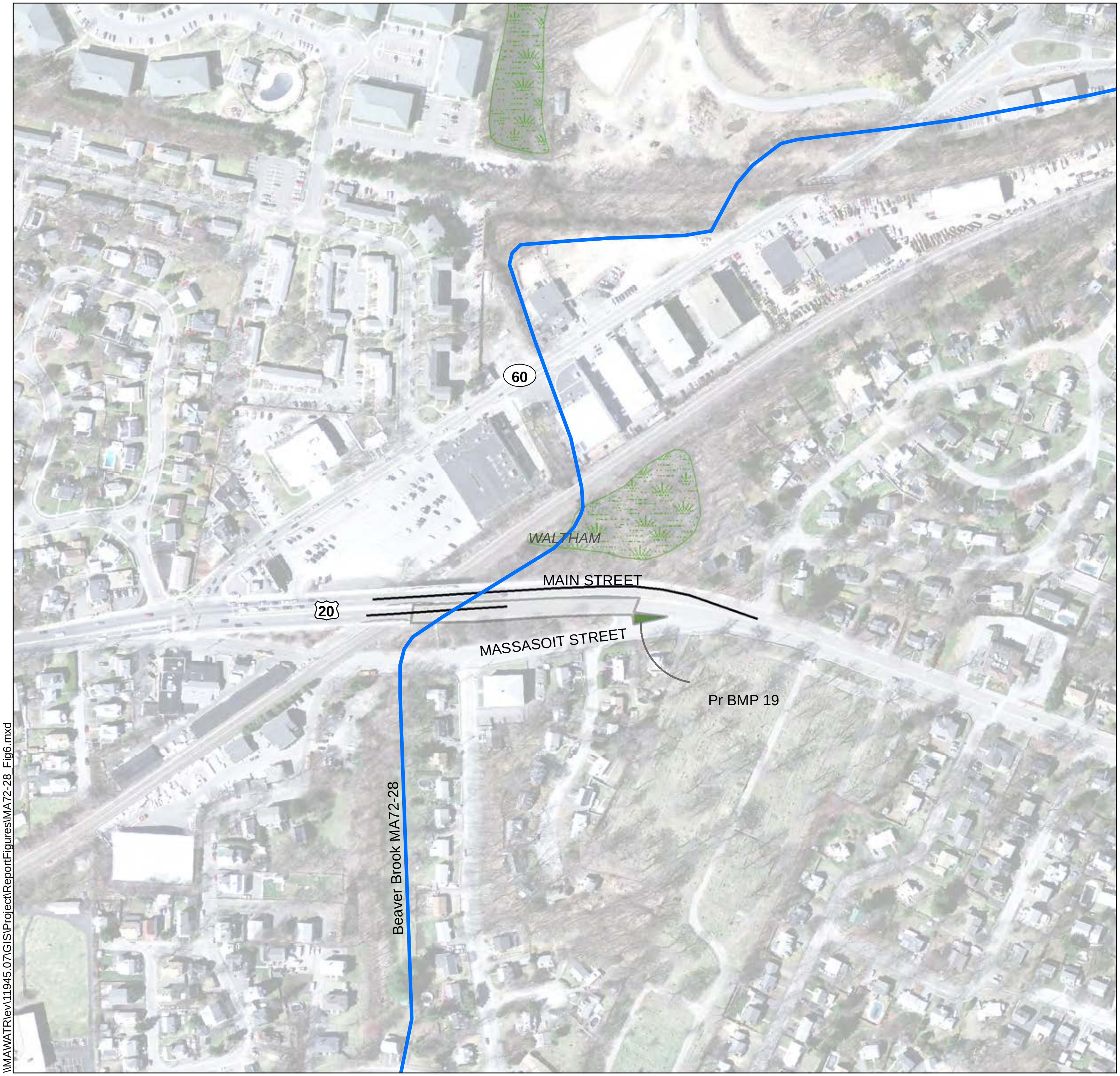

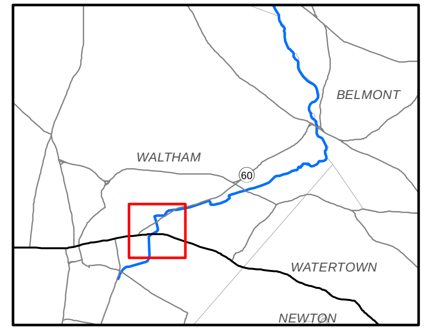

Assessed Segment
MassDOT Roadways
Proposed BMP Watersheds
Proposed Rain Garden
DEP Wetlands

N

0 250 500 Feet

Figure 6

Beaver Brook (MA72-28) Proposed BMPs

June 2013

massDOT Massachusetts Department of Transportation Highway Division

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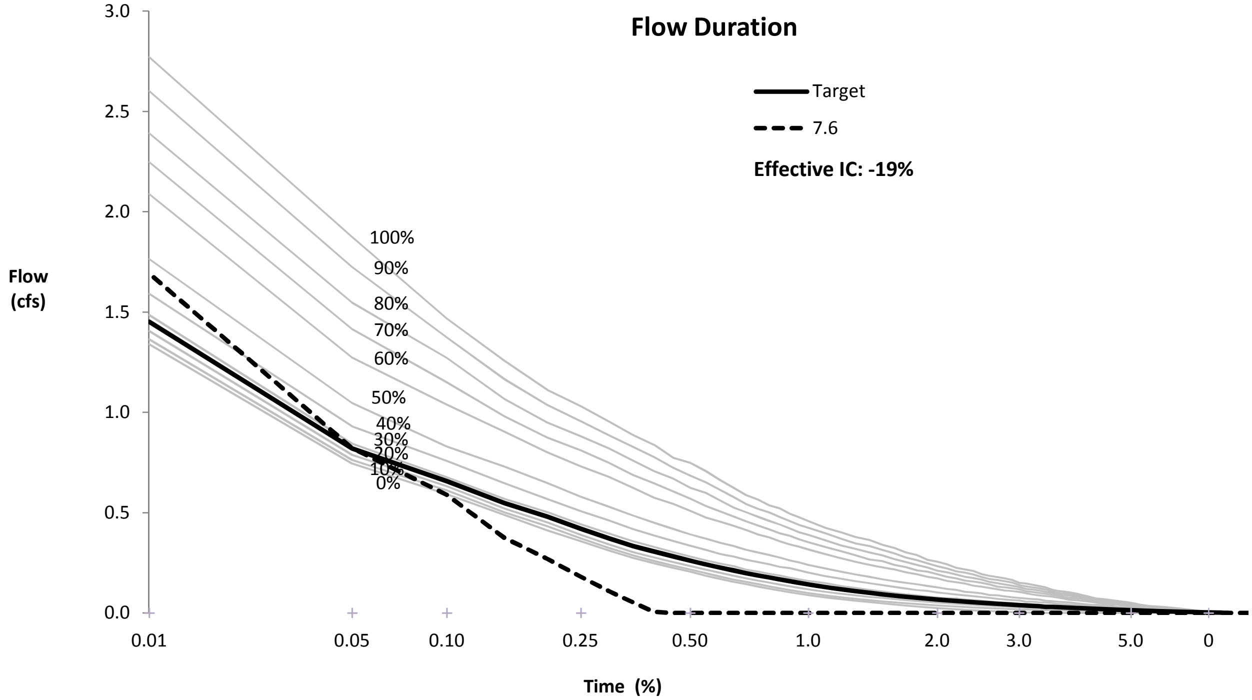
MA72-28 Assessment Model Result Summary for Impervious Cover
7.6 PR BMP 01



Median Annual Load Comparison Table

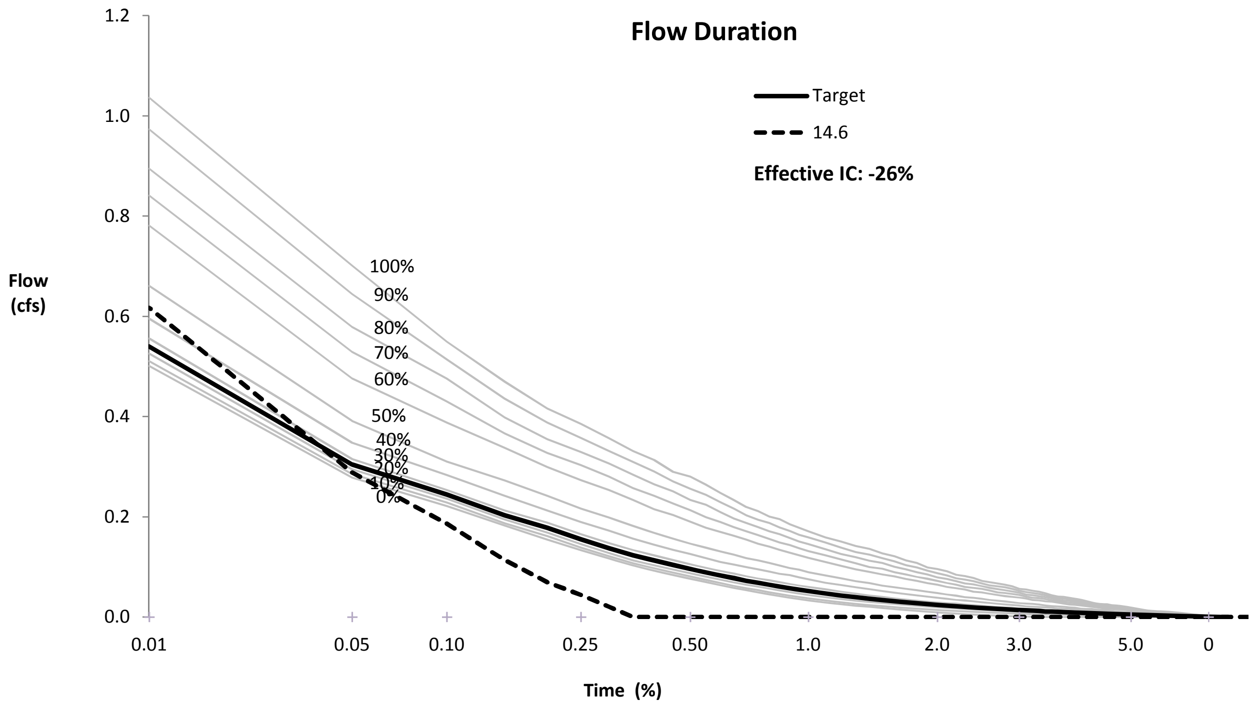
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	2.8	0.2	14
5%IC	3.3	0.3	67
10% IC	3.8	0.5	142
20% IC	4.7	1.0	392
30% IC	5.7	1.7	800
40% IC	6.7	2.7	1,351
50% IC	7.6	3.9	2,024
60% IC	8.5	5.2	2,760
70% IC	9.5	6.5	3,504
80% IC	10.4	7.8	4,245
90% IC	11.3	9.1	4,967
100% IC	12.3	10.4	5,702
Watershed Load	8.01	4.10	2,147
BMP Output	1.28	0.11	15
Target	4.34	0.76	286 `
Reduction %	**84%**	**97%**	**99%**
Effective IC	**-15%**	**-4%**	**0%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		3.9
Watershed IC (no BMP)	52%	2.0
Target IC reduction	70%	1.4
Effective IC w/BMP	-11%	(0.4)
IC Reduction	121%	2.5

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA72-28 Assessment Model Result Summary for Impervious Cover
14.6 PR BMP 02



Median Annual Load Comparison Table

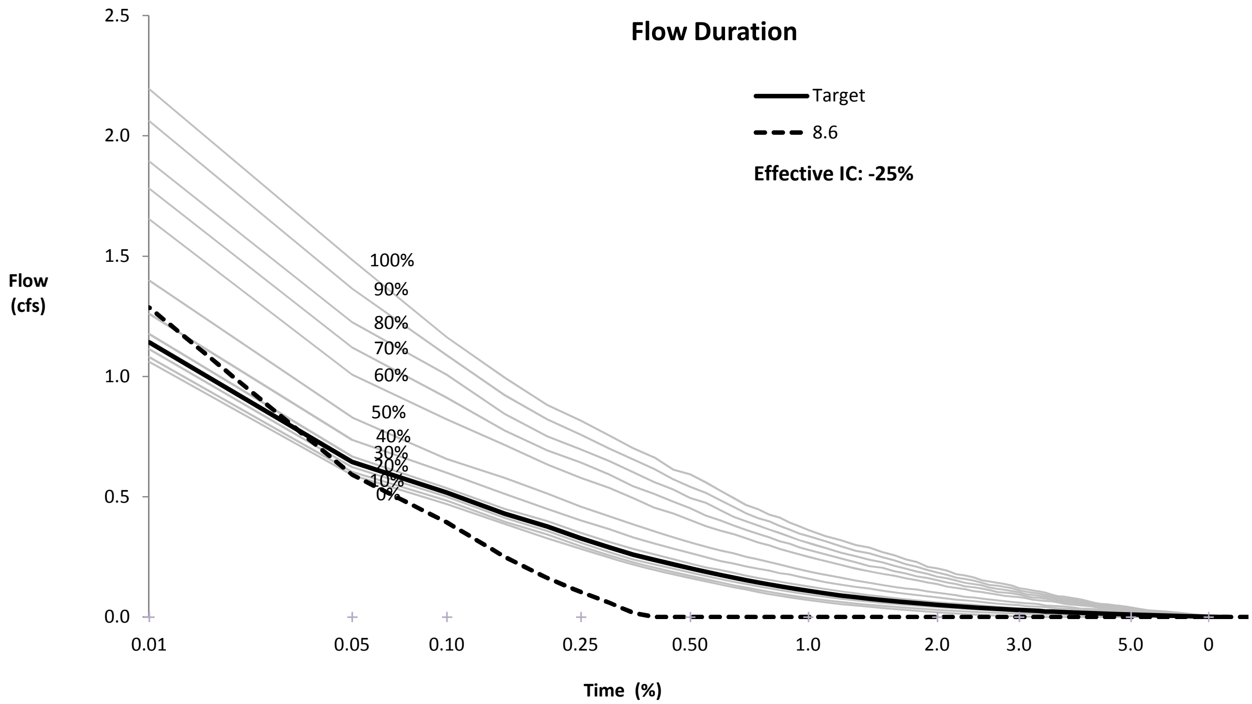
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	1.0	0.1	5
5%IC	1.2	0.1	25
10% IC	1.4	0.2	53
20% IC	1.8	0.4	147
30% IC	2.1	0.6	299
40% IC	2.5	1.0	505
50% IC	2.8	1.5	757
60% IC	3.2	1.9	1,032
70% IC	3.5	2.4	1,310
80% IC	3.9	2.9	1,588
90% IC	4.2	3.4	1,858
100% IC	4.6	3.9	2,133
Watershed Load	2.88	1.42	735
BMP Output	0.40	0.03	4
Target	1.59	0.27	98 `
Reduction %	**86%**	**98%**	**99%**
Effective IC	**-17%**	**-5%**	**0%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		1.4
Watershed IC (no BMP)	49%	0.7
Target IC reduction	70%	0.5
Effective IC w/BMP	-14%	(0.2)
IC Reduction	129%	0.9

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA72-28 Assessment Model Result Summary for Impervious Cover
8.6 PR BMP 03



Median Annual Load Comparison Table

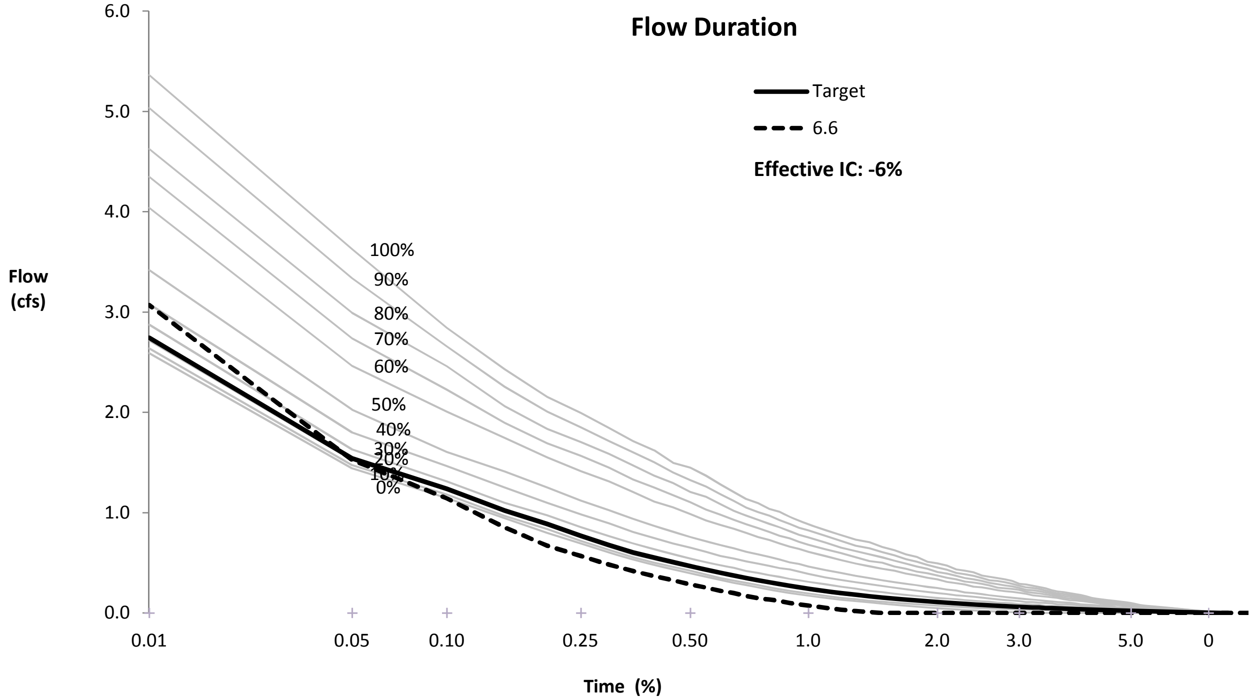
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	2.2	0.2	11
5%IC	2.6	0.3	53
10% IC	3.0	0.4	112
20% IC	3.8	0.8	311
30% IC	4.5	1.4	634
40% IC	5.3	2.2	1,070
50% IC	6.0	3.1	1,604
60% IC	6.8	4.1	2,187
70% IC	7.5	5.1	2,776
80% IC	8.2	6.2	3,363
90% IC	9.0	7.2	3,935
100% IC	9.7	8.2	4,517
Watershed Load	5.96	2.99	1,559
BMP Output	0.88	0.07	9
Target	3.34	0.55	203 `
Reduction %	**85%**	**98%**	**99%**
Effective IC	**-17%**	**-5%**	**0%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		3.1
Watershed IC (no BMP)	49%	1.5
Target IC reduction	70%	1.0
Effective IC w/BMP	-14%	(0.4)
IC Reduction	129%	1.9

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA72-28 Assessment Model Result Summary for Impervious Cover
6.6 PR BMP 04



Median Annual Load Comparison Table

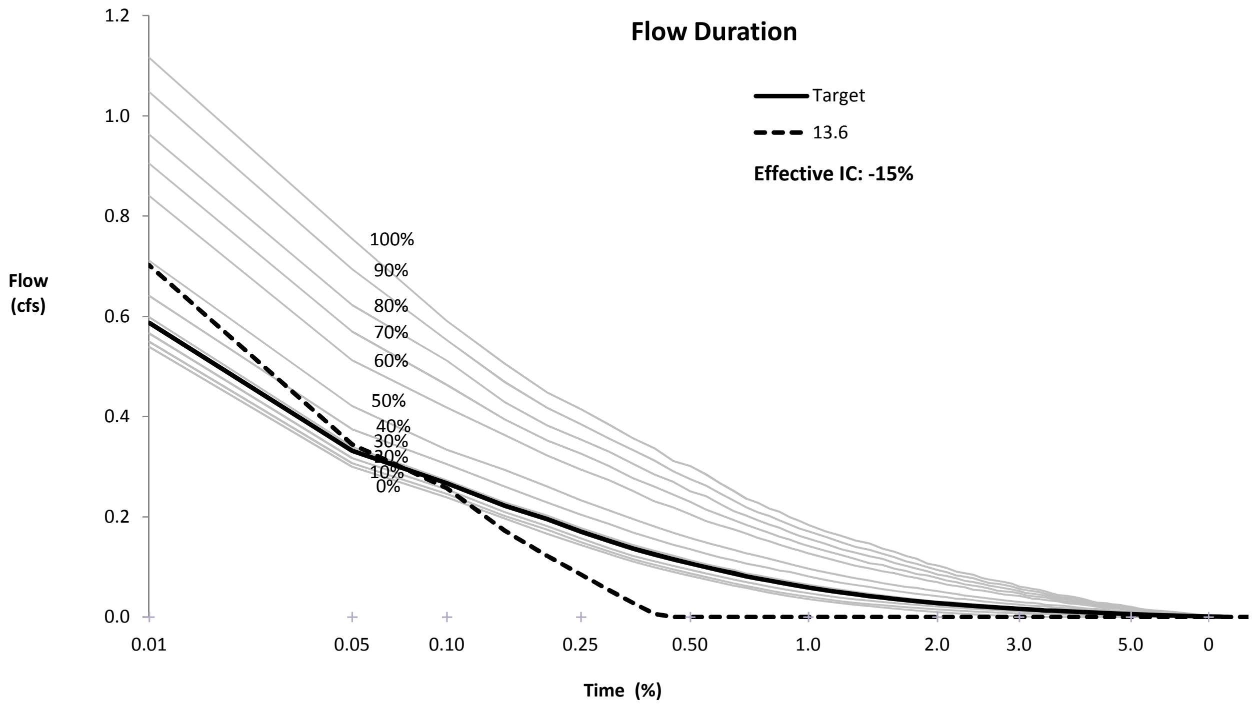
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	5.4	0.4	26
5%IC	6.4	0.6	130
10% IC	7.3	0.9	275
20% IC	9.2	1.9	759
30% IC	11.0	3.3	1,549
40% IC	12.9	5.3	2,615
50% IC	14.7	7.6	3,917
60% IC	16.5	10.0	5,341
70% IC	18.3	12.6	6,780
80% IC	20.1	15.1	8,213
90% IC	21.9	17.6	9,612
100% IC	23.8	20.1	11,034
Watershed Load	12.58	5.59	2,862
BMP Output	3.89	0.57	145
Target	7.62	1.07	353 `
Reduction %	**69%**	**90%**	**95%**
Effective IC	**-8%**	**4%**	**6%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		7.5
Watershed IC (no BMP)	39%	2.9
Target IC reduction	70%	2.0
Effective IC w/BMP	-3%	(0.2)
IC Reduction	107%	3.1

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA72-28 Assessment Model Result Summary for Impervious Cover
13.6 PR BMP 05



Median Annual Load Comparison Table

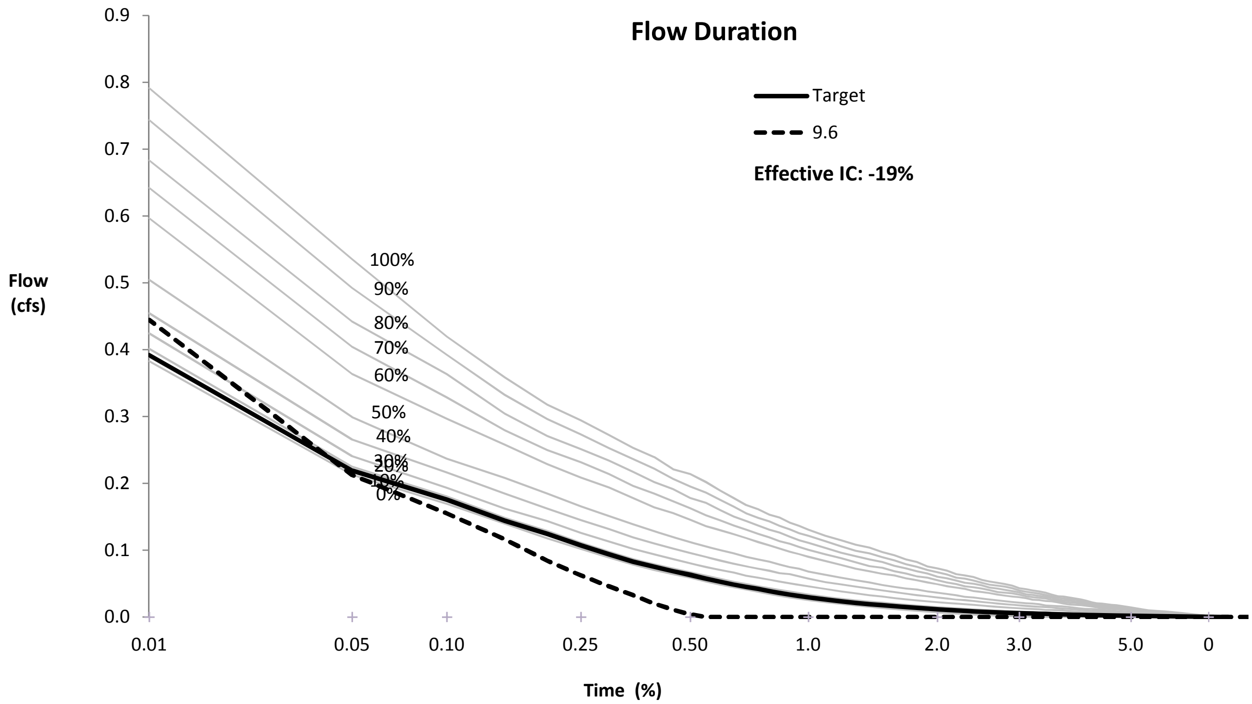
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	1.1	0.1	5
5%IC	1.3	0.1	27
10% IC	1.5	0.2	57
20% IC	1.9	0.4	158
30% IC	2.3	0.7	322
40% IC	2.7	1.1	544
50% IC	3.1	1.6	815
60% IC	3.4	2.1	1,111
70% IC	3.8	2.6	1,411
80% IC	4.2	3.1	1,709
90% IC	4.6	3.7	2,000
100% IC	4.9	4.2	2,296
Watershed Load	3.34	1.77	930
BMP Output	0.57	0.05	7
Target	1.78	0.32	124 `
Reduction %	**83%**	**97%**	**99%**
Effective IC	**-14%**	**-3%**	**0%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		1.6
Watershed IC (no BMP)	55%	0.9
Target IC reduction	70%	0.6
Effective IC w/BMP	-10%	(0.1)
IC Reduction	117%	1.0

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA72-28 Assessment Model Result Summary for Impervious Cover
9.6 PR BMP 06



Median Annual Load Comparison Table

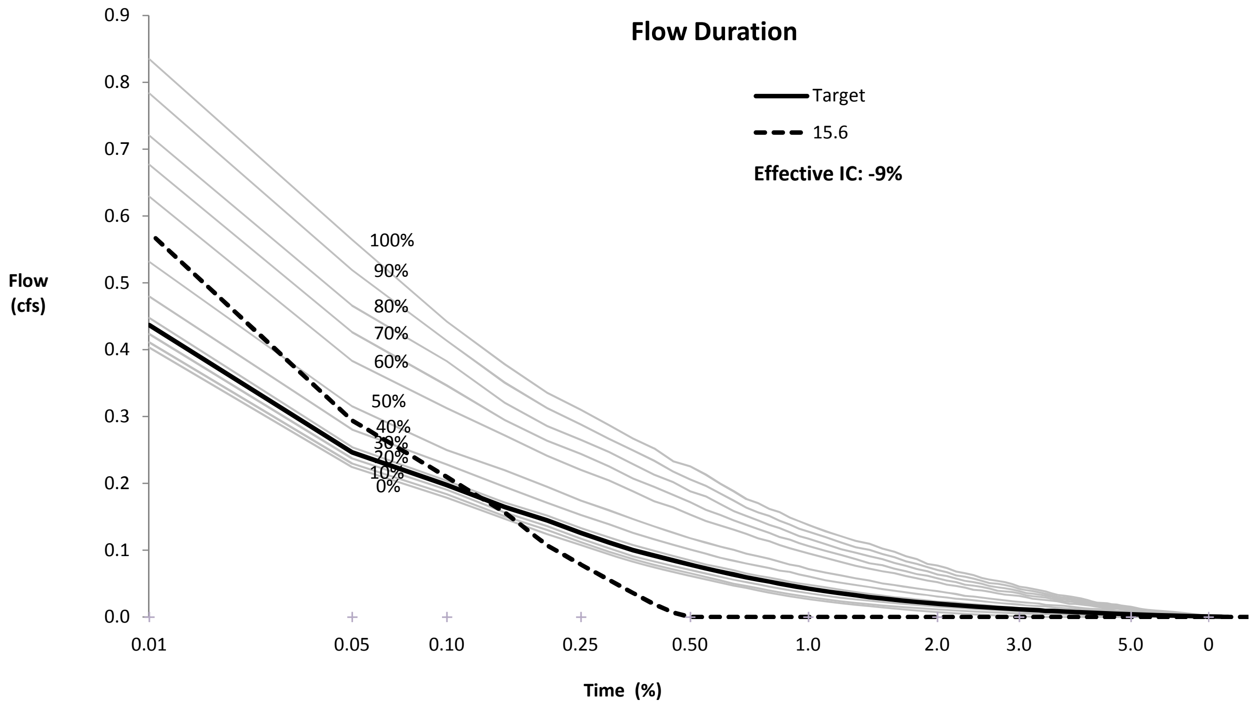
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	0.8	0.1	4
5%IC	0.9	0.1	19
10% IC	1.1	0.1	41
20% IC	1.4	0.3	112
30% IC	1.6	0.5	229
40% IC	1.9	0.8	386
50% IC	2.2	1.1	578
60% IC	2.4	1.5	789
70% IC	2.7	1.9	1,001
80% IC	3.0	2.2	1,213
90% IC	3.2	2.6	1,419
100% IC	3.5	3.0	1,629
Watershed Load	1.23	0.46	229
BMP Output	0.37	0.03	3
Target	0.97	0.10	23 `
Reduction %	**70%**	**94%**	**99%**
Effective IC	**-15%**	**-4%**	**0%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		1.1
Watershed IC (no BMP)	20%	0.2
Target IC reduction	70%	0.2
Effective IC w/BMP	-11%	(0.1)
IC Reduction	157%	0.3

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA72-28 Assessment Model Result Summary for Impervious Cover
15.6 PR BMP 07



Median Annual Load Comparison Table

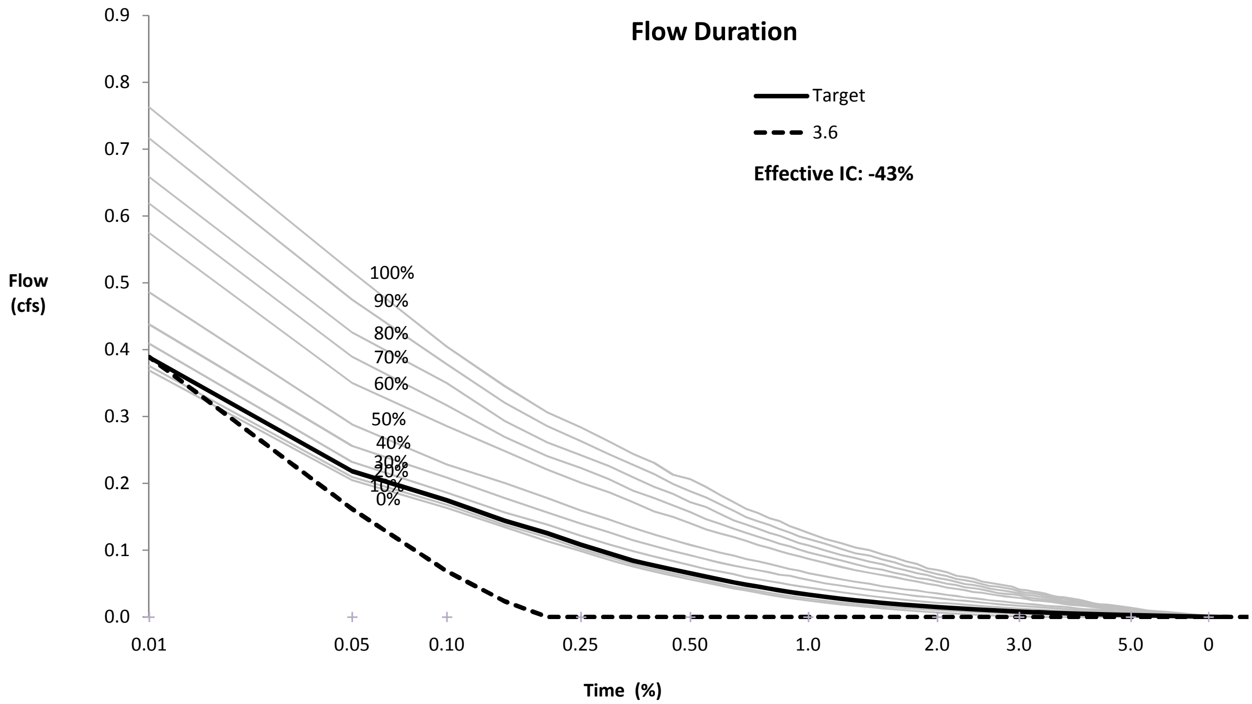
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	0.8	0.1	4
5%IC	1.0	0.1	20
10% IC	1.1	0.1	43
20% IC	1.4	0.3	118
30% IC	1.7	0.5	241
40% IC	2.0	0.8	407
50% IC	2.3	1.2	610
60% IC	2.6	1.6	832
70% IC	2.9	2.0	1,056
80% IC	3.1	2.4	1,279
90% IC	3.4	2.7	1,497
100% IC	3.7	3.1	1,718
Watershed Load	2.40	1.19	621
BMP Output	0.49	0.05	7
Target	1.30	0.23	84 `
Reduction %	**79%**	**96%**	**99%**
Effective IC	**-12%**	**-2%**	**1%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		1.2
Watershed IC (no BMP)	52%	0.6
Target IC reduction	70%	0.4
Effective IC w/BMP	-7%	(0.1)
IC Reduction	113%	0.7

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA72-28 Assessment Model Result Summary for Impervious Cover
3.6 PR BMP 08



Median Annual Load Comparison Table

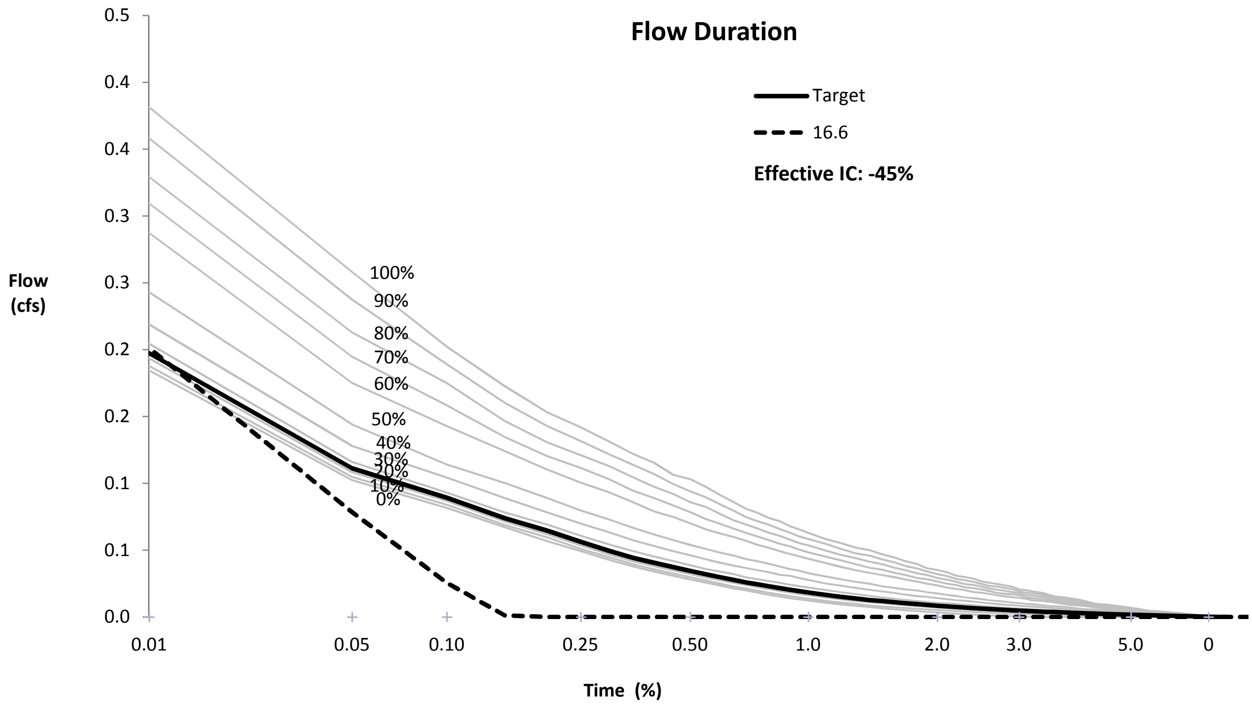
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	0.8	0.1	4
5%IC	0.9	0.1	18
10% IC	1.0	0.1	39
20% IC	1.3	0.3	108
30% IC	1.6	0.5	220
40% IC	1.8	0.7	372
50% IC	2.1	1.1	557
60% IC	2.3	1.4	760
70% IC	2.6	1.8	965
80% IC	2.9	2.1	1,169
90% IC	3.1	2.5	1,368
100% IC	3.4	2.9	1,570
Watershed Load	1.78	0.78	395
BMP Output	0.16	0.01	1
Target	1.06	0.14	44 `
Reduction %	**91%**	**99%**	**100%**
Effective IC	**-22%**	**-7%**	**-1%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		1.1
Watershed IC (no BMP)	36%	0.4
Target IC reduction	70%	0.3
Effective IC w/BMP	-22%	(0.2)
IC Reduction	161%	0.6

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA72-28 Assessment Model Result Summary for Impervious Cover
16.6 PR BMP 09



Median Annual Load Comparison Table

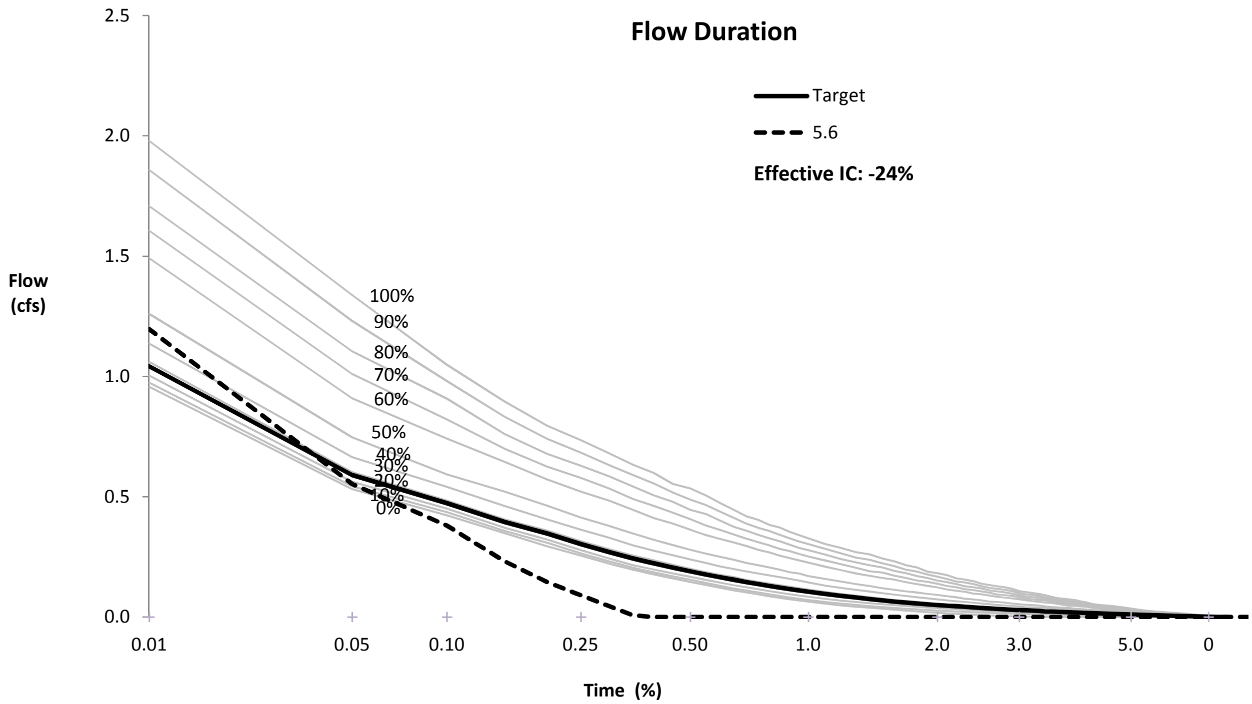
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	0.4	0.0	2
5%IC	0.5	0.0	9
10% IC	0.5	0.1	20
20% IC	0.7	0.1	54
30% IC	0.8	0.2	110
40% IC	0.9	0.4	186
50% IC	1.0	0.5	279
60% IC	1.2	0.7	380
70% IC	1.3	0.9	482
80% IC	1.4	1.1	584
90% IC	1.6	1.3	684
100% IC	1.7	1.4	785
Watershed Load	0.98	0.48	247
BMP Output	0.07	0.01	0
Target	0.57	0.09	32 `
Reduction %	**93%**	**99%**	**100%**
Effective IC	**-23%**	**-7%**	**-1%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		0.5
Watershed IC (no BMP)	45%	0.2
Target IC reduction	70%	0.2
Effective IC w/BMP	-23%	(0.1)
IC Reduction	150%	0.4

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
    a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
    b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA72-28 Assessment Model Result Summary for Impervious Cover
5.6 PR BMP 10



Median Annual Load Comparison Table

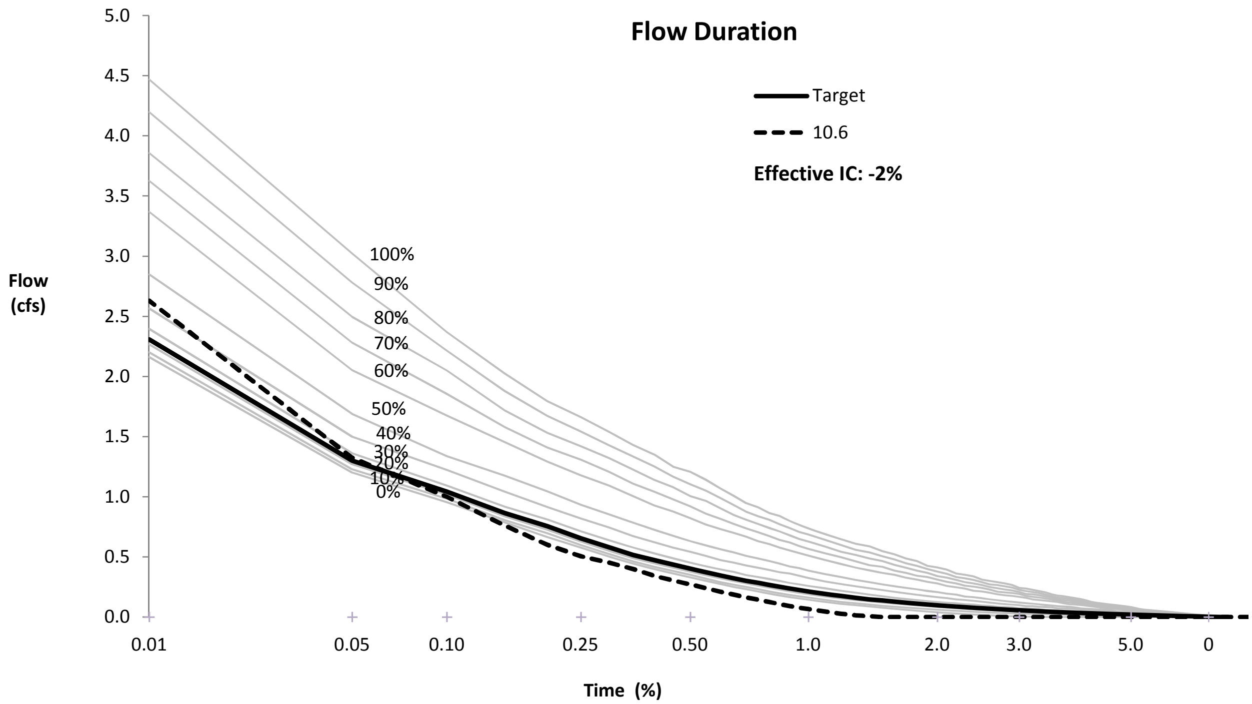
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	2.0	0.1	10
5%IC	2.4	0.2	48
10% IC	2.7	0.3	101
20% IC	3.4	0.7	280
30% IC	4.1	1.2	572
40% IC	4.8	1.9	965
50% IC	5.4	2.8	1,446
60% IC	6.1	3.7	1,972
70% IC	6.8	4.6	2,503
80% IC	7.4	5.6	3,032
90% IC	8.1	6.5	3,548
100% IC	8.8	7.4	4,073
Watershed Load	5.97	3.07	1,610
BMP Output	0.80	0.07	8
Target	3.17	0.58	223 `
Reduction %	**87%**	**98%**	**99%**
Effective IC	**-17%**	**-5%**	**0%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		2.8
Watershed IC (no BMP)	56%	1.5
Target IC reduction	70%	1.1
Effective IC w/BMP	-14%	(0.4)
IC Reduction	124%	1.9

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA72-28 Assessment Model Result Summary for Impervious Cover
10.6 PR BMP 11



Median Annual Load Comparison Table

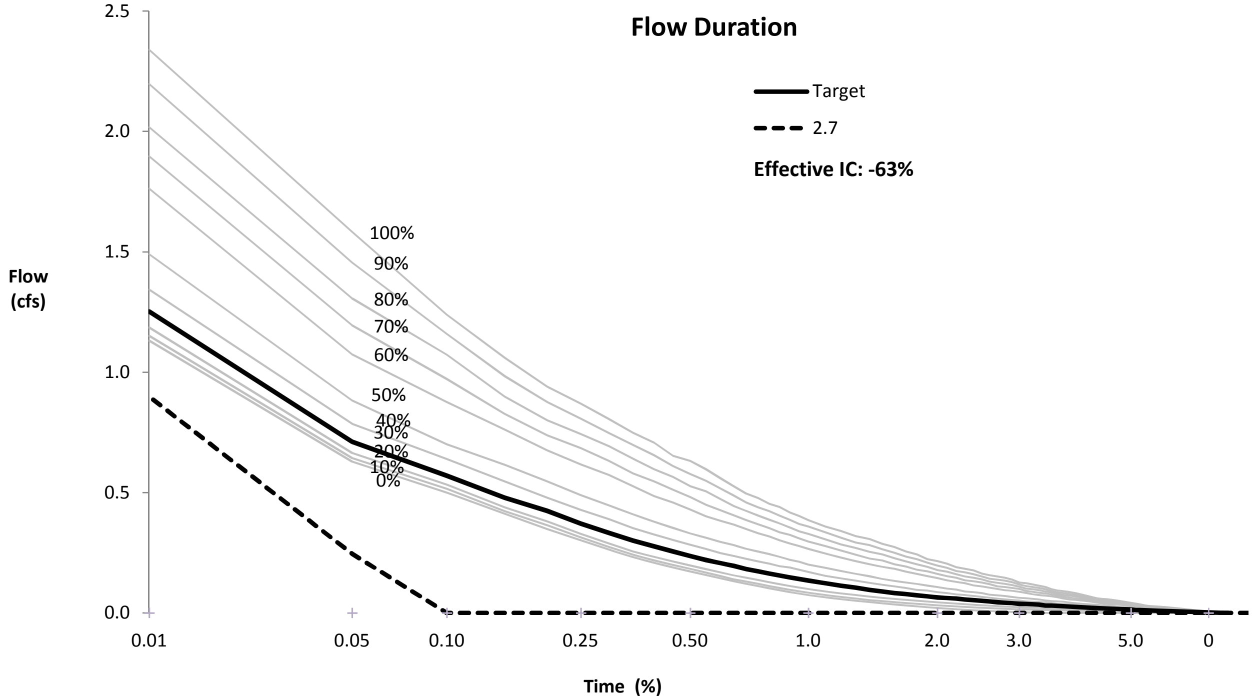
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	4.5	0.3	22
5%IC	5.3	0.5	108
10% IC	6.1	0.8	229
20% IC	7.7	1.6	633
30% IC	9.2	2.8	1,291
40% IC	10.8	4.4	2,179
50% IC	12.3	6.3	3,265
60% IC	13.8	8.4	4,452
70% IC	15.3	10.5	5,651
80% IC	16.8	12.6	6,846
90% IC	18.3	14.7	8,012
100% IC	19.8	16.8	9,197
Watershed Load	11.42	5.53	2,868
BMP Output	3.48	0.45	108
Target	6.60	1.02	360 `
Reduction %	**70%**	**92%**	**96%**
Effective IC	**-6%**	**3%**	**5%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		6.2
Watershed IC (no BMP)	44%	2.7
Target IC reduction	70%	1.9
Effective IC w/BMP	-1%	(0.1)
IC Reduction	102%	2.8

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA72-28 Assessment Model Result Summary for Impervious Cover
2.7 PR BMP 12



Median Annual Load Comparison Table

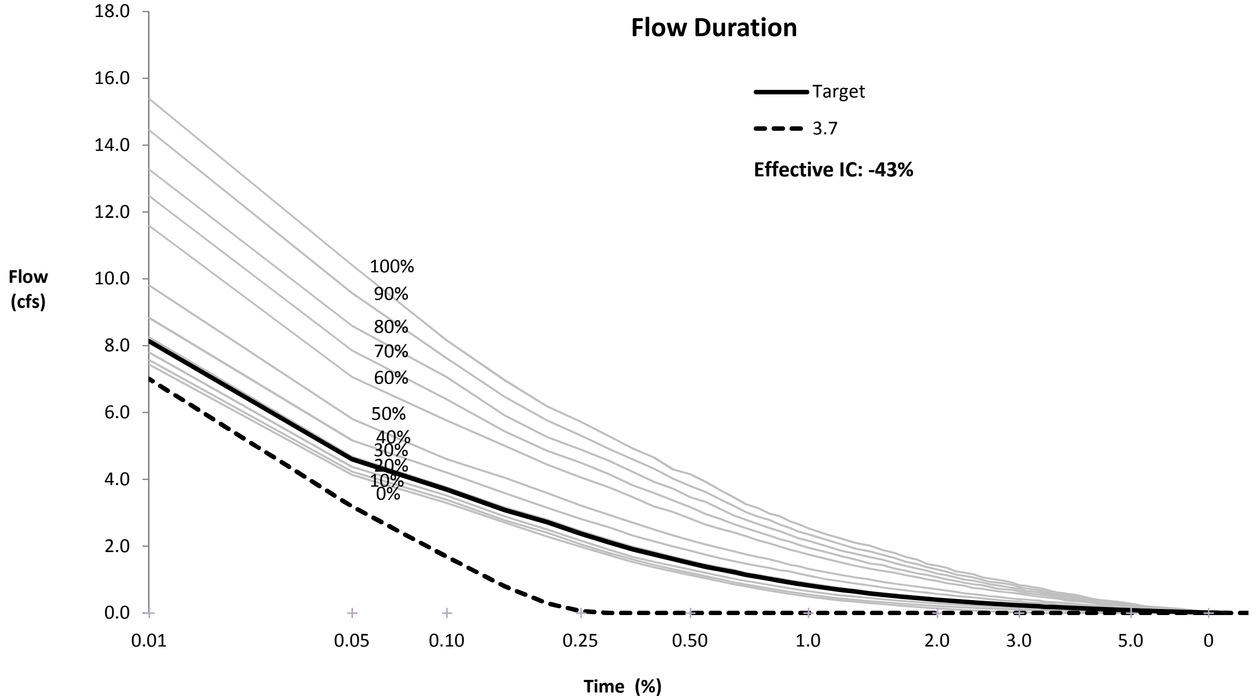
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	2.4	0.2	11
5%IC	2.8	0.3	57
10% IC	3.2	0.4	120
20% IC	4.0	0.8	331
30% IC	4.8	1.5	676
40% IC	5.6	2.3	1,141
50% IC	6.4	3.3	1,709
60% IC	7.2	4.4	2,330
70% IC	8.0	5.5	2,958
80% IC	8.8	6.6	3,583
90% IC	9.6	7.7	4,193
100% IC	10.4	8.8	4,813
Watershed Load	7.83	4.22	2,220
BMP Output	0.26	0.02	1
Target	3.99	0.81	326 `
Reduction %	**97%**	**100%**	**100%**
Effective IC	**-25%**	**-8%**	**-1%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		3.3
Watershed IC (no BMP)	66%	2.1
Target IC reduction	70%	1.5
Effective IC w/BMP	-30%	(1.0)
IC Reduction	145%	3.1

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA72-28 Assessment Model Result Summary for Impervious Cover
3.7 PR BMP 13



Median Annual Load Comparison Table

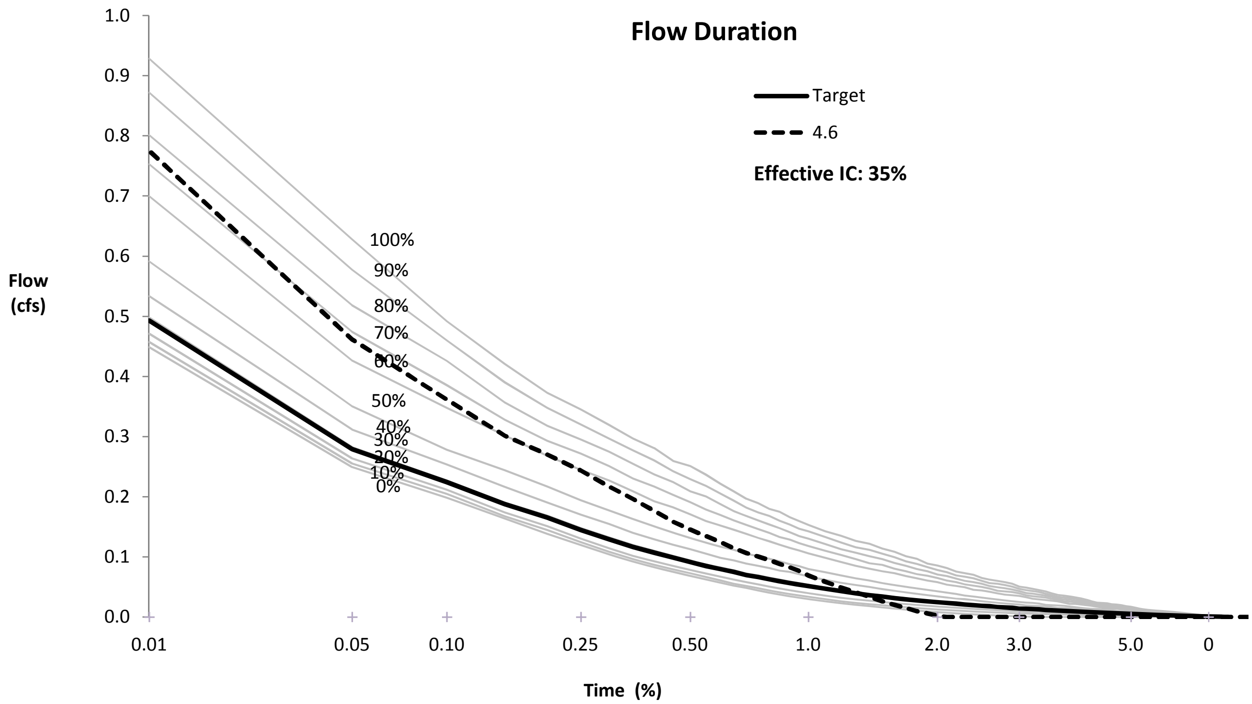
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	15.5	1.1	75
5%IC	18.3	1.8	372
10% IC	21.0	2.6	788
20% IC	26.4	5.4	2,178
30% IC	31.7	9.6	4,445
40% IC	37.1	15.1	7,504
50% IC	42.2	21.7	11,241
60% IC	47.4	28.8	15,328
70% IC	52.5	36.1	19,456
80% IC	57.7	43.4	23,571
90% IC	63.0	50.4	27,583
100% IC	68.2	57.7	31,664
Watershed Load	47.06	24.19	12,693
BMP Output	3.99	0.29	27
Target	24.97	4.67	1,816 `
Reduction %	**92%**	**99%**	**100%**
Effective IC	**-21%**	**-6%**	**-1%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		21.4
Watershed IC (no BMP)	58%	12.4
Target IC reduction	70%	8.7
Effective IC w/BMP	-22%	(4.6)
IC Reduction	137%	17.0

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA72-28 Assessment Model Result Summary for Impervious Cover
4.6 PR BMP 14



Median Annual Load Comparison Table

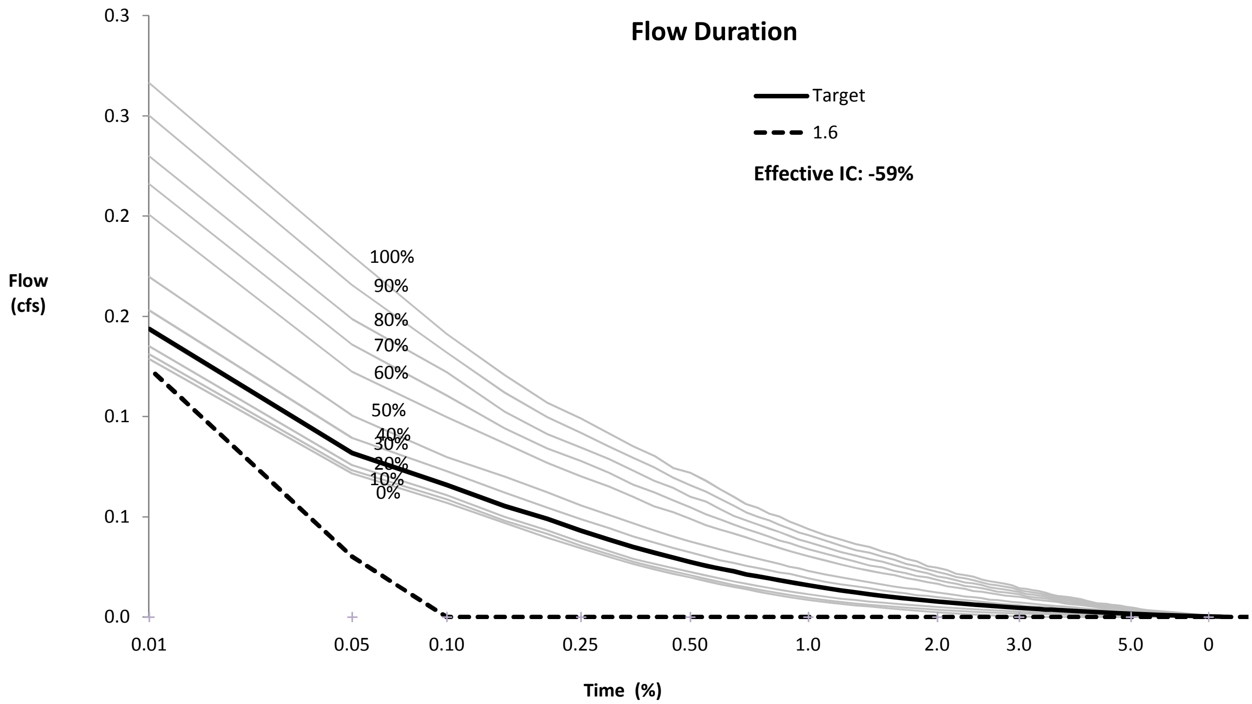
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	0.9	0.1	5
5%IC	1.1	0.1	22
10% IC	1.3	0.2	48
20% IC	1.6	0.3	131
30% IC	1.9	0.6	268
40% IC	2.2	0.9	453
50% IC	2.5	1.3	678
60% IC	2.9	1.7	925
70% IC	3.2	2.2	1,174
80% IC	3.5	2.6	1,422
90% IC	3.8	3.0	1,664
100% IC	4.1	3.5	1,911
Watershed Load	2.99	1.48	753
BMP Output	1.67	0.52	180
Target	1.54	0.30	117 `
Reduction %	**44%**	**65%**	**76%**
Effective IC	**22%**	**28%**	**24%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		1.3
Watershed IC (no BMP)	61%	0.8
Target IC reduction	70%	0.6
Effective IC w/BMP	29%	0.4
IC Reduction	53%	0.4

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA72-28 Assessment Model Result Summary for Impervious Cover
1.6 PR BMP 15



Median Annual Load Comparison Table

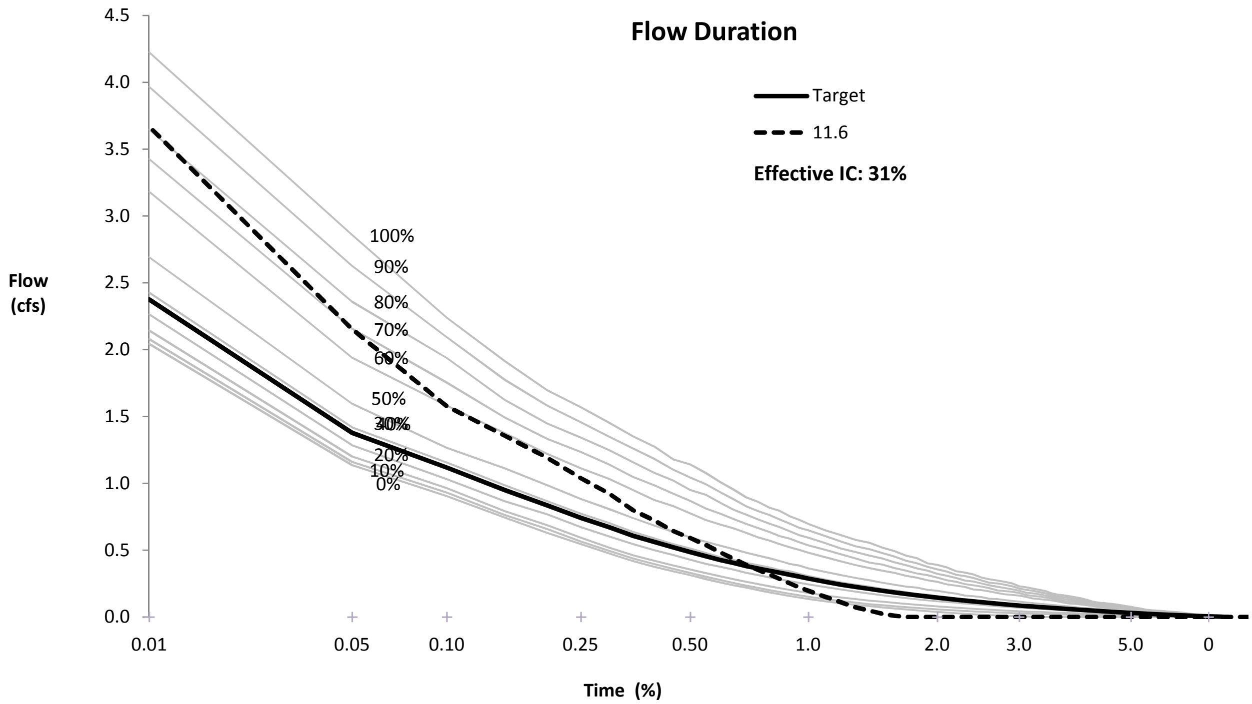
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	0.3	0.0	1
5%IC	0.3	0.0	6
10% IC	0.4	0.0	14
20% IC	0.5	0.1	38
30% IC	0.5	0.2	77
40% IC	0.6	0.3	130
50% IC	0.7	0.4	195
60% IC	0.8	0.5	265
70% IC	0.9	0.6	337
80% IC	1.0	0.8	408
90% IC	1.1	0.9	477
100% IC	1.2	1.0	548
Watershed Load	0.93	0.48	253
BMP Output	0.03	0.00	0
Target	0.47	0.10	42 `
Reduction %	**96%**	**99%**	**100%**
Effective IC	**-24%**	**-7%**	**-1%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		0.4
Watershed IC (no BMP)	70%	0.3
Target IC reduction	70%	0.2
Effective IC w/BMP	-28%	(0.1)
IC Reduction	140%	0.4

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA72-28 Assessment Model Result Summary for Impervious Cover
11.6 PR BMP 17



Median Annual Load Comparison Table

Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	4.3	0.3	21
5%IC	5.0	0.5	102
10% IC	5.8	0.7	216
20% IC	7.2	1.5	598
30% IC	8.7	2.6	1,220
40% IC	10.2	4.1	2,060
50% IC	11.6	6.0	3,086
60% IC	13.0	7.9	4,208
70% IC	14.4	9.9	5,342
80% IC	15.8	11.9	6,471
90% IC	17.3	13.8	7,573
100% IC	18.7	15.8	8,694
Watershed Load	17.56	10.20	5,465
BMP Output	6.41	1.40	420
Target	8.26	2.28	1,029 `
Reduction %	**63%**	**86%**	**92%**
Effective IC	**14%**	**19%**	**15%**

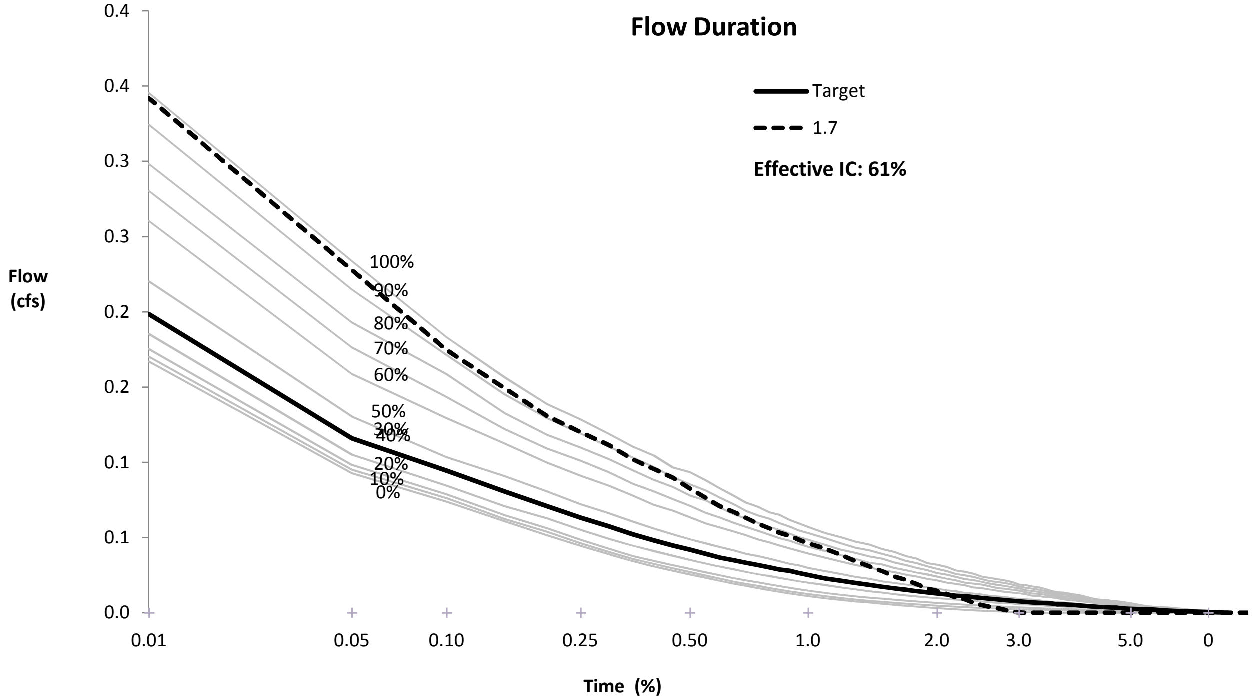
Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		5.9
Watershed IC (no BMP)	90%	5.3
Target IC reduction	70%	3.7
Effective IC w/BMP	21%	1.3
IC Reduction	76%	4.0

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA72-28 Assessment Model Result Summary for Impervious Cover

1.7 PR BMP 18



Median Annual Load Comparison Table

Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	0.3	0.0	2
5%IC	0.4	0.0	8
10% IC	0.5	0.1	18
20% IC	0.6	0.1	49
30% IC	0.7	0.2	100
40% IC	0.8	0.3	168
50% IC	0.9	0.5	252
60% IC	1.1	0.6	344
70% IC	1.2	0.8	437
80% IC	1.3	1.0	529
90% IC	1.4	1.1	619
100% IC	1.5	1.3	711
Watershed Load	1.55	0.99	531
BMP Output	0.99	0.36	121
Target	0.71	0.21	100 `
Reduction %	**36%**	**64%**	**77%**
Effective IC	**54%**	**41%**	**33%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		0.5
Watershed IC (no BMP)	100%	0.5
Target IC reduction	70%	0.3
Effective IC w/BMP	52%	0.2
IC Reduction	48%	0.2

* Effective IC calculated as follows:

1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

Impaired Waters Assessment for Russell Pond (MA73003)

Impaired Water Body

Name: Russell Pond

Location: Milton, MA

Water Body ID: MA73003

Impairments

Russell Pond (MA73003) is listed under Category 5, “Waters Requiring a TMDL”, on MassDEP’s final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). The causes for Russell Pond impairment are listed as the following:

- turbidity
- (non-native aquatic plants*)

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *314 CMR 4.05 (5)(a) Aesthetics*. All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.
- *314 CMR 4.05 (3)(b) 6 Color and Turbidity*. These waters shall be free from color and turbidity in concentrations or combinations that are aesthetically objectionable or would impair any use assigned to this class.

Site Description

Russell Pond (MA73003) is an 8.94 acre pond located adjacent to Route 28 in Milton, Massachusetts approximately 0.95 mile north of the Quincy border (Figure 1). The Russell Pond’s 1.50 square mile watershed extends east from the pond in the towns of Milton and Quincy. The eastern portion of the watershed includes undeveloped areas in the Blue Hills Reservation and the Blue Hills Reservoir. The western portion of the watershed includes densely developed residential areas.

Approximately 1.2 miles of MassDOT road (Route 28) in Milton passes through the Russell Pond watershed. Stormwater runoff from approximately 0.93 mile of Route 28 discharges directly into tributaries of Russell Pond (Figure 2). Approximately 0.57 miles of Route 28 discharge directly into the unnamed eastern tributary stream within 450 feet of Russell Pond. The remaining 0.36 miles of Route 28 discharge into the unnamed northern tributary stream that parallels Route 28. The northern tributary stream is channelized through the mapped wetlands and based on field inspection does not appear to have any characteristics that would promote stormwater treatment. Due to the close proximity of the outfalls from Route 28 in this area relative to Russell Pond and the tributary characteristics, the 0.93 mile segment of Route 28 is considered to be directly contributing to stormwater from impervious surfaces to Russell Pond. Approximately 0.2 miles of Route 28 north of Reed Street and Access Road drains to an outfall at the Access Road and Route 28 intersection. This outfall discharges into an emergent wetland that appears to functionally disconnect stormwater discharge from the associated impervious roadway surface and the northern tributary, thus the associated segment of Route 28 is not considered a directly contributing impervious surface to Russell Pond.

The section of Route 28 that is directly contributing stormwater runoff to Russell Pond is curbed and equipped with catch basins and trunk-line storm drains. The land adjacent to this section of Route 28 primarily consists of moderate to highly developed residential lots.

Assessment under BMP 7U

The following impairments for Russell Pond have not been addressed by a TMDL. Therefore, MassDOT assessed the impairments using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of stormwater on many impairments. For this water body, MassDOT used the IC method to assess the following impairments:

- turbidity

According to the MassDEP's final *Massachusetts Year 2012 Integrated List of Waters*, the impairment of non-native aquatic plants is not caused by pollutants (MassDEP, 2013). Therefore, this impairment is not considered further in this assessment.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction required to ensure that stormwater is not the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. IC data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer.

In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for Russell Pond (MA73003):

Table 1. Site Parameters for Russell Pond (MA73003)

Total and Subwatershed		
Watershed Area	958	acres
Impervious Cover (IC) Area	108	acres
Percent Impervious	11.3	%
IC Area at 9% Goal	86	acres
Target Reduction % in IC	20.4	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	5.0	acres
MassDOT's Target Reduction in Effective IC (20.4% of DOT Directly Contributing IC)	1.0	acres

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 20.4%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 1.0 acres.

Existing BMPs

There are no existing BMPs in the Russell Pond (MA73003) directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to the Russell Pond.

Mitigation Plan

There are no existing structural BMPs in place to mitigate the effects of MassDOT impervious surfaces that directly discharge to Russell Pond. Therefore, MassDOT considered the implementation of additional BMPs to reach the target reduction of 1.0 acres.

Based on the review of MassDOT's directly contributing drainage area, the installation of structural BMPs to address the impairments of Russell Pond is not feasible for the MassDOT direct drainage areas due to the lack of undeveloped right-of-way along this section of Route 28 and the steep topography in undeveloped areas. The outfalls from the storm drains are located in the tributary streams, thus end-of-pipe structural BMPs are not feasible.

Conclusions

MassDOT used the IC Method to assess Russell Pond (MA73003) for the impairments identified in MassDEP's final *Massachusetts Year 2010 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing watershed by **1.0** acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Russell Pond to identify existing BMPs and found that no BMPs exist to reduce effective IC. This information is summarized in Table 2 below.

Table 2. Effective IC Reductions under Existing & Proposed Conditions

IC in Directly Contributing Watershed	5.0	acres
Target Reduction in Effective IC	1.0	acres
IC Effectively Reduced by Existing BMPs	0	acres
IC Remaining to Mitigate	**1.0**	**acres**

MassDOT should reduce its effective IC within the directly contributing watershed by an additional 1.0 acres to achieve the targeted reduction in IC. However, site limitations in the Russell Pond watershed include direct connections of Route 28 drainage to outfalls into the tributaries and limited undeveloped areas within the right-of-way. Therefore, no further action will be taken as part of the Retrofit Initiative of the MassDOT Impaired Waters program for this water body.

Furthermore, MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of additional BMPs, and finalized assessments including reductions achieved by finalized BMP designs. MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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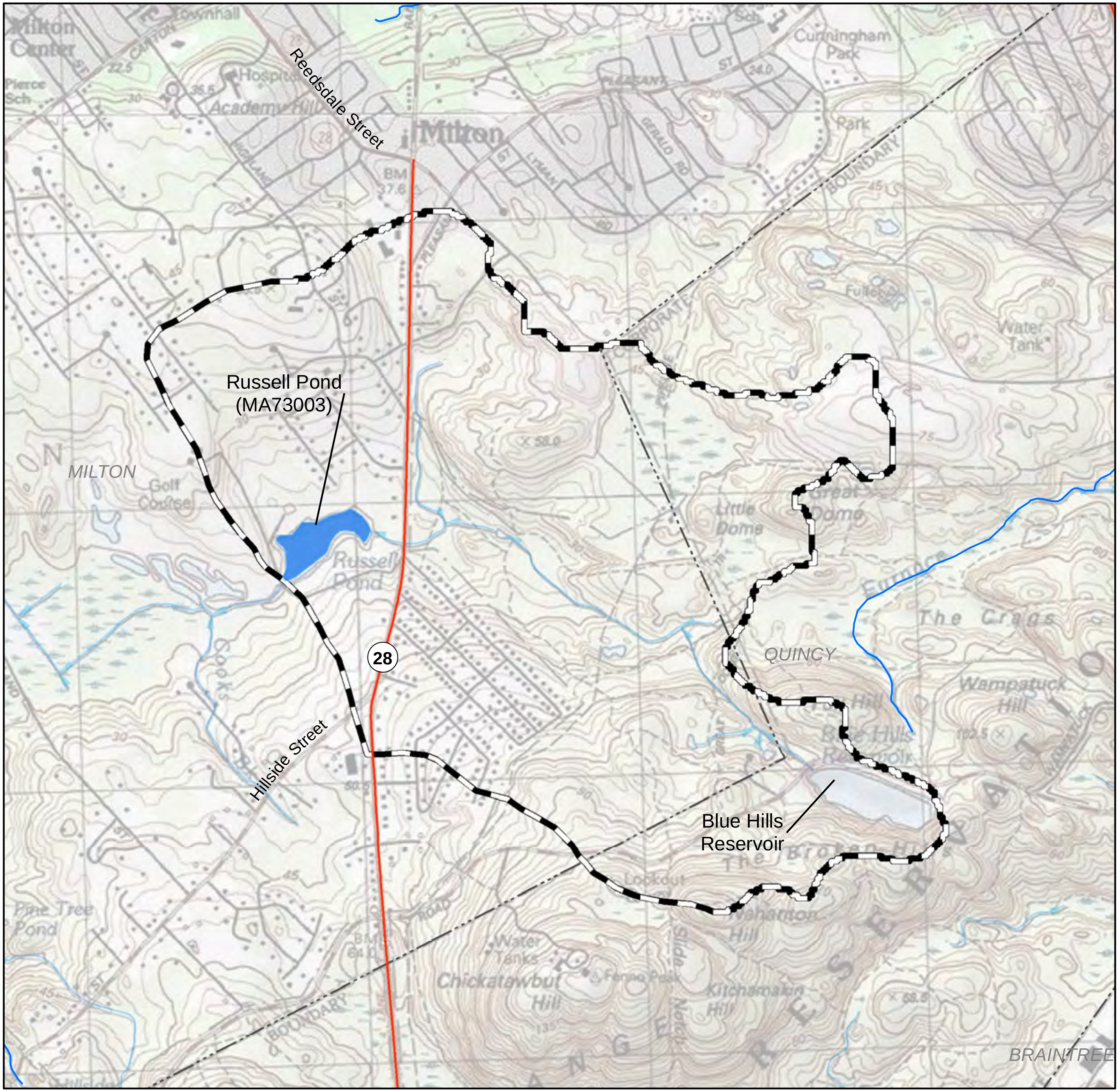

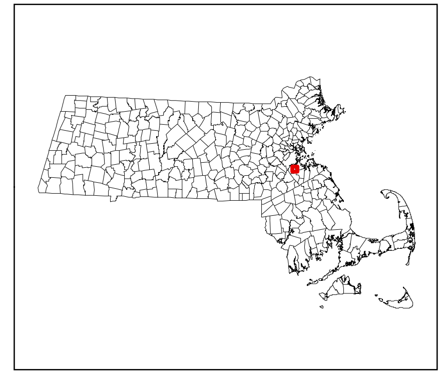

Russell Pond (MA73003)
Impaired Water Body
Impaired Stream Segment
Non-Impaired/Non-Assessed Stream
Total and Subwatershed
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 0.1 0.2 0.3 0.4 0.5 0.6 Miles

1 in = 0.3 miles

Figure 1

Russell Pond
Total and Subwatershed
MA73003

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MassDOT Outfall

Russell Pond (MA73003)

MassDOT Directly Contributing Watershed

Russell Pond Watershed

NWI Wetland Areas

Non-Impaired/Non-Assessed Stream

MassDOT Roads in Urban Area

N

0 350 700 1,050 1,400 Feet

1 inch = 700 feet

<u>Figure 2</u>

Russell Pond
MA73003
Directly Contributing
MassDOT Watershed

June 2013

massDOT Massachusetts Department of Transportation Highway Division

Impaired Waters Assessment for Unquity Brook (MA73-26) – Progress Report

Impaired Water Body

Name: Unquity Brook

Location: Milton, MA

Water Body ID: MA73-26

Impairments

Unquity Brook (MA73-26) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). Unquity Brook is impaired for the following:

- fecal coliform
- Escherichia coli
- dissolved oxygen
- low pH
- sedimentation/siltation
- total phosphorus
- (low flow alterations*)
- (debris/floatables/trash*)
- (physical substrate habitat alterations*)

The 1.5-mile reach of Unquity Brook is impaired for Escherichia coli according to the *Neponset River Watershed 2004 Water Quality Assessment Report* (MassDEP, 2010). Sources of Escherichia coli are unknown. Unquity Brook is also covered by the final *TMDL of Bacteria for Neponset River Basin* (MassDEP, 2002).

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *314 CMR 4.05 (3)(b) 5 Solids*. These waters shall be free from floating, suspended and settleable solids in concentrations or combinations that would impair any use assigned to this class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.
- *314 CMR 4.05 (3)(b) 3 pH*. Shall be in the range of 6.5 through 8.3 standard units but not more than 0.5 units outside of the natural background range. There shall be no change from natural background conditions that would impair any use assigned to this Class.
- *314 CMR 4.05 (5) (b) Bottom Pollutants or Alterations*. All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.

- *314 CMR 4.05 (5) (c) Nutrients*. Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established by the Department pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.
- *314 CMR 4.05 (3)(b) 1 Dissolved Oxygen*. Shall not be less than 6.0 mg/l in cold water fisheries and not less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.
- *314 CMR 4.05 (3)(b) 4 Bacteria*.
    - a. At bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: where E. coli is the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml; alternatively, where enterococci are the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no single sample taken during the bathing season shall exceed 61 colonies per 100 ml;
    - b.for other waters and, during the non bathing season, for waters at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: the geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml; alternatively, the geometric mean of all enterococci samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 61 colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department;

Site Description

The headwaters of Unquity Brook are perennial and begin approximately at the discharge of two outfalls located behind 86 Sias Lane in Milton, MA. The brook flows for 1.5 miles to its confluence with Gulliver Creek. The brook is culverted underground east of Otis Street in Milton and daylights at the intersection of Christopher Street and Squantum Street in Milton. Runoff from the I-93 drainage system discharges at this location, joining Unquity Brook for approximately 100 feet before Unquity brook ends and Gulliver Creek begins.

MassDOT’s property directly contributing stormwater runoff to Unquity Brook is comprised of portions of the following roadways:

- Granite Avenue
- Squantum Street

- Randolf Avenue
- I-93
- Guilford Road

Refer to Figure 1 for the location of the roadways listed above within the total and subwatershed of Unquity Brook, and Figures 2a and 2b for DOT property directly contributing to Unquity Brook. Stormwater from the areas of I-93, Granite Avenue, Squantum Street, and Guilford Road as depicted on Figure 2a is collected in catch basins, flows through a trunk line, and ultimately discharges through an outfall to Unquity brook at the intersection of Christopher Street and Squantum Street in Milton. The area of Randolf Avenue shown in Figure 2b is collected in catch basins and flows through a main trunk line, discharging to an outfall behind 86 Sias Lane. The outfall behind 86 Sias Lane contributes runoff to the headwaters of Unquity Brook. Figures 2a and 2b show the direction of flow by black arrows.

Assessment under BMP 7U

Of the impairments listed for the Unquity Brook, four are potentially linked to stormwater runoff and have not been addressed by a TMDL. Therefore, MassDOT assessed the impairments using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of storm water on many impairments. For this water body, MassDOT used the IC method to assess the following impairments:

- dissolved oxygen
- low pH
- sedimentation/siltation
- total phosphorus

According to MassDEP's final *Massachusetts Year 2012 Integrated List of Waters*, the impairments of low flow alterations, debris/floatables/trash, and physical substrate habitat alterations are not caused by pollutants (MassDEP, 2013). Therefore, these impairments are not considered further.

The impairments for fecal coliform and Escherichia coli are assessed separately in the section titled Assessment of Pathogen Impairment under BMP 7R.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction necessary to attain the percent imperviousness in the watershed at which stormwater is not likely the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. IC data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer.

In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for Unquity Brook (MA73-26):

Table 1. Site Parameters for Unquity Brook (MA73-26)

Total and Subwatershed		
Watershed Area	920	acres
Impervious Cover (IC) Area	290	acres
Percent Impervious	31.5	%
IC Area at 9% Goal	83	acres
Target Reduction % in IC	71.4	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	18.2	acres
MassDOT's Target Reduction in Effective IC (71.4% of DOT Directly Contributing IC)	13.0	acres

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 71.4%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 13.0 acres.

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 13.0 acres, MassDOT will consider the implementation of additional BMPs.

Assessment of Pathogen Impairment under BMP 7R

MassDOT assessed the pathogen impairment using the approach described in BMP 7R of MassDOT's Storm Water Management Plan (TMDL Watershed Review), which applies to impairments that have been assigned to a water body covered by a final TMDL. Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by an order of magnitude within a given storm event at a single location (MassDEP, 2009b). Therefore, it is difficult to predict pathogen concentrations in stormwater with accuracy. Due to this difficulty, MassDOT generally will not conduct site specific assessments of loading at each location impaired for pathogens. Instead these sites will be assessed collectively based on available information on pathogen loading from highways, MassDOT actions, and information available from EPA and DEP. Based on this information MassDOT developed an approach to be consistent with relevant TMDL and permit condition requirements and an iterative adaptive management approach to stormwater management.

In addition, while there is a positive relationship between IC and pathogen loading, the relationship is not as direct as other impairments. According to the Center for Watershed Protection "…Other studies show that concentrations of bacteria are typically higher in urban areas than rural areas (USGS, 1999), but they are not always directly related to IC (CWP, 2003)." Therefore, DOT did not rely solely on the IC method to assess pathogen impairments. Instead, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

Pathogens in MassDOT Discharge

A study conducted on MassDOT's South East Expressway measured bacterial concentrations in stormwater runoff (Smith, 2002). This study found a geometric mean of 186 fecal coliforms/100 ml. Concentrations of pathogens in stormwater runoff from roadways can vary widely and pathogen concentrations in runoff across the state likely deviate significantly from this stretch of roadway's specific estimate. Event mean concentrations of fecal coliform bacteria in urban stormwater from other sources ranging between 14,000 and 17,000 fecal coliform organisms/100 mL have been reported (MassDEP, 2009b). These data suggest that pathogen loading from highways may be lower than other urban areas.

Consideration of the potential sources of pathogens supports the idea that pathogens are present in lower concentrations in highway runoff since potential pathogen sources are likely to be less prevalent in the highway environment than along other urban roadways:

- <u>Illicit discharges:</u> Due to the typical setback of highways from residential and commercial developments and the stand alone nature of the drainage system, the potential for illicit discharges (e.g. sewer connections, laundry tie-ins) is much lower than in other stormwater systems. This has been confirmed by MassDOT's illicit discharge detection on many miles of urban roadways within a broad range of areas across Massachusetts. After assessment of almost 140 miles, and investigation of more than 2,500 stormwater features, MassDOT's consultant performing the broad scope reviews has found no confirmed illicit discharges.
- <u>Limited Sewer Utilities in Road Right of Ways:</u> Since DOT does not provide sewer services, many MassDOT roads do not have sewer utilities within the road's right of way;

thereby eliminating the chance of cross-connections or leaking pipes as a source of pathogens into the stormwater system.

- Pet waste: Pets are only present on highways in rare instances. In urban residential areas pets and their associated waste are much more common. MassDOT is aware that pet waste at road side rest stops may represent a potential source of pathogens to stormwater in certain situations.
- Wildlife: Highways are not generally an attractive place for wildlife. Wildlife generally avoids highways and only occasionally crosses them.

The dearth of pathogen sources on highways and the relatively low concentrations of pathogens measured in the South East Expressway study together suggest that pathogen loading from stormwater runoff from highways is lower than other urban sources.

Furthermore, in almost all cases the contribution of pathogens from MassDOT to a specific water body is likely to be very small relative to other sources of pathogens in the watershed. Since MassDOT urban roadways are linear and usually cross watersheds, they represent a small fraction of the receiving water body's watershed. The water quality within these water bodies is dependent on discharge from various sources, including discharges from other stormwater systems and a large number of other factors.

Assessment

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

TMDLs for pathogen impairments in Massachusetts recognize that pathogens are highly variable and difficult to address and emphasize the need for an iterative adaptive management approach to address pathogens. Examples of relevant language from these TMDLs are included below:

- "given the vast potential number of bacteria sources and the difficulty of identifying and removing them from some sources such as stormwater require an iterative process and will take some time to accomplish. While the stated goal in the TMDL is to meet the water quality standard at the point of discharge it also attempts to be clear that MassDEP's expectation is that for stormwater an iterative approach is needed…" (MassDEP, 2009a)
- "The NPDES permit does not, however, establish numeric effluent limitations for stormwater discharges. Maximum extent practicable (MEP) is the statutory standard that establishes the level of pollutant reductions that regulated municipalities must achieve. The MEP standard is a narrative effluent limitation that is satisfied through implementation of SWMPs and achievement of measurable goals."(MassDEP, 2009b)
- "Although the TMDL presents quantified WLAs for stormwater that are set equivalent to the criteria in the Massachusetts Water Quality Standards, the Phase II NPDES permits will not include numeric effluent limitations. Phase II permits are intended to be BMP based permits that will require communities to develop and implement comprehensive stormwater management programs involving the use of BMPs. Massachusetts and EPA believe that BMP based Phase II permits involving comprehensive stormwater management together with specific emphasis on pollutants contributing to existing water quality problems can be consistent with the intent of the quantitative WLAs for stormwater discharges in TMDLs." (MassDEP, 2002).

This language clearly indicates that an iterative adaptive management approach is the appropriate way to address discharges to pathogen impaired waters. The recommendations in pathogen TMDLs for waters in Massachusetts generally require development and implementation of stormwater management programs, illicit discharge detection and elimination efforts, and in some cases installing BMPs to the maximum extent practicable

The draft North Coastal Watershed General MS4 permit and the draft Interstate, Merrimack, and South Coastal (IMS) watershed permits contain specific requirements for compliance with pathogen TMDLs (in Appendix G). While these permits are still in draft form, MassDOT believes they represent the best available guidance on what EPA believes is appropriate for addressing stormwater discharges to pathogen-impaired waters. Section 2.2.1(c) of the permit states "For any discharge from its MS4 to impaired waters with an approved TMDL, the permittee shall comply with the specific terms of Part 2.1 of this permit. In addition, where an approved TMDL establishes a WLA that applies to its MS4 discharges, the permittee shall implement the specific BMPs and other permit requirements identified in Appendix G to achieve consistency with the WLA." Appendix G references a number of programmatic BMPs that are necessary to address pathogen loading. These cover the following general topics:

- Residential educational program
- Illicit connection identification, tracking and removal
- Pet waste management

Mitigation Plan

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Stormwater Management Plan (SWMP) including educational programs, illicit connection review and source control. The specific BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In
- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

In addition, the structural BMPs that will be considered to reduce the IC will also have the effect of reducing pathogen loads.

MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations. MassDOT's existing stormwater management plan outlines BMPs that include education and illicit discharge detection and elimination. MassDOT will be implementing a pet waste management program at its rest stops that have discharges to pathogen impaired waters.

Conclusions

MassDOT used the IC Method to assess Unquity Brook for the impairments identified in MassDEP's final *Massachusetts Year 2012 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed by 13.0 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Unquity Brook to identify existing BMPs and found none. This information is summarized in Table 2 below.

Table 2. Effective IC Reductions under Existing & Proposed Conditions

IC in Directly Contributing Watershed	18.2	acres
Target Reduction in Effective IC	13.0	acres
IC Effectively Reduced by Existing BMPs	0	acres
IC Remaining to Mitigate with Proposed BMPs	**13.0**	**acres**

MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs to treat directly contributing IC as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide the target IC reduction or treatment to the maximum extent practicable.

MassDOT has concluded based on review of the draft North Coastal Watershed General MS4 permit, the draft Interstate, Merrimack, and South Coastal watershed permits, and pathogen TMDLs for Massachusetts waters, that the BMPs outlined in the stormwater management plan and those under consideration for reducing effective IC from MassDOT areas are consistent with its existing permit requirements. MassDOT believes that these measures achieve pathogen reductions (including fecal coliform) to the maximum extent practicable and are consistent with the intent of its existing stormwater permit and the applicable Pathogen TMDLs.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of additional BMPs, and finalized assessments including reductions achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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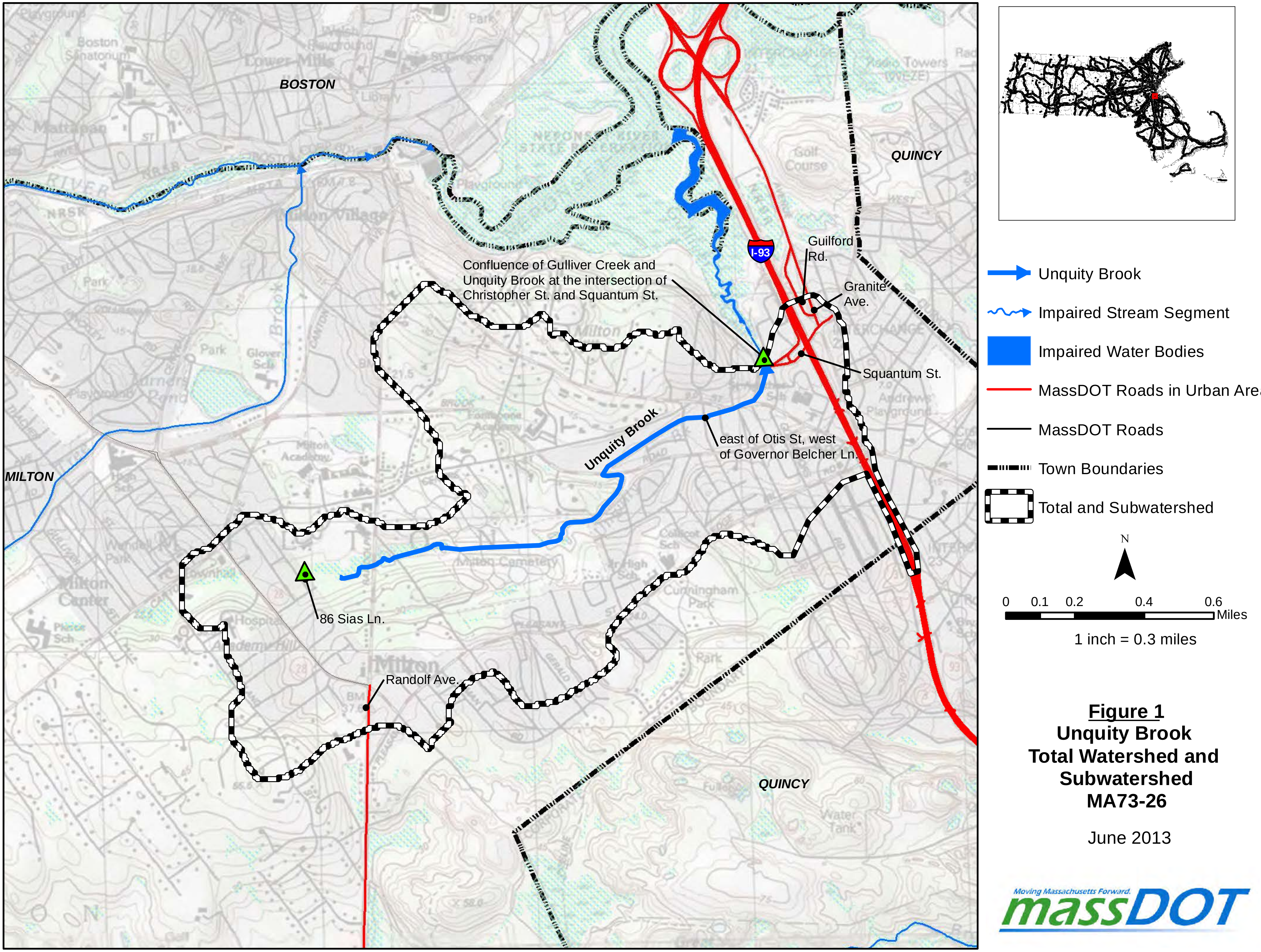

Figure 1
Unquity Brook
Total Watershed and Subwatershed
MA73-26

June 2013

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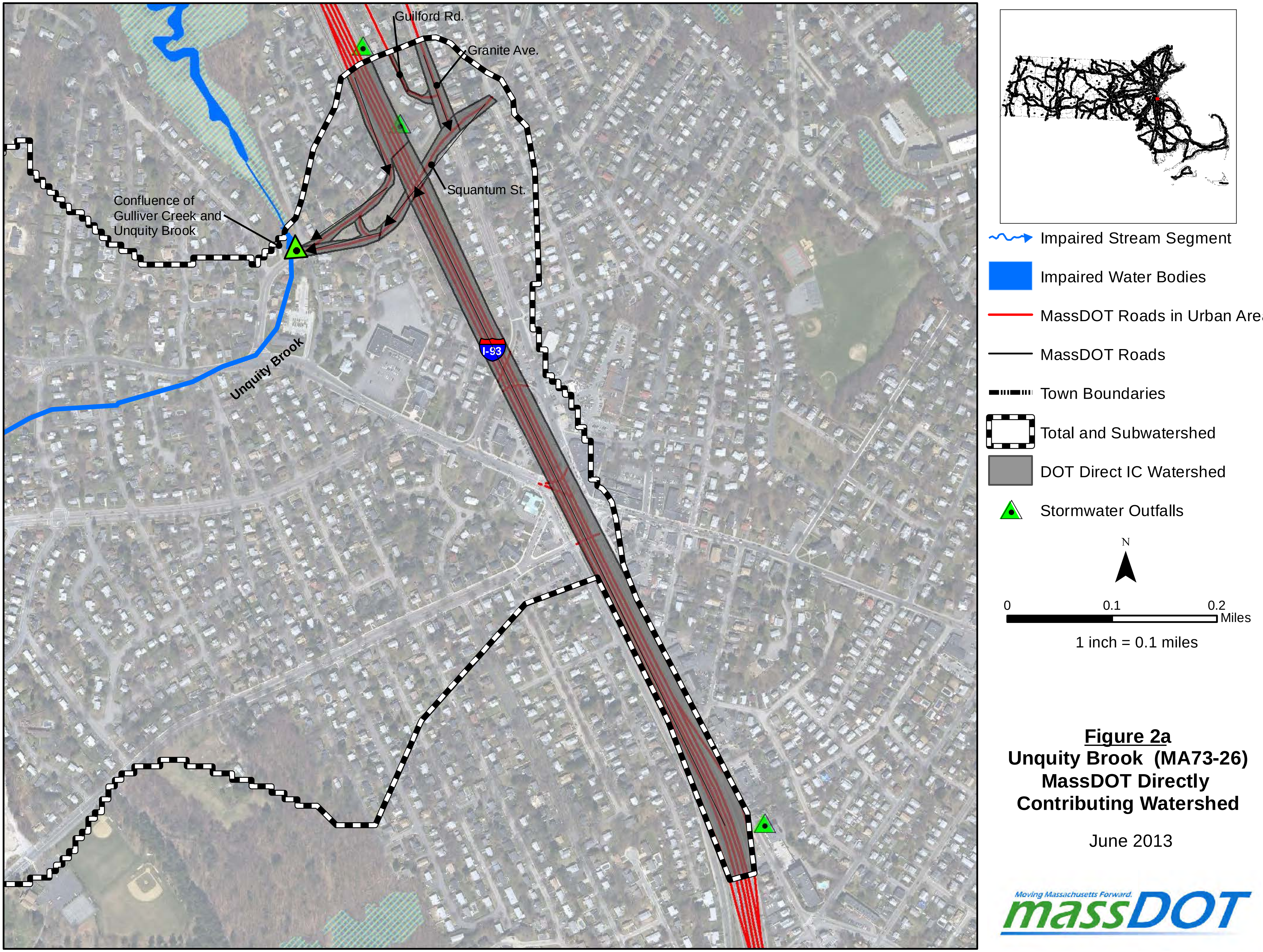

Figure 2a
Unquity Brook (MA73-26)
MassDOT Directly
Contributing Watershed

June 2013

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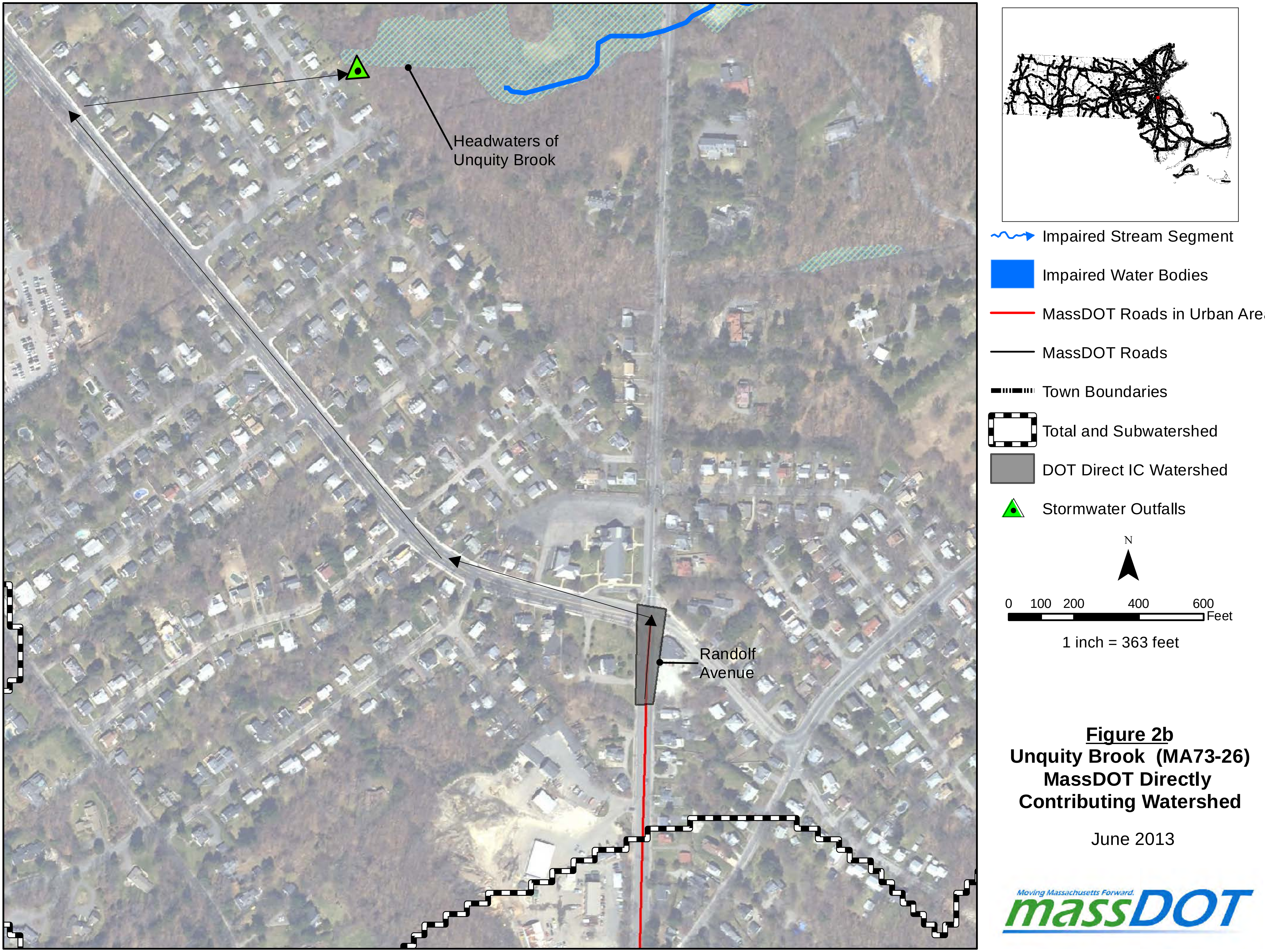

Figure 2b
Unquity Brook (MA73-26)
MassDOT Directly
Contributing Watershed

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Impaired Waters Assessment for Gulliver Creek (MA73-30) – Progress Report

Impaired Waterbody

Name: Gulliver Creek

Location: Milton, MA

Water Body ID: MA73-30

Impairments

Gulliver Creek (MA73-30) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). Gulliver Creek is impaired for the following:

- fecal coliform
- PCB in fish tissue
- other

According to MassDEP's *Neponset River Watershed 2004 Water Quality Assessment Report* (MassDEP, 2010), the 0.9 mile length of Gulliver Creek is impaired for PCBs in fish tissue and other. The report stated that Gulliver creek is impaired for the use of fish consumption and MassDEP issued a fish consumption advisory due to PCBs and other contaminates. Gulliver Creek is also impaired due to fecal coliform and is covered by the *TMDL of Bacteria for Neponset River Basin* (MassDEP, 2002).

Relevant Water Quality Standards

Water Body Classification: Class SB

Applicable State Regulations:

- 3*14 CMR 4.05 (4)(b) 1 Dissolved Oxygen.* Shall not be less than 5.0 mg/l. Seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained. Where natural background conditions are lower, DO shall not be less than natural background.

- *314 CMR 4.05 (4)(b) 3 pH.* Shall be in the range of 6.5 through 8.5 standard units and not more than 0.2 standard units outside of the natural background range. There shall be no change from natural background conditions that would impair any use assigned to this Class.
- *314 CMR 4.05 (4)(b) 4 Pathogens*.

  a. Waters designated for shellfishing shall not exceed a fecal coliform median or geometric mean MPN of 88 organisms per 100 ml, nor shall more than 10% of the samples exceed an MPN of 260 per 100 ml or other values of equivalent protection based on sampling and analytical methods used by the Massachusetts Division of Marine Fisheries and approved by the National Shellfish Sanitation Program in the latest revision of the Guide For The Control of Molluscan Shellfish (more stringent regulations may apply, see 314 CMR 4.06(1)(d)(5));

b. at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010, no single enterococci sample taken during the bathing season shall exceed 104 colonies per 100 ml and the geometric mean of the five most recent samples taken within the same bathing season shall not exceed 35 enterococci colonies per 100 ml. In non bathing beach waters and bathing beach waters during the non bathing season, no single enterococci sample shall exceed 104 colonies per 100 ml and the geometric mean of all of the samples taken during the most recent six months typically based on a minimum of five samples shall not exceed 35 enterococci colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department.

- *314 CMR 4.05 (4)(b) 5 Solids.* These waters shall be free from floating, suspended and settleable solids in concentrations or combinations that would impair any use assigned to this class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.

- *314 CMR 4.05 (5) (b) Bottom Pollutants or Alterations.* All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.
- *314 CMR 4.05 (5)(e) Toxic Pollutants*

All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife. For pollutants not otherwise listed in 314 CMR 4.00, the National Recommended Water Quality Criteria: 2002, EPA 822R-02-047, November 2002 published by EPA pursuant to Section 304(a) of the Federal Water Pollution Control Act, are the allowable receiving water concentrations for the affected waters, unless the Department either establishes a site specific criterion or determines that naturally occurring background concentrations are higher. Where the Department determines that naturally occurring background concentrations are higher, those concentrations shall be the allowable receiving water concentrations. The Department shall use the water quality criteria for the protection of aquatic life expressed in terms of the dissolved fraction of metals when EPA's 304(a) recommended criteria provide for use of the dissolved fraction. The EPA recommended criteria based on total recoverable metals shall be converted to dissolved metals using EPA's published conversion factors. Permit limits will be written in terms of total recoverable metals. Translation from dissolved metals criteria to total recoverable metals permit limits will be based on EPA's conversion factors or other methods approved by the Department. The Department may establish site specific criteria for toxic pollutants based on site specific considerations.

Site Description

Gulliver Creek encompasses a 0.9 mile stretch between the confluence of Unquity Brook, and the confluence of the Neponset River in Milton.

MassDOT's property directly contributing stormwater runoff to Gulliver Creek is comprised of I-93 between exit 10 for Squantum Street and Exit 11 for Granite Avenue. Stormwater runoff from the interstate flows into small piped stormwater systems that discharge through outfalls into wetlands directly adjacent and hydraulically connected to Gulliver Creek. Refer to Figure 1 for the location of

I-93 within the total and subwatershed of Gulliver Creek. Refer to Figure 2 for DOT property directly contributing to Gulliver Creek and the general direction of flow to Gulliver Creek.

Assessment under BMP 7U

Of the impairments listed for the Gulliver Creek, one is potentially linked to stormwater runoff and has not been addressed by a TMDL. Therefore, MassDOT assessed the impairment using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of storm water on many impairments. For this water body, MassDOT used the IC method to assess the following impairments:

- other

MassDOT concluded that the impairment for PCB in fish tissue is unrelated to storm water runoff. The *Nationwide Urban Runoff Program* (NURP) conducted by the EPA found that PCB was detected in less than 1% of stormwater samples collected (EPA, 1983). Therefore, MassDOT concluded that stormwater runoff from its roadways does not contribute to the impairments of PCB in fish tissue.

The impairment for fecal coliform is assessed separately in the section titled Assessment of Pathogen Impairment under BMP 7R.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction necessary to attain the percent imperviousness in the watershed at which stormwater is not likely the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. IC data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer.

In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in

BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for Gulliver Creek (MA73-30):

Table 1. Site Parameters for Gulliver Creek (MA73-30)

Total Watershed and Subwatershed		
Watershed Area	1,130	acres
Impervious Cover (IC) Area	348	acres
Percent Impervious	30.7*	%
IC Area at 9% Goal	102	acres
Target Reduction % in IC	70.7	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	9.5	acres
MassDOT's Target Reduction in Effective IC (70.7% of DOT Directly Contributing IC)	6.7	acres

*Rounding accounts for differences in calculations.

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 70.7%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 6.7 acres.

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 6.7 acres, MassDOT will consider the implementation of additional BMPs.

Assessment of Pathogen Impairment under BMP 7R

MassDOT assessed the pathogen impairment using the approach described in BMP 7R of MassDOT's Storm Water Management Plan (TMDL Watershed Review), which applies to impairments that have been assigned to a water body covered by a final TMDL. Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by an order of magnitude within a given storm event at a single location (MassDEP, 2009b). Therefore, it is difficult to predict pathogen concentrations in stormwater with accuracy. Due to this difficulty, MassDOT generally will not conduct site specific assessments of loading at each location impaired for pathogens. Instead these sites will be assessed collectively based on available information on pathogen loading from highways, MassDOT actions, and information available from EPA and DEP. Based on this information MassDOT developed an approach to be consistent with relevant TMDL and permit condition requirements and an iterative adaptive management approach to stormwater management.

In addition, while there is a positive relationship between IC and pathogen loading, the relationship is not as direct as other impairments. According to the Center for Watershed Protection "…Other studies show that concentrations of bacteria are typically higher in urban areas than rural areas (USGS, 1999), but they are not always directly related to IC (CWP, 2003)." Therefore, DOT did not rely solely on the IC method to assess pathogen impairments. Instead, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

Pathogens in MassDOT Discharge

A study conducted on MassDOT's South East Expressway measured bacterial concentrations in stormwater runoff (Smith, 2002). This study found a geometric mean of 186 fecal coliforms/100 ml. Concentrations of pathogens in stormwater runoff from roadways can vary widely and pathogen concentrations in runoff across the state likely deviate significantly from this stretch of roadway's specific estimate. Event mean concentrations of fecal coliform bacteria in urban stormwater from other sources ranging between 14,000 and 17,000 fecal coliform organisms/100 mL have been reported (MassDEP, 2009b). These data suggest that pathogen loading from highways may be lower than other urban areas.

Consideration of the potential sources of pathogens supports the idea that pathogens are present in lower concentrations in highway runoff since potential pathogen sources are likely to be less prevalent in the highway environment than along other urban roadways:

- <u>Illicit discharges:</u> Due to the typical setback of highways from residential and commercial developments and the stand alone nature of the drainage system, the potential for illicit discharges (e.g. sewer connections, laundry tie-ins) is much lower than in other stormwater systems. This has been confirmed by MassDOT's illicit discharge detection on many miles of urban roadways within a broad range of areas across Massachusetts. After assessment of almost 140 miles, and investigation of more than 2,500 stormwater features, MassDOT's consultant performing the broad scope reviews has found no confirmed illicit discharges.
- <u>Limited Sewer Utilities in Road Right of Ways:</u> Since DOT does not provide sewer services, many MassDOT roads do not have sewer utilities within the road's right of way; thereby eliminating the chance of cross-connections or leaking pipes as a source of pathogens into the stormwater system.
- <u>Pet waste:</u> Pets are only present on highways in rare instances. In urban residential areas pets and their associated waste are much more common. MassDOT is aware that pet waste at road side rest stops may represent a potential source of pathogens to stormwater in certain situations.
- <u>Wildlife:</u> Highways are not generally an attractive place for wildlife. Wildlife generally avoids highways and only occasionally crosses them.

The dearth of pathogen sources on highways and the relatively low concentrations of pathogens measured in the South East Expressway study together suggest that pathogen loading from stormwater runoff from highways is lower than other urban sources.

Furthermore, in almost all cases the contribution of pathogens from MassDOT to a specific water body is likely to be very small relative to other sources of pathogens in the watershed. Since MassDOT urban roadways are linear and usually cross watersheds, they represent a small fraction of the receiving water body's watershed. The water quality within these water bodies is dependent on discharge from various sources, including discharges from other stormwater systems and a large number of other factors.

Assessment

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

TMDLs for pathogen impairments in Massachusetts recognize that pathogens are highly variable and difficult to address and emphasize the need for an iterative adaptive management approach to address pathogens. Examples of relevant language from these TMDLs are included below:

- "given the vast potential number of bacteria sources and the difficulty of identifying and removing them from some sources such as stormwater require an iterative process and will take some time to accomplish. While the stated goal in the TMDL is to meet the water quality standard at the point of discharge it also attempts to be clear that MassDEP's expectation is that for stormwater an iterative approach is needed…" (MassDEP, 2009a)
- "The NPDES permit does not, however, establish numeric effluent limitations for stormwater discharges. Maximum extent practicable (MEP) is the statutory standard that establishes the level of pollutant reductions that regulated municipalities must achieve. The MEP standard is a narrative effluent limitation that is satisfied through implementation of SWMPs and achievement of measurable goals."(MassDEP, 2009b)
- "Although the TMDL presents quantified WLAs for stormwater that are set equivalent to the criteria in the Massachusetts Water Quality Standards, the Phase II NPDES permits will not include numeric effluent limitations. Phase II permits are intended to be BMP based permits that will require communities to develop and implement comprehensive stormwater management programs involving the use of BMPs. Massachusetts and EPA believe that BMP based Phase II permits involving comprehensive stormwater management together with specific emphasis on pollutants contributing to existing water quality problems can be consistent with the intent of the quantitative WLAs for stormwater discharges in TMDLs." (MassDEP, 2002).

This language clearly indicates that an iterative adaptive management approach is the appropriate way to address discharges to pathogen impaired waters. The recommendations in pathogen TMDLs for waters in Massachusetts generally require development and implementation of stormwater management programs, illicit discharge detection and elimination efforts, and in some cases installing BMPs to the maximum extent practicable

The draft North Coastal Watershed General MS4 permit and the draft Interstate, Merrimack, and South Coastal (IMS) watershed permits contain specific requirements for compliance with pathogen TMDLs (in Appendix G). While these permits are still in draft form, MassDOT believes they represent the best available guidance on what EPA believes is appropriate for addressing stormwater discharges to pathogen-impaired waters. Section 2.2.1(c) of the permit states "For any discharge from its MS4 to impaired waters with an approved TMDL, the permittee shall comply with the specific terms of Part 2.1 of this permit. In addition, where an approved TMDL establishes a WLA that applies to its MS4 discharges, the permittee shall implement the specific BMPs and other permit requirements identified in Appendix G to achieve consistency with the WLA." Appendix G references a number of programmatic BMPs that are necessary to address pathogen loading. These cover the following general topics:

- Residential educational program
- Illicit connection identification, tracking and removal
- Pet waste management

Mitigation Plan

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Stormwater Management Plan (SWMP) including educational programs, illicit connection review and source control. The specific BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In
- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

In addition, the structural BMPs that will be considered to reduce the IC will also have the effect of reducing pathogen loads.

MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations. MassDOT's existing stormwater management plan outlines BMPs that include education and illicit discharge detection and elimination. MassDOT will be implementing a pet waste management program at its rest stops that have discharges to pathogen impaired waters.

Conclusions

MassDOT used the IC Method to assess Gulliver Creek for the impairments identified in MassDEP's final *Massachusetts Year 2012 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed by 6.7 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Gulliver Creek to identify existing BMPs and found that existing BMPs provide 0% of the target reduction in effective IC. This information is summarized in Table 2 below.

Table 2. Effective IC Reductions under Existing & Proposed Conditions

IC in Directly Contributing Watershed	9.5	acres
Target Reduction in Effective IC	6.7	acres
IC Effectively Reduced by Existing BMPs	0	acres
IC Remaining to Mitigate with Proposed BMPs	**6.7**	**acres**

MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs to treat directly contributing IC as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide the target IC reduction or treatment to the maximum extent practicable.

MassDOT has concluded based on review of the draft North Coastal Watershed General MS4 permit, the draft Interstate, Merrimack, and South Coastal watershed permits, and pathogen TMDLs for Massachusetts waters, that the BMPs outlined in the stormwater management plan and those under consideration for reducing effective IC from MassDOT areas are consistent with its existing permit requirements. MassDOT believes that these measures achieve pathogen reductions (including fecal coliform) to the maximum extent practicable and are consistent with the intent of its existing stormwater permit and the applicable Pathogen TMDLs.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of additional BMPs, and finalized assessments including reductions achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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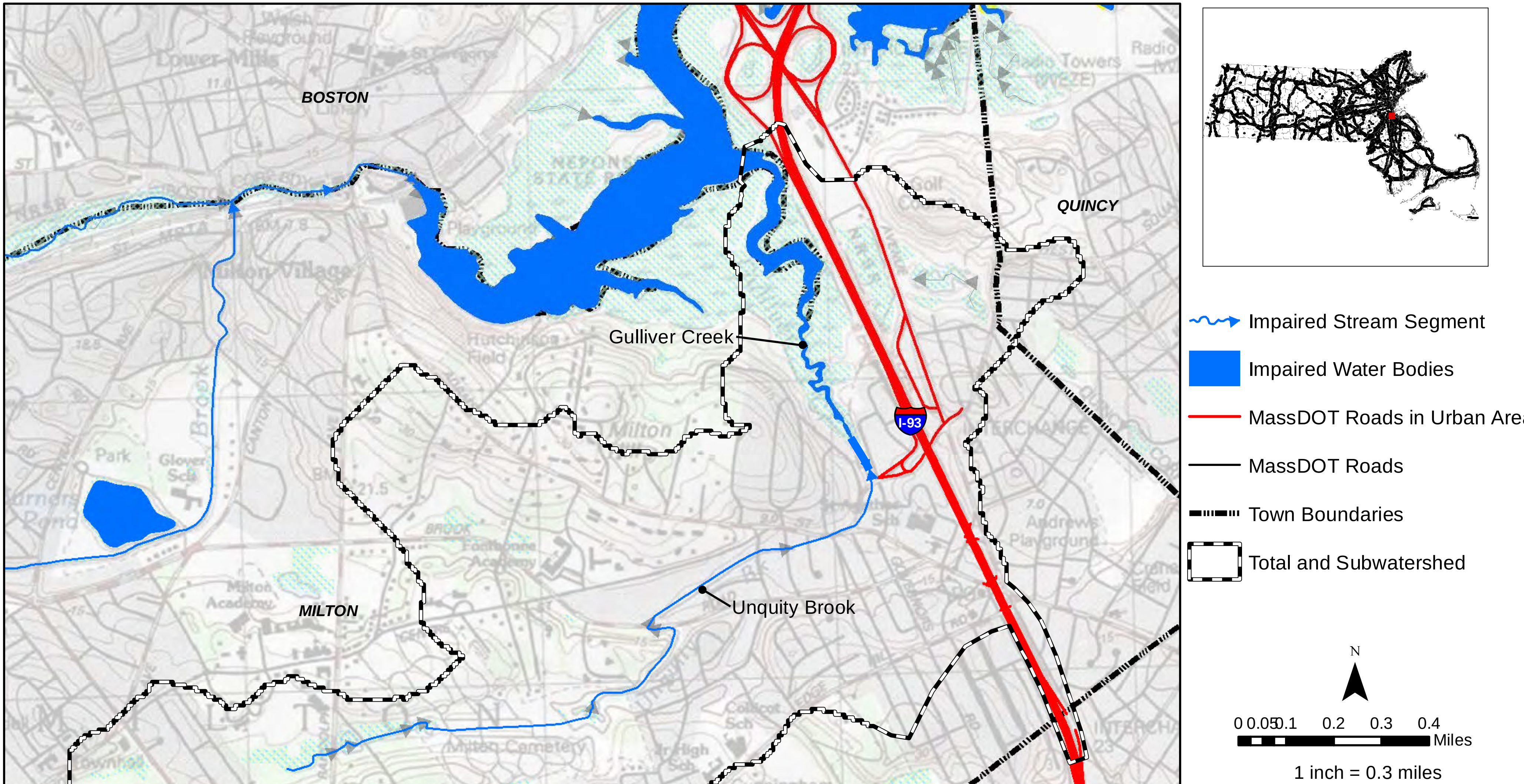

Figure 1
Gulliver Creek
Total and Subwatershed
MA73-30

June 2013

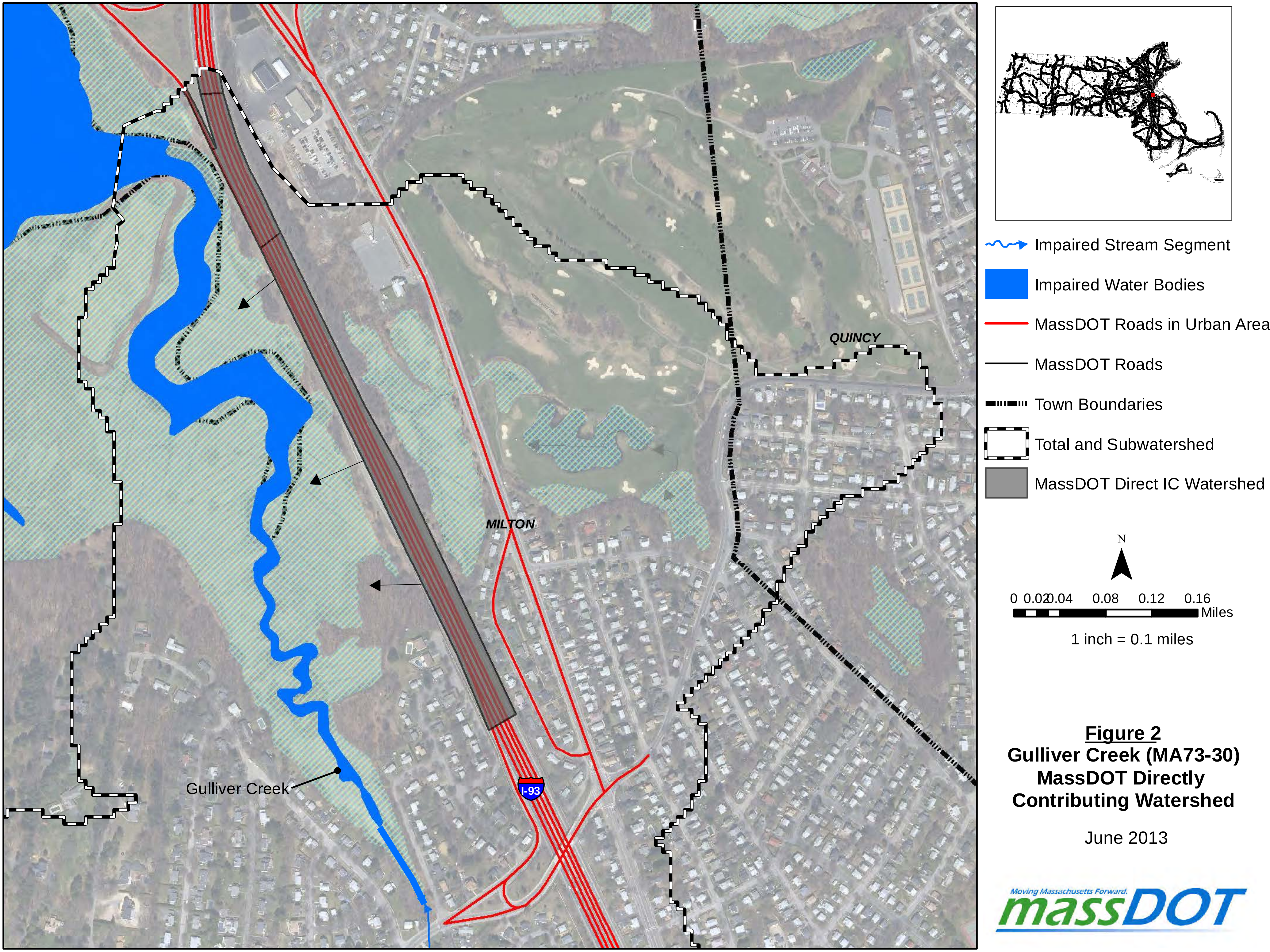

Figure 2
Gulliver Creek (MA73-30)
MassDOT Directly
Contributing Watershed

June 2013

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Impaired Waters Assessment for Mill River (MA74-04) – Progress Report

Impaired Waterbody

Name: Mill River

Location: Weymouth, MA

Water Body ID: MA74-04

Impairments

Mill River (MA74-04) is listed under Category 5, “Waters requiring a TMDL”, on MassDEP’s final *Massachusetts Year 2012 Integrated List of Waters (2013)*. According to this list, Mill River is impaired for the following:

- fecal coliform
- nutrient/eutrophication biological indicators

Mill River (MA74-04) was not assessed for any uses in MassDEP’s *Weymouth and Weir River Basin 2004 Water Quality Assessment Report* (MassDEP, 2010).

Mill River (MA74-04) is covered by the Draft Pathogen TMDL for the Boston Harbor Watershed (MassDEP, no date). MassDOT’s approach to water bodies that are impaired for pathogens is to comply with their current illicit discharge detention and elimination (IDDE) program outlined in their Storm Water Management Plan (SWMP).

Relevant Water Quality Standards

Water Body Classification: Class A

Applicable State Regulations:

- *314 CMR 4.05 (3)(a) 4 Bacteria*.
    a. At water supply intakes in unfiltered public water supplies: either fecal coliform shall not exceed 20 fecal coliform organisms per 100 ml in all samples taken in any six month period, or total coliform shall not exceed 100 organisms per 100 ml in 90% of the samples taken in any six month period, If both fecal coliforn and total coliform are measured, then only the fecal coliform criterion must be met. More stringent regulations may apply under the Massachusetts Drinking Water regulations, 310 CMR 22.00 (see 314 CMR 4.06(1)(d)1.);
    b. at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: where E. coli is the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml; alternatively, where enterococci are the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per

100 ml and no single sample taken during the bathing season shall exceed 61 colonies per 100 ml;

c. for other waters and, during the non bathing season, for waters at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: the geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml; alternatively, where enterococci are the chosen indicator, the geometric mean of all enterococci samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples, and no single sample shall exceed 61 colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department

- *314 CMR 4.05 (5)(c) Nutrients*. Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established by the Department pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.

Site Description

Segment MA74-04 of Mill River is located in Weymouth, MA. It begins just west of the intersection of Hollis Street/Derby Street and Pond Street. The river flows north approximately 3.4 miles and flows into Whitmans Pond (MA74025). The total watershed of segment MA74-04 is approximately 6 square miles. The subwatershed is the same area as the total watershed as shown in Figure 1.

There are several MassDOT-owned urban roadways in the subwatershed of segment MA74-04. These include Washington Street (Route 53), Route 3, Main Street (Route 18), ramps to and from Route 3 and Route 18, Columbian Street and Park Avenue West. Portions of all of these roadways contribute stormwater runoff directly to Mill River. The drainage systems along each of these roadways are described briefly below.

<u>Washington Street (Route 53)</u>
The Mill River passes through culverts beneath Washington Street and large shopping complex parking lots on both sides of Washington Street. The drainage system along this portion of Washington Street consists of catch basins on both sides of the road. There are three drainage manholes at the lowest point of the road. These manholes could not be opened during the field investigation, however, it is likely that the catch basins along the roadway connect to these manholes which likely discharge to the river culverted below. Therefore, Washington Street was considered as directly contributing IC area in this assessment. The directly contributing area from Route 53 is shown on Figure 2.

<u>Route 3</u>
Mill River flows through the Route 3 and Route 18 interchange. Catch basins on the two northeastern ramps capture stormwater and discharge it to wetlands on the outer side of the ramps. These wetlands are connected to Mill River. Therefore, these ramps are considered direct.

Stormwater from portions of the southeastern ramps is captured by catch basins and discharged to the inside of the cloverleaf via pipes. Stormwater that is discharged at these outfalls infiltrates in the vegetated cloverleaf area. There are also portions of these two ramps which contribute stormwater runoff to the outside of the outer ramp via drain pipes. This stormwater also infiltrates in vegetated areas. Thus, these two ramps are indirect.

Stormwater runoff from the two southwestern ramps is captured by catch basins and is piped and discharged to the inside of the cloverleaf area. Stormwater discharged from the northern-most outfall infiltrates in the vegetated cloverleaf area. Stormwater discharged from the rest of the outfalls in this cloverleaf travels to Mill River via ditches. Thus, the portions of roadway contributing to these outfalls are considered direct.

Adjacent to the southwestern ramps, there is an existing ditch which is in good condition. It is grassy, dry, appropriately graded, and infiltrates stormwater well. Outlets discharging to the ditch should be dug out and sediment should be removed. The existing ditch and suggested remedial work is described in the AECOM memorandum titled “FY14 Route 3 Resurfacing – Stormwater Improvements Recommendations”, submitted to MassDOT on 1/21/2013. It may be possible to convert this ditch into an infiltration BMP.

Stormwater runoff from the northwestern ramp is captured by catch basins and is discharged directly to the river via an outfall. The directly contributing area from Route 3 and Route 18 are shown on Figure 3.

<u>Main Street (Route 18)</u>
There is a system of catch basins along the portion of Route 18 north of the Route 3 interchange. These catch basins capture stormwater which is then piped in the direction of a drainage easement which continues to Mill River. Thus, this portion of Route 18 was considered direct in this assessment.

The Route 3/Route 18 interchange system uses a drainage system comprised of catch basins, pipes, and ditches. Stormwater runoff from the portion of Route 18 within this interchange and just south of the interchange is captured by catch basins and is then piped either directly to the river or to ditches inside the southwestern cloverleaf which carry water to the river.

<u>Columbian Street/Park Avenue West</u>
Mill River flows under Columbian Street and Park Avenue West where Park Ave West merges with Columbian Street. There is a catch basin at a low point near the river which discharges runoff directly to the river via a projecting pipe outfall. There is also a curb cut with a paved waterway to the river on the northern side of the road at this low area. Stormwater runoff from Columbian Street and Park Ave West flows to this curb cut and directly into the river. The directly contributing area from Route 53 is shown on Figure 4.

Assessment under BMP 7U

The impairment of nutrient/eutrophication biological indicators for segment MA74-04 of Mill River has not been addressed by a TMDL. Therefore, MassDOT assessed the impairments using the approach described in BMP 7U of MassDOT’s Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT’s Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of stormwater on many impairments. For this water body, MassDOT used the IC method to assess the impairment of nutrient/eutrophication biological indicators.

The impairment of fecal coliform is assessed separately in the section titled Assessment of Pathogen Impairment.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction required to ensure that stormwater is not the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. IC data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer.

In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for Mill River (MA74-04):

Table 1. Site Parameters for Mill River (MA74-04)

Total and Subwatershed	
Watershed Area	4,008 acres
Impervious Cover (IC) Area	689 acres
Percent Impervious	17.2%
IC Area at 9% Goal	689 acres
Target Reduction % in IC	47.6%
Reductions Applied to DOT Direct Watershed	
MassDOT's IC Area **Directly** Contributing to Impaired Segment	24.3 acres
MassDOT's Target Reduction in Effective IC (47.6% of DOT Directly Contributing IC)	11.5 acres

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 47.6%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 11.5 acres.

Existing BMPs

Based on the site visit, there are no existing BMPs within MassDOT's directly contributing watershed to segment MA74-04 that are mitigating potential storm water quality impacts. Therefore, no effective IC reduction is provided by existing MassDOT BMPs.

Mitigation Plan

Because there are no existing BMPs mitigating impervious surface, MassDOT will consider the implementation of new BMPs to meet the 11.5 acre target reduction in impervious cover.

The majority of the Route 3 and Route 18 interchange falls within falls within a DEP Zone II Wellhead protection area, thereby prohibiting the installation of any infiltration BMPs. There is, however, a small area adjacent to the southwest off ramps that may be suitable for a future BMP, as described in the Site Description section of this assessment and the AECOM memo titled "FY14 Route 3 Resurfacing – Stormwater Improvements Recommendations".

Assessment of Pathogen Impairment

MassDOT assessed the pathogen impairment using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by an order of magnitude within a given storm event at a single location (MassDEP, 2009b). Therefore, it is difficult to predict pathogen concentrations in stormwater with accuracy. Due to this difficulty, MassDOT generally will not conduct site specific assessments of loading at each location impaired for pathogens. Instead these sites will be assessed collectively based on available information on pathogen loading from highways, MassDOT actions, and information available from EPA and DEP. Based on this information MassDOT developed an approach to be consistent with relevant TMDL and permit condition requirements and an iterative adaptive management approach to stormwater management.

In addition, while there is a positive relationship between IC and pathogen loading, the relationship is not as direct as other impairments. According to the Center for Watershed Protection "…Other studies show that concentrations of bacteria are typically higher in urban areas than rural areas (USGS, 1999), but they are not always directly related to IC (CWP, 2003)." Therefore, DOT did not rely solely on the IC method to assess pathogen impairments. Instead, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

Pathogens in MassDOT Discharge

A study conducted on MassDOT's South East Expressway measured bacterial concentrations in stormwater runoff (Smith, 2002). This study found a geometric mean of 186 fecal coliforms/100 ml. Concentrations of pathogens in stormwater runoff from roadways can vary widely and pathogen concentrations in runoff across the state likely deviate significantly from this stretch of roadway's specific estimate. Event mean concentrations of fecal coliform bacteria in urban stormwater from other sources ranging between 14,000 and 17,000 fecal coliform organisms/100 mL have been reported (MassDEP, 2009b). These data suggest that pathogen loading from highways may be lower than other urban areas.

Consideration of the potential sources of pathogens supports the idea that pathogens are present in lower concentrations in highway runoff since potential pathogen sources are likely to be less prevalent in the highway environment than along other urban roadways:

- Illicit discharges: Due to the typical setback of highways from residential and commercial developments and the stand alone nature of the drainage system, the potential for illicit discharges (e.g. sewer connections, laundry tie-ins) is much lower than in other stormwater systems. This has been confirmed by MassDOT's illicit discharge detection on many miles of urban roadways within a broad range of areas across Massachusetts. After assessment of almost 140 miles, and investigation of more than 2,500 stormwater features, MassDOT's consultant performing the broad scope reviews has found no confirmed illicit discharges.
- Limited Sewer Utilities in Road Right of Ways: Since DOT does not provide sewer services, many MassDOT roads do not have sewer utilities within the road's right of way; thereby eliminating the chance of cross-connections or leaking pipes as a source of pathogens into the stormwater system.
- Pet waste: Pets are only present on highways in rare instances. In urban residential areas pets and their associated waste are much more common. MassDOT is aware that pet waste at road side rest stops may represent a potential source of pathogens to stormwater in certain situations.
- Wildlife: Highways are not generally an attractive place for wildlife. Wildlife generally avoids highways and only occasionally crosses them.

The dearth of pathogen sources on highways and the relatively low concentrations of pathogens measured in the South East Expressway study together suggest that pathogen loading from stormwater runoff from highways is lower than other urban sources.

Furthermore, in almost all cases the contribution of pathogens from MassDOT to a specific water body is likely to be very small relative to other sources of pathogens in the watershed. Since MassDOT urban roadways are linear and usually cross watersheds, they represent a small fraction of the receiving water body's watershed. The water quality within these water bodies is dependent on discharge from various sources, including discharges from other stormwater systems and a large number of other factors.

Assessment

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

TMDLs for pathogen impairments in Massachusetts recognize that pathogens are highly variable and difficult to address and emphasize the need for an iterative adaptive management approach to address pathogens. Examples of relevant language from these TMDLs are included below:

- "given the vast potential number of bacteria sources and the difficulty of identifying and removing them from some sources such as stormwater require an iterative process and will take some time to accomplish. While the stated goal in the TMDL is to meet the water quality standard at the point of discharge it also attempts to be clear that MassDEP's expectation is that for stormwater an iterative approach is needed…" (MassDEP, 2009a)
- "The NPDES permit does not, however, establish numeric effluent limitations for stormwater discharges. Maximum extent practicable (MEP) is the statutory standard that establishes the level of pollutant reductions that regulated municipalities must achieve. The MEP standard is a narrative effluent limitation that is satisfied through implementation of SWMPs and achievement of measurable goals."(MassDEP, 2009b)
- "Although the TMDL presents quantified WLAs for stormwater that are set equivalent to the criteria in the Massachusetts Water Quality Standards, the Phase II NPDES permits will not include numeric effluent limitations. Phase II permits are intended to be BMP based permits that will require communities to develop and implement comprehensive stormwater management programs involving the use of BMPs. Massachusetts and EPA believe that BMP based Phase II permits involving comprehensive stormwater management together with specific emphasis on pollutants contributing to existing water quality problems can be consistent with the intent of the quantitative WLAs for stormwater discharges in TMDLs." (MassDEP, 2002).

This language clearly indicates that an iterative adaptive management approach is the appropriate way to address discharges to pathogen impaired waters. The recommendations in pathogen TMDLs for waters in Massachusetts generally require development and implementation of stormwater management programs, illicit discharge detection and elimination efforts, and in some cases installing BMPs to the maximum extent practicable

The draft North Coastal Watershed General MS4 permit and the draft Interstate, Merrimack, and South Coastal (IMS) watershed permits contain specific requirements for compliance with pathogen TMDLs (in Appendix G). While these permits are still in draft form, MassDOT believes they represent the best available guidance on what EPA believes is appropriate for addressing stormwater discharges to pathogen-impaired waters. Section 2.2.1(c) of the permit states "For any discharge from its MS4 to impaired waters with an approved TMDL, the permittee shall comply with the specific terms of Part 2.1 of this permit. In addition, where an approved TMDL establishes a WLA that applies to its MS4 discharges, the permittee shall implement the specific BMPs and other permit requirements identified in Appendix G to achieve consistency with the WLA." Appendix G references a number of programmatic BMPs that are necessary to address pathogen loading. These cover the following general topics:

- Residential educational program
- Illicit connection identification, tracking and removal
- Pet waste management.

Mitigation Plan

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Stormwater Management Plan (SWMP) including educational programs, illicit connection review and source control. The specific BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In
- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

In addition, the structural BMPs that will be considered to reduce the IC will also have the effect of reducing pathogen loads.

MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations. MassDOT's existing stormwater management plan outlines BMPs that include education and illicit discharge detection and elimination. MassDOT will be implementing a pet waste management program at its rest stops that have discharges to pathogen impaired waters.

Conclusions

MassDOT used the IC Method to assess Mill River Segment MA74-04 for the impairments identified in MassDEP's final *Massachusetts Year 2012 Integrated List of Waters (2013)*. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed by 11.5 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Mill River segment MA74-04 to identify existing BMPs and found that no BMPs exist to reduce effective IC.

MassDOT should reduce its effective IC within the directly contributing watershed to achieve the targeted reduction in IC. MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs to treat directly contributing IC as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide the target IC reduction or treatment to the maximum extent practicable.

MassDOT has concluded based on review of the draft North Coastal Watershed General MS4 permit, the draft Interstate, Merrimack, and South Coastal watershed permits, and pathogen TMDLs for Massachusetts waters, that the BMPs outlined in the stormwater management plan and those under consideration for reducing effective IC from MassDOT areas are consistent with its existing permit requirements. MassDOT believes that these measures achieve pathogen reductions (including fecal coliform) to the maximum extent practicable and are consistent with the intent of its existing stormwater permit and the applicable Pathogen TMDLs.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of additional BMPs, and finalized assessments including reductions achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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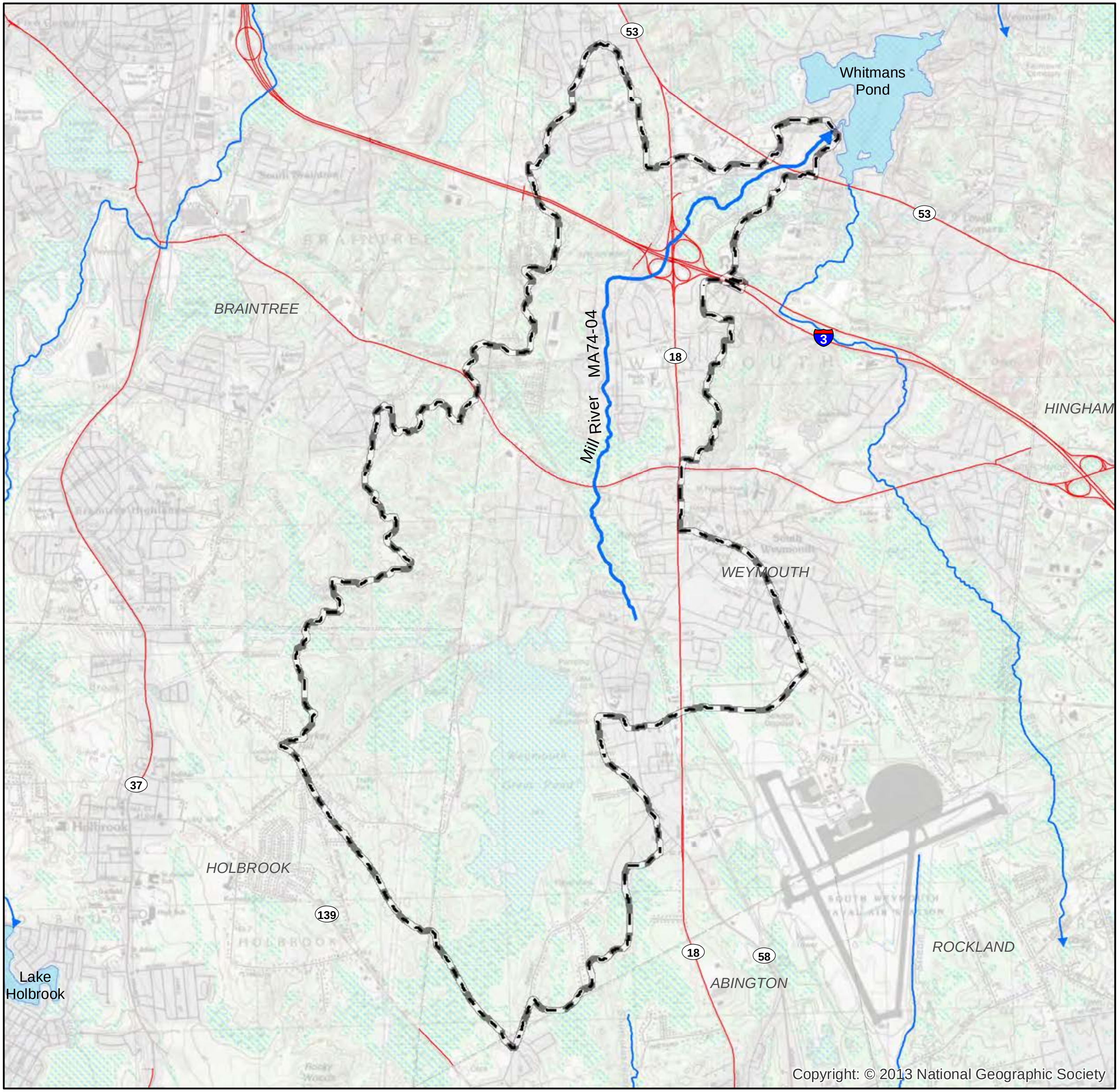

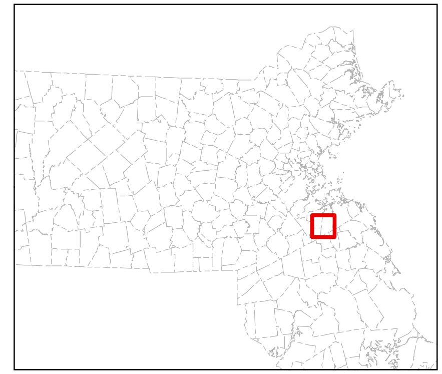

MA74-04_Subwatershed
MA74-04_TotalWatershed
Mill River
Impaired Stream Segment
Impaired Water Body
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 875 1,750 3,500 5,250 7,000 Feet

1 in = 3,500 feet

Figure 1

Mill River Total Watershed and Subwatershed (MA74-04)

June 2013

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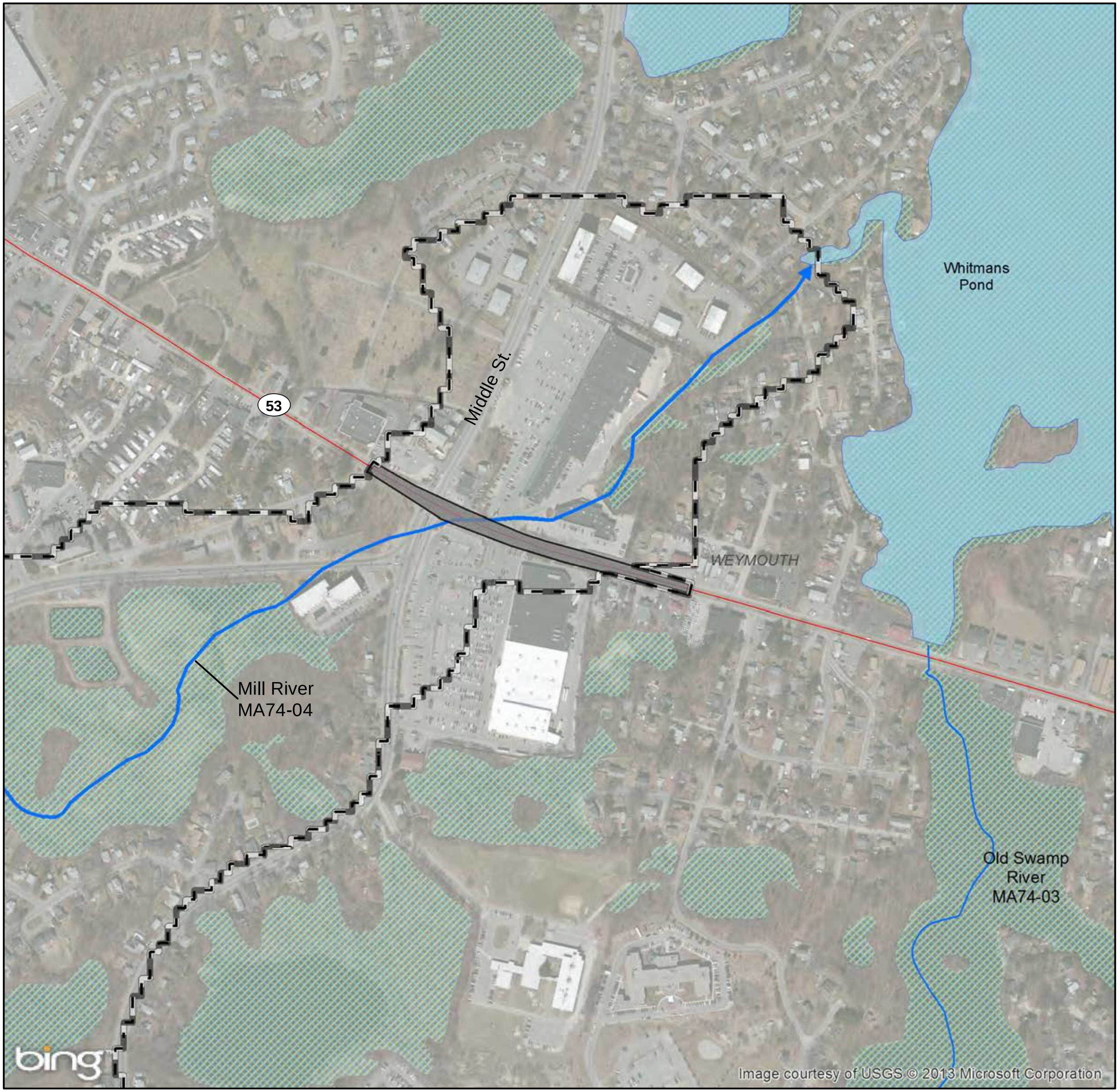

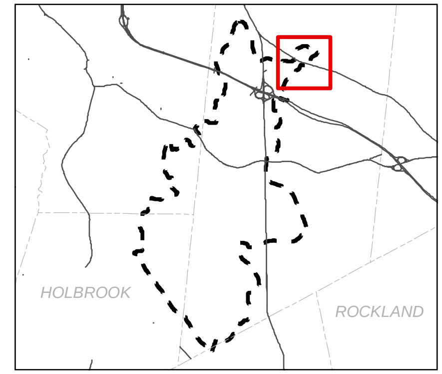

MA74-04 SubWatershed
MA74-04 TotalWatershed
MassDOT Contributing Watershed
Mill River
Impaired Stream Segment
Impaired Water Body
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 125 250 500 750 1,000
Feet

1 in = 500 feet

Figure 2

Mill River (MA74-04)
MassDOT Directly
Contributing Watershed

June 2013

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massDOT

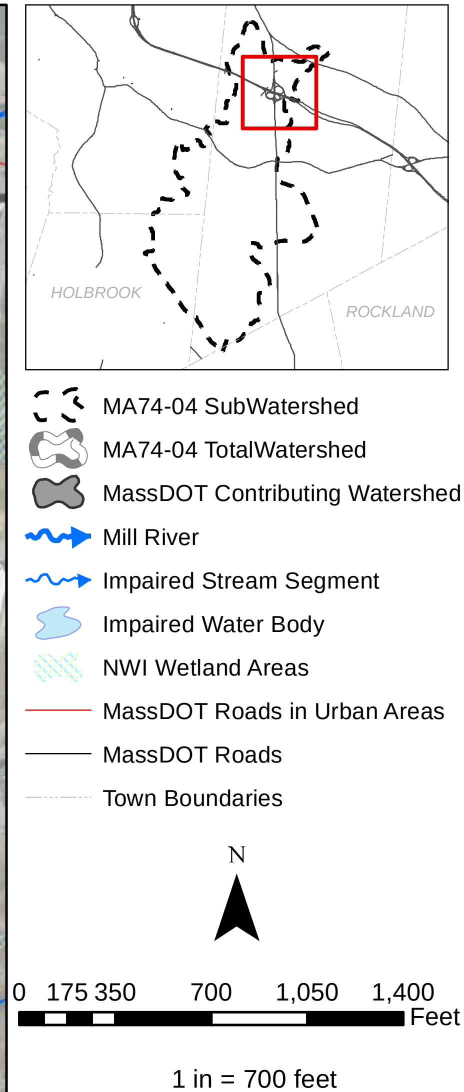
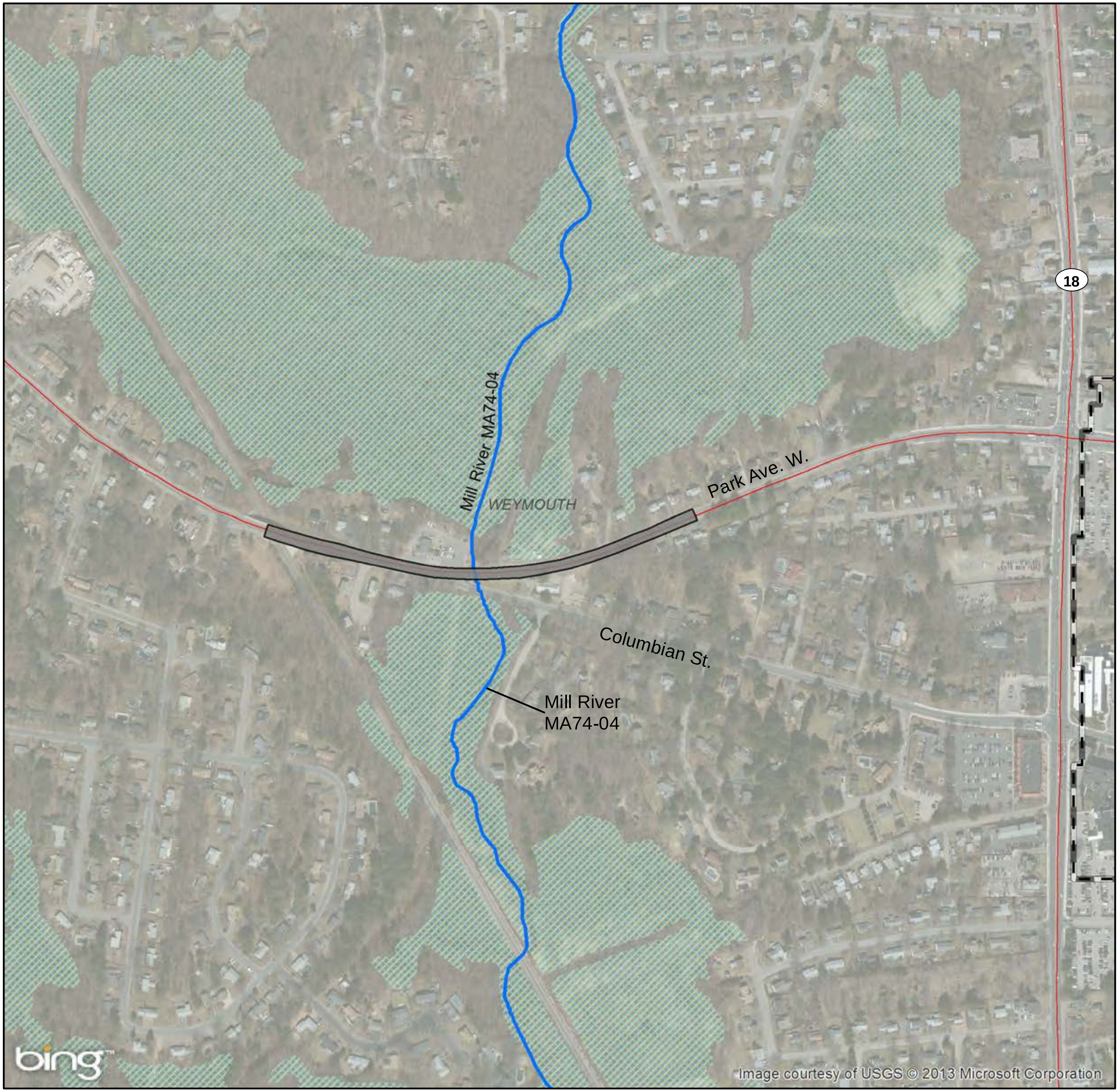
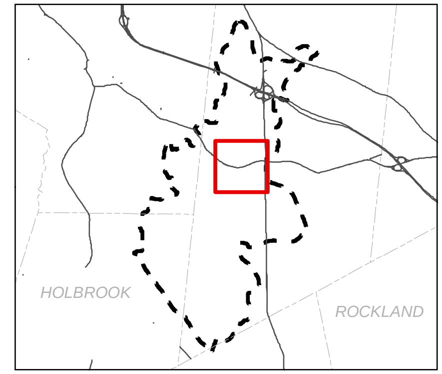


Figure 3

Mill River (MA74-04)
MassDOT Directly
Contributing Watershed

June 2013





MA74-04 SubWatershed
MA74-04 TotalWatershed
MassDOT Contributing Watershed
Mill River
Impaired Stream Segment
Impaired Water Body
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 125 250 500 750 1,000 Feet

1 in = 500 feet

Figure 4

Mill River (MA74-04) MassDOT Directly Contributing Watershed

June 2013

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Impaired Waters Assessment for Town Brook (MA74-09) – Progress Report

Impaired Waterbody

Name: Town Brook

Location: Braintree and Quincy, MA

Water Body ID: MA74-09

Impairments

Town Brook (MA74-09) is listed under Category 5, "Waters requiring a TMDL", on MassDEP's final *Massachusetts Year 2010 Integrated List of Waters* (MassDEP, 2011). According to this list, Town Brook is impaired for the following:

- fecal coliform
- (physical substrate habitat alterations*)
- aquatic macroinvertebrate bioassessments

MassDEP's *Weymouth and Weir River Basin 2004 Water Quality Assessment Report* (MassDEP, 2010) states that Town Brook is impaired for physical substrate habitat alterations and other flow regime alteration due to impacts from hydrostructure flow regulation/modification, habitat modification (other than hydromodification) and channelization. Town Brook is also covered by a draft Total Maximum Daily Load (TMDL) for pathogens according to MassDEP's Draft Pathogen TMDL for the Boston Harbor Watershed (excluding the Neponset River sub-basin) (MassDEP, no date).

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *314 CMR 4.05 (3)(b) 5 Solids*. These waters shall be free from floating, suspended and settleable solids in concentrations or combinations that would impair any use assigned to this class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.

- *314 CMR 4.05 (5) (b) Bottom Pollutants or Alterations*. All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.

- *314 CMR 4.05 (5)(e) Toxic Pollutants*. All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife. For pollutants not otherwise listed in 314 CMR 4.00, the National Recommended Water Quality Criteria: 2002, EPA 822R-02-047, November 2002 published by EPA pursuant to Section 304(a) of the Federal Water Pollution Control Act, are the allowable receiving water concentrations for the affected waters, unless the Department either establishes a site specific criterion or determines that naturally occurring background concentrations are higher. Where the Department determines that naturally occurring background concentrations are higher, those concentrations shall be the allowable receiving water concentrations. The Department shall use the water quality criteria for the protection of aquatic life expressed in terms of the dissolved fraction of metals when EPA's 304(a) recommended criteria provide for use of the dissolved fraction. The EPA recommended criteria based on total recoverable metals shall be converted to dissolved metals using EPA's published conversion factors. Permit limits will be written in terms of total recoverable metals. Translation from dissolved metals criteria to total recoverable metals permit limits will be based on EPA's conversion factors or other methods approved by the Department. The Department may establish site specific criteria for toxic pollutants based on site specific considerations.

- *314 CMR 4.05 (3)(b) 1 Dissolved Oxygen*.a. Shall not be less than 6.0 mg/l in cold water fisheries and not less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.

- *314 CMR 4.05 (3)(b) 2 Temperature*.
  - Shall not exceed 68°F (20°C) based on the mean of the daily maximum temperature over a seven day period in cold water fisheries, unless naturally occurring. Where a reproducing cold water aquatic community exists at a naturally occurring higher temperature, the temperature necessary to protect the community shall not be exceeded and the natural daily and seasonal temperature fluctuations necessary to protect the community shall be maintained. Temperature shall not exceed 83°F (28.3°C) in warm water fisheries. The rise in temperature due to a discharge shall not exceed 3°F (1.7°0C) in rivers and streams designated as cold water fisheries nor 5°F (2.8°C) in rivers and streams designated as warm water fisheries (based on the minimum expected flow for the month); in lakes and ponds the rise shall not exceed 3°F (1.7°0C) in the epilimnion (based on the monthly average of maximum daily temperature);
  - b. natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained. There shall be no changes from natural background conditions that would impair any use assigned to this Class, including those conditions necessary to protect normal species diversity, successful migration, reproductive functions or growth of aquatic organisms.

- *314 CMR 4.05 (3)(b) 3 pH*. Shall be in the range of 6.5 through 8.3 standard units but not more than 0.5 units outside of the natural background range. There shall be no change from natural background conditions that would impair any use assigned to this Class.

- *314 CMR 4.05 (3)(b) 4 Bacteria*.
  - At bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: where E. coli is the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml; alternatively, where enterococci are the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no single sample taken during the bathing season shall exceed 61 colonies per 100 ml;
  - for other waters and, during the non bathing season, for waters at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: the geometric mean of all E. coli samples taken within the most

> recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml; alternatively, the geometric mean of all enterococci samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 61 colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department.

Site Description

Segment MA74-09 of Town Brook begins at Old Quincy Reservoir (MA74017) in Braintree and flows approximately 3.5 miles before flowing into Town River Bay (MA74-15) in Quincy. The total watershed of segment MA74-09 is approximately 4.0 square miles. The subwatershed is the same area as the total watershed for this brook. The watershed area is shown in Figure 1.

There are several MassDOT-owned urban roadways in the subwatershed of Segment MA74-09. These include Granite Street (Route 37), Interstate 93, Route 3, Washington Street, ramps to Burgin Parkway, and ramps to and from I-93 and Rte 3. Of these roadways, stormwater from portions of the ramp from Route 3 to I-93, the ramp from I-93 to Rte 3, Washington Street ramps to and from Washington Street, ramps to and from Burgin Parkway, a bridge on Burgin Parkway and the MBTA driveway off of Burgin Parkway all discharge directly to Town Brook. These directly contributing MassDOT areas are shown in Figure 2.

Most of the stormwater from the directly contributing roadways is collected by catch basins along the shoulders and discharged to systems of paved ditches which carry stormwater to Town Brook. Some stormwater is collected by catch basins and piped directly to the culvert which carries Town Brook beneath the ramp system.

Assessment under BMP 7U

The impairment of aquatic macroinvertebrate bioassessments for segment Town Brook has not been addressed by a TMDL. Therefore, MassDOT assessed this impairment using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of stormwater on many impairments. For this water body, MassDOT used the IC method to assess the impairment of aquatic macroinvertebrate bioassessments.

According to the final *Massachusetts Year 2010 Integrated List of Waters*, physical substrate habitat alterations are considered a non-pollutant and unrelated to stormwater. Therefore, MassDOT has determined that further assessment of this impairment is not required under BMP 7U.

The impairment of fecal coliform is assessed separately in the section titled Assessment of Pathogen Impairment.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction necessary to attain the percent imperviousness in the watershed at which stormwater is not likely the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. IC data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer. In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for Town Brook (MA74-09):

Table 1. Site Parameters for Mill River (MA74-04)

Total Watershed and Subwatershed		
Watershed Area	2,840	acres
Impervious Cover (IC) Area	1,170	acres
Percent Impervious	41.2	%
IC Area at 9% Goal	256	acres
Target Reduction % in IC	78.1	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	34.7	acres
MassDOT's Target Reduction in Effective IC (78.1% of DOT Directly Contributing IC)	27.1	acres

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 78.1%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 27.1 acres.

Existing BMPs

There are no existing BMPs withint MassDOT's directly contributing watershed to Town Brook that are mitigating potential storm water quality impacts. Therefore, no effective IC reduction is provided by existing MassDOT BMPs.

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 27.1 acres, MassDOT will consider the implementation of additional BMPs. MassDOT's assessment provides only a preliminary estimate of the level of impervious cover to be considered. MassDOT will rely on a variety of other factors apart from numeric guidelines, including site constraints, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT has recommended the design of fifteen stormwater BMPs to address its direct stormwater discharges to Town Brook. Conceptual designs for the BMPs are documented in a memorandum prepared for Programmed Project # 606639, the resurfacing of Route 3 from mile markers 38.0 to 43.0 in Weymouth, Braintree and Quincy, titled "*FY14 Route 3 Resurfacing – Stormwater Improvement Recommendations*" prepared by AECOM and dated 1/21/2013. These BMPs consist of twelve infiltration swales and one infiltration basin which would treat stormwater runoff from MassDOT-owned property within MassDOT's directly contributing IC watershed. One of these infiltration swales, Pr-BMP-6B, also treats stormwater runoff from non-DOT owned roadway. In total, these recommended BMPs are estimated to provide an effective IC reduction of 5.1 acres within MassDOT's directly contributing IC area. Table 2 summarizes the percent reductions in effective IC provided by these BMPs and Figure 3 shows the locations of these BMPs. The remaining two BMPs recommended in the Resurfacing Memo address only stormwater runoff from non-DOT owned roadways and therefore are not included in this assessment.

Table 2: Rte 3 Resurfacing Project #606639 BMP Recommendations

BMP Name	BMP Type	Contributing Watershed Impervious Area (ac)[1]	Effective IC Percent Reduction	Effective IC Reduction of MassDOT-owned roadway (ac.)	Effective IC Reduction of Non MassDOT-owned roadway (ac.)
Pr-BMP-1	Infiltration Basin	1.2	67%	0.8	-
Pr-BMP-2*	Infiltration Swale	1.4	93%	1.3	-
Pr-BMP-3	Infiltration Swale	0.5	35%	0.2	-
Pr-BMP-4*	Infiltration Swale	0.6	73%	0.5**	-
Pr-BMP-5	Infiltration Swale	0.8	49%	0.4	-
Pr-BMP-6a*	Infiltration Swale	0.5	93%	0.5	-
Pr-BMP-6b*	Infiltration Swale	0.8	88%	0.6**	0.04
Pr-BMP-6C*	Infiltration Swale	0.5	47%	0.2	0.05
Pr-BMP-7	Infiltration Swale	0.1	97%	0.1	-
Pr-BMP-8	Infiltration Swale	0.7	46%	0.3	-
Pr-BMP-10	Infiltration Swale	0.6	97%	0.6	-
Pr-BMP-11	Infiltration Swale	0.4	67%	0.3	-
Pr-BMP-12	Infiltration Swale	0.5	85%	0.4	-
Pr-BMP-13	Infiltration Swale	0.2	93%	0.2	-
Total				**6.4**	**0.09**

*BMP in series.
[1]For BMPs in series, the contributing watershed impervious area includes the remaining impervious cover area from upstream BMPs after mitigation provided by the upstream BMPs is taken into account.
**Rounding accounts for differences in calculation.

For descriptions of the conceptual designs of the BMPs listed above, refer to the memorandum for Resurfacing Project #605588 for additional details.

Assessment of Pathogen Impairment

MassDOT assessed the pathogen impairment using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by an order of magnitude within a given storm event at a single location (MassDEP, 2009b). Therefore, it is difficult to predict pathogen concentrations in stormwater with accuracy. Due to this difficulty, MassDOT generally will not conduct site specific assessments of loading at each location impaired for pathogens. Instead these sites will be assessed collectively based on available information on pathogen loading from highways, MassDOT actions, and information available from EPA and DEP. Based on this information MassDOT developed an approach to be consistent with relevant TMDL and permit condition requirements and an iterative adaptive management approach to stormwater management.

In addition, while there is a positive relationship between IC and pathogen loading, the relationship is not as direct as other impairments. According to the Center for Watershed Protection "…Other studies show that concentrations of bacteria are typically higher in urban areas than rural areas (USGS, 1999), but they are not always directly related to IC (CWP, 2003)." Therefore, DOT did not rely solely on the IC method to assess pathogen impairments. Instead, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

Pathogens in MassDOT Discharge

A study conducted on MassDOT's South East Expressway measured bacterial concentrations in stormwater runoff (Smith, 2002). This study found a geometric mean of 186 fecal coliforms/100 ml. Concentrations of pathogens in stormwater runoff from roadways can vary widely and pathogen concentrations in runoff across the state likely deviate significantly from this stretch of roadway's specific estimate. Event mean concentrations of fecal coliform bacteria in urban stormwater from other sources ranging between 14,000 and 17,000 fecal coliform organisms/100 mL have been reported (MassDEP, 2009b). These data suggest that pathogen loading from highways may be lower than other urban areas.

Consideration of the potential sources of pathogens supports the idea that pathogens are present in lower concentrations in highway runoff since potential pathogen sources are likely to be less prevalent in the highway environment than along other urban roadways:

- Illicit discharges: Due to the typical setback of highways from residential and commercial developments and the stand alone nature of the drainage system, the potential for illicit discharges (e.g. sewer connections, laundry tie-ins) is much lower than in other stormwater systems. This has been confirmed by MassDOT's illicit discharge detection on many miles of urban roadways within a broad range of areas across Massachusetts. After assessment of almost 140 miles, and investigation of more than 2,500 stormwater features, MassDOT's consultant performing the broad scope reviews has found no confirmed illicit discharges.
- Limited Sewer Utilities in Road Right of Ways: Since DOT does not provide sewer services, many MassDOT roads do not have sewer utilities within the road's right of way; thereby eliminating the chance of cross-connections or leaking pipes as a source of pathogens into the stormwater system.
- Pet waste: Pets are only present on highways in rare instances. In urban residential areas pets and their associated waste are much more common. MassDOT is aware that pet waste at road side rest stops may represent a potential source of pathogens to stormwater in certain situations.
- Wildlife: Highways are not generally an attractive place for wildlife. Wildlife generally avoids highways and only occasionally crosses them.

The dearth of pathogen sources on highways and the relatively low concentrations of pathogens measured in the South East Expressway study together suggest that pathogen loading from stormwater runoff from highways is lower than other urban sources.

Furthermore, in almost all cases the contribution of pathogens from MassDOT to a specific water body is likely to be very small relative to other sources of pathogens in the watershed. Since MassDOT urban roadways are linear and usually cross watersheds, they represent a small fraction of the receiving water body's watershed. The water quality within these water bodies is dependent on discharge from various sources, including discharges from other stormwater systems and a large number of other factors.

Assessment

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

TMDLs for pathogen impairments in Massachusetts recognize that pathogens are highly variable and difficult to address and emphasize the need for an iterative adaptive management approach to address pathogens. Examples of relevant language from these TMDLs are included below:

- "given the vast potential number of bacteria sources and the difficulty of identifying and removing them from some sources such as stormwater require an iterative process and will take some time to accomplish. While the stated goal in the TMDL is to meet the water quality standard at the point of discharge it also attempts to be clear that MassDEP's expectation is that for stormwater an iterative approach is needed…" (MassDEP, 2009a)
- "The NPDES permit does not, however, establish numeric effluent limitations for stormwater discharges. Maximum extent practicable (MEP) is the statutory standard that establishes the level of pollutant reductions that regulated municipalities must achieve. The MEP standard is a narrative effluent limitation that is satisfied through implementation of SWMPs and achievement of measurable goals."(MassDEP, 2009b)
- "Although the TMDL presents quantified WLAs for stormwater that are set equivalent to the criteria in the Massachusetts Water Quality Standards, the Phase II NPDES permits will not include numeric effluent limitations. Phase II permits are intended to be BMP based permits that will require communities to develop and implement comprehensive stormwater management programs involving the use of BMPs. Massachusetts and EPA believe that BMP based Phase II permits involving comprehensive stormwater management together with specific emphasis on pollutants contributing to existing water quality problems can be consistent with the intent of the quantitative WLAs for stormwater discharges in TMDLs." (MassDEP, 2002).

This language clearly indicates that an iterative adaptive management approach is the appropriate way to address discharges to pathogen impaired waters. The recommendations in pathogen TMDLs for waters in Massachusetts generally require development and implementation of stormwater management programs, illicit discharge detection and elimination efforts, and in some cases installing BMPs to the maximum extent practicable

The draft North Coastal Watershed General MS4 permit and the draft Interstate, Merrimack, and South Coastal (IMS) watershed permits contain specific requirements for compliance with pathogen TMDLs (in Appendix G). While these permits are still in draft form, MassDOT believes they represent the best available guidance on what EPA believes is appropriate for addressing stormwater discharges to pathogen-impaired waters. Section 2.2.1(c) of the permit states "For any discharge from its MS4 to impaired waters with an approved TMDL, the permittee shall comply with the specific terms of Part 2.1 of this permit. In addition, where an approved TMDL establishes a WLA that applies to its MS4 discharges, the permittee shall implement the specific BMPs and other permit requirements identified in Appendix G to achieve consistency with the WLA." Appendix G references a number of programmatic BMPs that are necessary to address pathogen loading. These cover the following general topics:

- Residential educational program
- Illicit connection identification, tracking and removal
- Pet waste management.

Mitigation Plan

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Stormwater Management Plan (SWMP) including educational programs, illicit connection review and source control. The specific BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In
- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

In addition, the structural BMPs that will be considered to reduce the IC will also have the effect of reducing pathogen loads.

MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations. MassDOT's existing stormwater management plan outlines BMPs that include education and illicit discharge detection and elimination. MassDOT will be implementing a pet waste management program at its rest stops that have discharges to pathogen impaired waters.

Conclusions

MassDOT used the IC Method to assess Town Brook (MA74-09) for the impairments identified in MassDEP's final *Massachusetts Year 2010 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed by 27.1 acres to achieve the targeted reduction in effective IC.

MassDOT has recommended the design of stormwater BMPs under Programmed Project #606639. These proposed BMPs provide a combined reduction in effective IC within MassDOT's directly contributing watershed to Unnamed Tributary of approximately 6.4 acres. MassDOT's remaining retrofit target after subtracting the reduction in effective IC provided by the proposed BMPs is 20.7 acres. Table 3 summarizes IC reductions within MassDOT's directly contributing watershed under existing and proposed conditions.

Table 2. Effective IC Reductions under Existing & Proposed Conditions

MassDOT Target Reduction in Effective IC	27.1	acres
Effective IC Reduction under Existing Conditions	0	acres
IC Effective Reduction under Proposed Conditions for Programmed Project #606639	6.4	acres
Remaining Target IC Reduction	20.7	acres

MassDOT will now work with its design consultants to identify opportunities for additional BMPs to meet the remaining target of 20.7acres of effective IC. Note that this remaining target may change depending on the final designs for the conceptual BMPs included in the memorandum for Programmed Project # 606639. The design consultants will strive to meet the remaining target plus any difference in effective IC reduction resulting from final BMP designs. The final BMP designs will provide treatment to the maximum extent practicable given site constraints that are identified as the design process moves forward. Once the designs are finalized, MassDOT will perform a final assessment of this water body under the Impaired Waters program.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT''s Programmed Projects Initiative, such as Programmed Project #606639. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding the design progress made towards meeting the IC reduction, plans for construction of the BMPs and finalized assessments. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of storm water.

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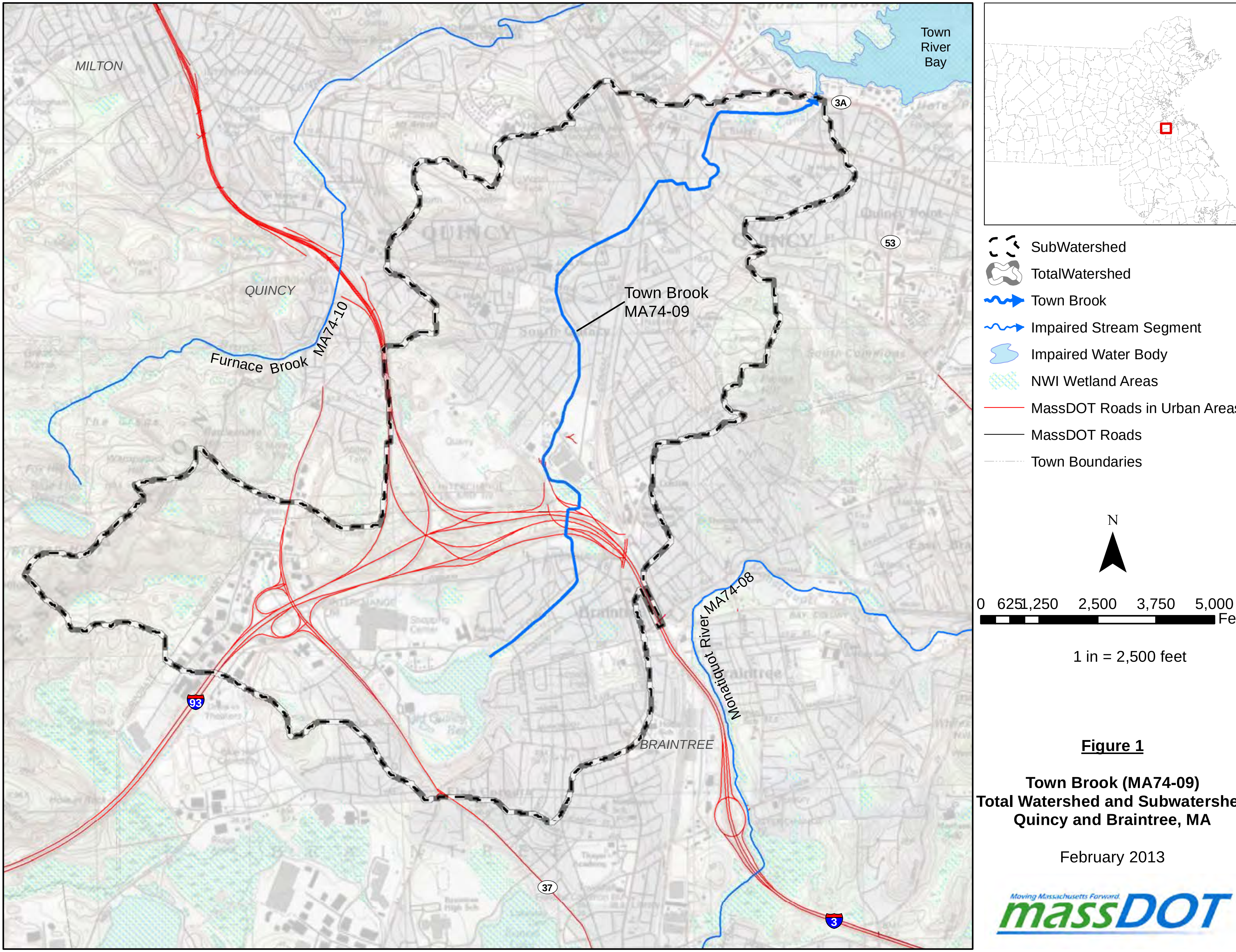

Figure 1

Town Brook (MA74-09)
Total Watershed and Subwatershed
Quincy and Braintree, MA

February 2013

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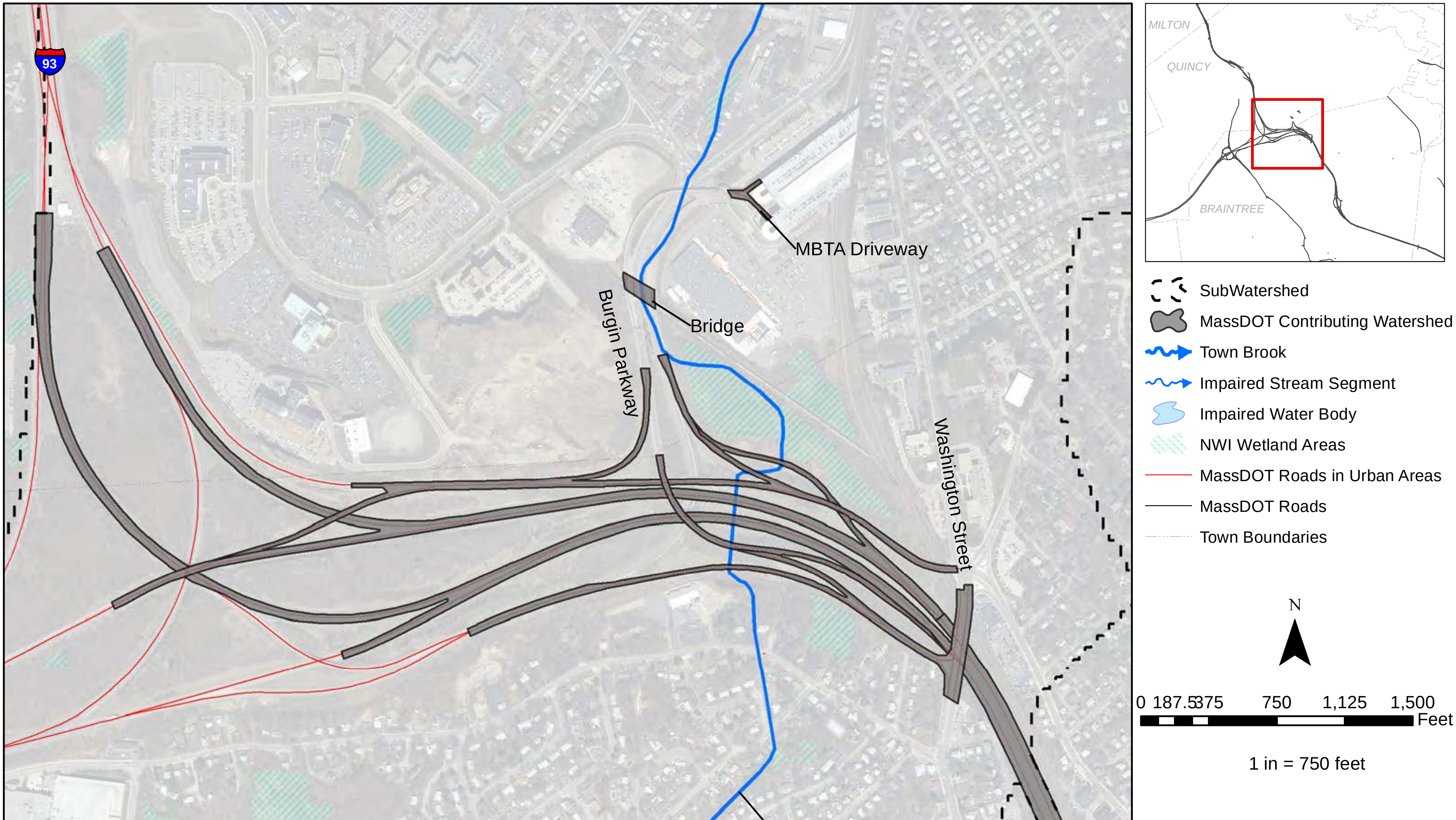

Figure 2

Town Brook (MA74-09)
Directly Contributing IC
MassDOT Watershed
Quincy and Braintree, MA

February 2013

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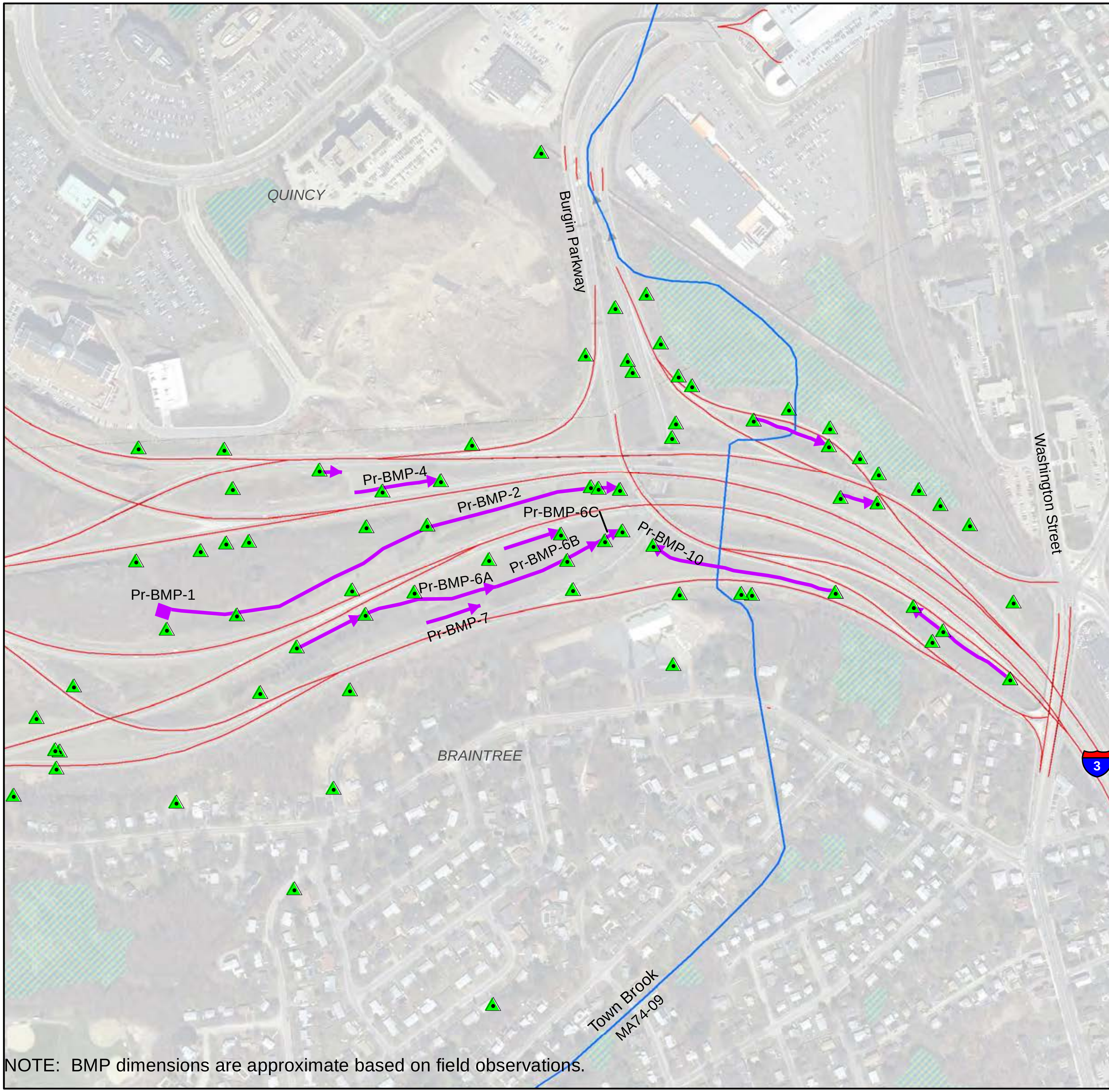

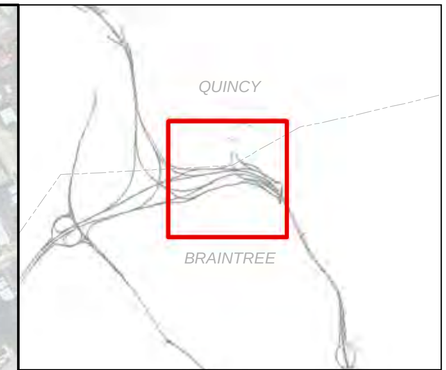

Stormwater Outfalls
Proposed Stormwater Improvement
Proposed BMP - Swales
Proposed BMP - Basins
Impaired Stream Segment
Impaired Water Body
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 210 420 840 Feet

1 in = 500 feet

Figure 3

BMPs Proposed in Rte 3 Resurfacing Programmed Project #606639 Memo Which Will Treat Runoff from MassDOT-Owned Roadways Quincy and Braintree, MA

February 2013

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Impaired Waters Assessment for Concord River (MA82A-08) – Progress Report

Impaired Waterbody

Name: Concord River

Location: Billerica and Lowell, MA

Water Body ID: MA82A-08

Impairments

Concord River (MA82A-08) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). Concord River is impaired for the following:

- total phosphorus
- mercury in fish tissue
- (non-native aquatic plants*)
- (Eurasian milfoil, Myriophyllum spicatum*)

According to MassDEP's *SuAsCo Watershed 2001 Water Quality Assessment Report* (MassDEP, 2005), a 5.1 mile reach of the Concord River, which flows from the Billerica water supply intake to the Rogers Street bridge in Lowell, is impaired for metals and nutrients from possible causes such as hydrostructure impacts on fish passage and flow regulation/modification, and as a result of mercury from the Nyanza Superfund Site and atmospheric deposition.

The Town of Billerica has a National Pollutant Discharge Elimination Permit (NPDES) to discharge an annual average of 5.4 million gallons per day (MGD) of treated sanitary wastewater to the Concord River. In addition, Baker Commodities, Incorporated is permitted to discharge 0.1 MGD of non-contact cooling water to a tributary of this segment of the Concord River, as well as stormwater.

The Mass Bay Company was issued a FERC exemption in 1981 to operate the Centennial Island Hydroelectric project which consists of a 320-foot long masonry and concrete dam with 8-inch high flashboards, a headpond, and a 2,300-foot long, 36-foot wide, and 8-foot deep canal that transports water to the powerhouse.

The *SuAsCo Watershed Water Quality Assessment Report* also states that the Corenco Industrial Landfill is located within the subwatershed of the Concord River (MA82A-08).

Relevant Water Quality Standards

Water Body Classification: Class B, Warm Water Fishery

Applicable State Regulations:

- *314 CMR 4.05 (5)(a) Aesthetics*. All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.

- *314 CMR 4.05 (5)(c) Nutrients*. Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established by the Department pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.

- *314 CMR 4.05 (3)(b) 2 Temperature*.

    - a. Shall not exceed 68°F (20°C) based on the mean of the daily maximum temperature over a seven day period in cold water fisheries, unless naturally occurring. Where a reproducing cold water aquatic community exists at a naturally occurring higher temperature, the temperature necessary to protect the community shall not be exceeded and the natural daily and seasonal temperature fluctuations necessary to protect the community shall be maintained. Temperature shall not exceed 83°F (28.3°C) in warm water fisheries. The rise in temperature due to a discharge shall not exceed 3°F (1.7°0C) in rivers and streams designated as cold water fisheries nor 5°F (2.8°C) in rivers and streams designated as warm water fisheries (based on the minimum expected flow for the month); in lakes and ponds the rise shall not exceed 3°F (1.7°0C) in the epilimnion (based on the monthly average of maximum daily temperature);

    - b. natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained. There shall be no changes from natural background conditions that would impair any use assigned to this Class, including those conditions necessary to protect normal species diversity, successful migration, reproductive functions or growth of aquatic organisms;

- *314 CMR 4.05 (5)(e) Toxic Pollutants*. All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife. For pollutants not otherwise listed in 314 CMR 4.00, the National Recommended Water Quality Criteria: 2002, EPA 822R-02-047, November 2002 published by EPA pursuant to Section 304(a) of the Federal Water Pollution Control Act, are the allowable receiving water concentrations for the affected waters, unless the Department either establishes a site specific criterion or determines that naturally occurring background concentrations are higher. Where the Department determines that naturally occurring background concentrations are higher, those concentrations shall be the allowable receiving water concentrations. The Department shall use the water quality criteria for the protection of aquatic life expressed in terms of the dissolved fraction of metals when EPA's 304(a) recommended criteria provide for use of the dissolved fraction. The EPA recommended criteria based on total recoverable metals shall be converted to dissolved metals using EPA's published conversion factors. Permit limits will be written in terms of total recoverable metals. Translation from dissolved metals criteria to total recoverable metals permit limits will be based on EPA's conversion factors or other methods approved by the Department. The Department may establish site specific criteria for toxic pollutants based on site specific considerations.

Site Description

The Concord River (MA82A-07) is formed by the confluence of the Assabet and Sudbury Rivers near the historic Egg Rock and Rude Bridge in the Town of Concord and flows for approximately 10.4 miles to the Billerica Water Supply intake. The Concord River (MA82A-08) then flows another 5.1 miles from the intake to the Rogers Street Bridge in Lowell. From the Rogers Street Bridge, the Concord River (MA82A-09) flows another 6.4 miles to the confluence with the Merrimack River. All three segments are classified as impaired according to the SuAsCo Watershed 2001 Water Quality Assessment Report; however, the 5.1 mile segment (MA82A-08) is the subject of this assessment.

MassDOT's property directly contributing stormwater runoff to the Concord River (MA82A-08) is comprised of portions of I-495, the Carlisle Street Bridge, Route 3A (Gorham Street) and Woburn Street (See Figures 3A, 3B and 3C). The total watershed is shown in Figure1 and the subwatershed is shown in Figure 2. The subwatershed also includes a portion of Concord River (MA82A-07).

Drainage ditches paralleling I- 495 northbound and southbound are the primary conveyers of stormwater from this roadway to the Concord River (MA82A-08). MassDOT Plan sets 5633 and 7672 support the field observation that drainage from I-495 flowing to the median and towards the shoulders of the roadway is discharged to these ditches which flow to the Concord River.

The Carlisle Street Bridge passing over I-495 is owned by MassDOT. The bridge is curbed and stormwater drains from the center of the bridge to catchbasins on either side. The flow entering these catch basins is discharged below the bridge to the ditches paralleling 1-495.

Similar to the Carlisle Street Bridge, stormwater drainage from the Gorham Street Bridge (Route 3A) passing over 1-495 flows into catchbasins at either end of the bridge and is discharged to the ditches below that are parallel to 1-495. Route 3A, extending approximately 1.5 miles south from the Gorham Street Bridge, also directly contributes drainage to the Concord River (MA82A-08). Along this stretch of roadway, stormwater drainage enters catchbasins and discharges through outfalls located near Albina Street, Brick Kiln Road and Bristol Street. Another half-mile stretch of Route 3A, north of the intersection with Bridge Street also contributes directly to the Concord River (MA82A-08)

Assessment under BMP 7U

None of the impairments for Black Brook have been addressed by a TMDL. MassDOT assessed the impairments using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of storm water on many impairments. For this water body, MassDOT used the IC method to assess the following impairments:

- phosphorus

The assessment does not further address the mercury in fish impairment as the *Northeast Regional Mercury TMDL* indicates that stormwater is a de minimis source of mercury contamination. According to the TMDL, the majority of mercury in stormwater comes from atmospheric deposition, and therefore the most effective-reductions in mercury loading can be achieved through controls on atmospheric deposition (NEIWPCC, 2007). Accordingly, MassDOT has concluded that stormwater runoff from its roadways is a de minimis contributor to the mercury impairment.

Similarly, the non-native plants and Eurasian milfoil, Myriophylum spicatum impairment is not addressed in this assessment as these impairments are considered non-pollutants and unrelated to stormwater according to the *final Massachusetts Year 2012 Integrated List of Waters*. Therefore, MassDOT has determined that further assessment of this impairment for the water bodies is not required under BMP 7U.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction necessary to attain the percent imperviousness in the watershed at which stormwater is not likely the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. IC data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer.

In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for Concord River (MA82A-08):

Table 1. Site Parameters for Concord River (MA82A-08)

Total Watershed		
Watershed Area	256,000	acres
Impervious Cover (IC) Area	34,200	acres
Percent Impervious	13.4	%
Subwatershed		
Subwatershed Area	13,000	acres
Impervious Cover (IC) Area	3,620	acres
Percent Impervious	27.9*	%
IC Area at 9% Goal	1,170	acres
Target Reduction% in IC	67.7	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area Directly Contributing to Impaired Segment	28.3	acres
MassDOT's Target Reduction in Effective IC (67.7% of DOT Directly Contributing IC)	19.2	acres

*Rounding accounts for differences in calculations.

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 67.7%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 19.2 acres.

Existing BMPs

Based on the site visit, there are no existing BMPs in the Concord River (MA82A-08) directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to Concord River (MA82A-08).

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT’s existing BMPs is less than the target reduction of 19.2 acres, MassDOT will consider the implementation of additional BMPs.

Conclusions

MassDOT used the IC Method to assess Concord River for the impairments identified in MassDEP's final Massachusetts Year 2012 Integrated List of Waters. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed by 19.1 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Concord River (MA82A-08) to identify existing BMPs and found that there were no existing BMPs to contribute to the target reduction in effective IC.

MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs to treat directly contributing IC as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide the target IC reduction or treatment to the maximum extent practicable.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of additional BMPs, and finalized assessments including reductions achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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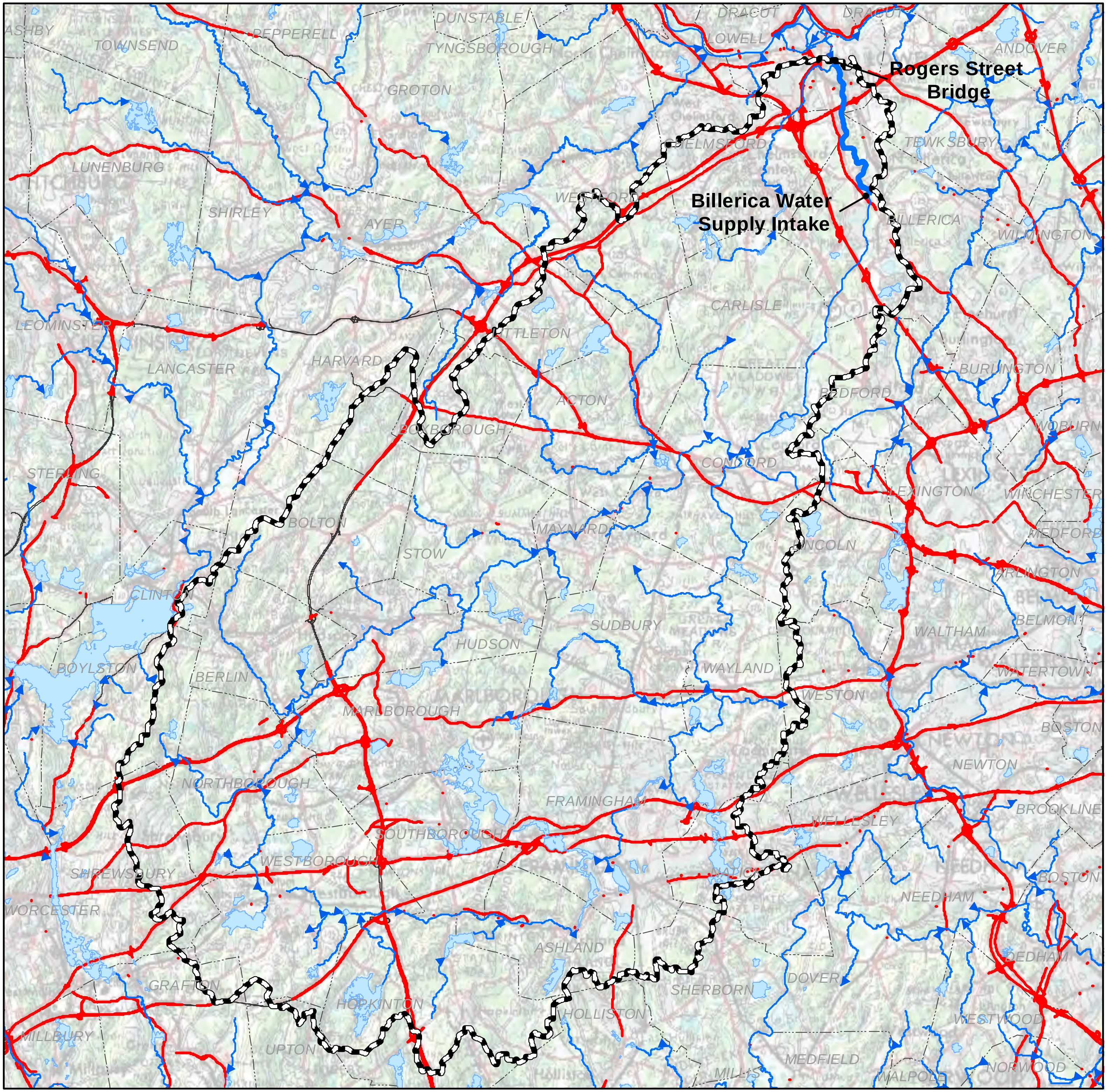
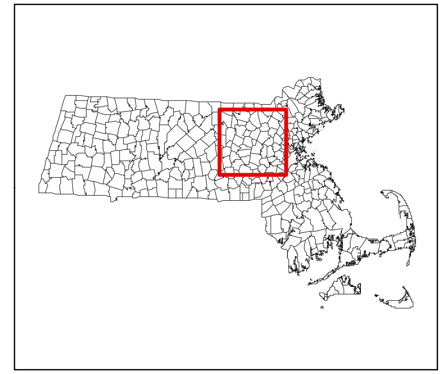




Total Watershed

Concord River

Impaired Water Bodies

Impaired Stream Segment

MassDOT Roads in Urban Areas

MassDOT Roads

Town Boundaries

N

0 1 2 4 Miles

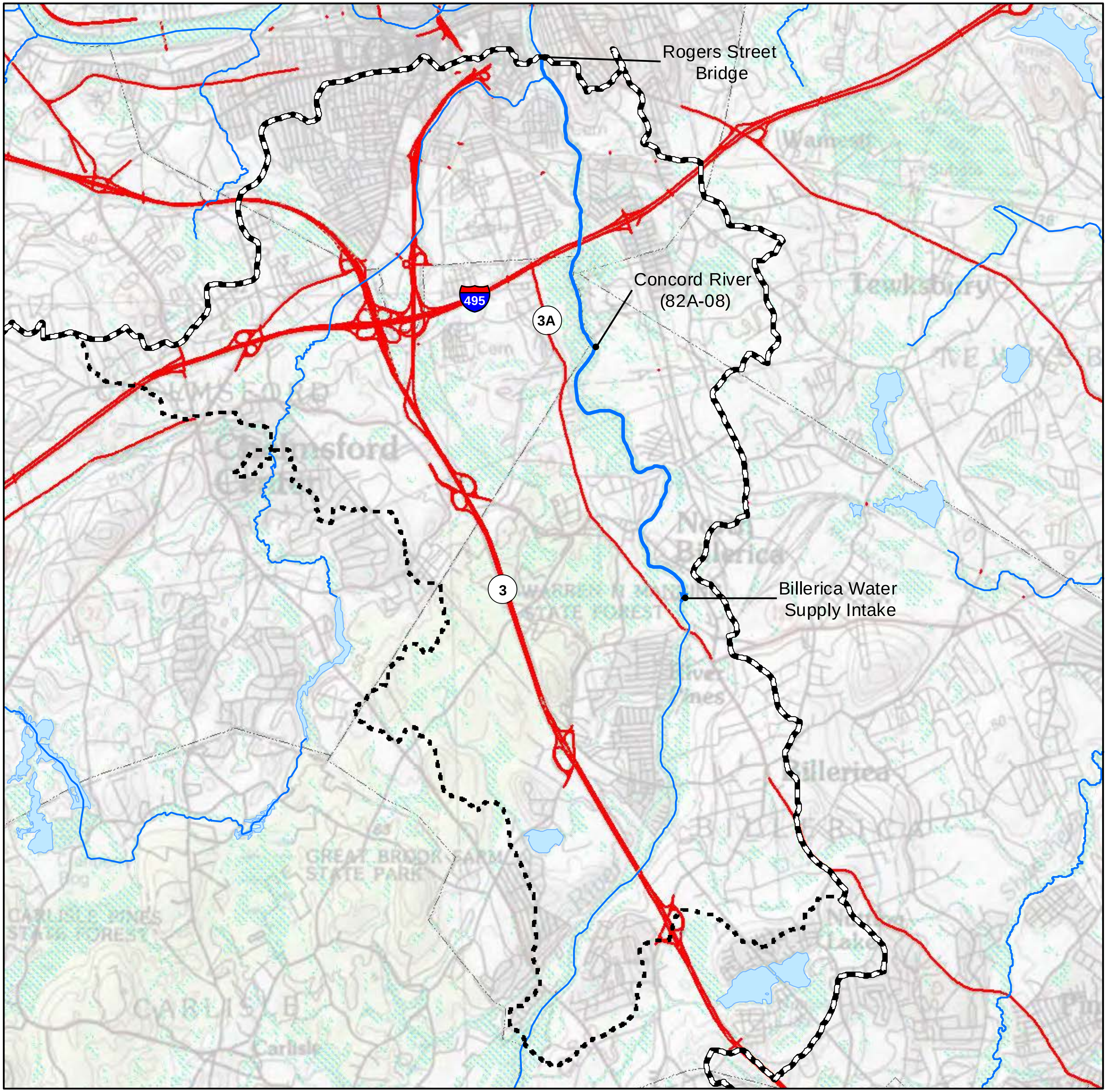
1 in = 4 miles

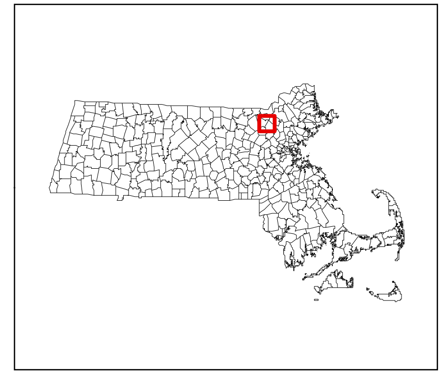
Figure 1

Concord River Total Watershed MA82A-08

June 2013

massDOT Massachusetts Department of Transportation Highway Division





Total Watershed

Subwatershed

Concord River

Impaired Stream Segment

Impaired Water Bodies

NWI Wetland Areas

MassDOT Roads in Urban Areas

MassDOT Roads

Town Boundaries

N

0 0.375 0.75 1.5 Miles

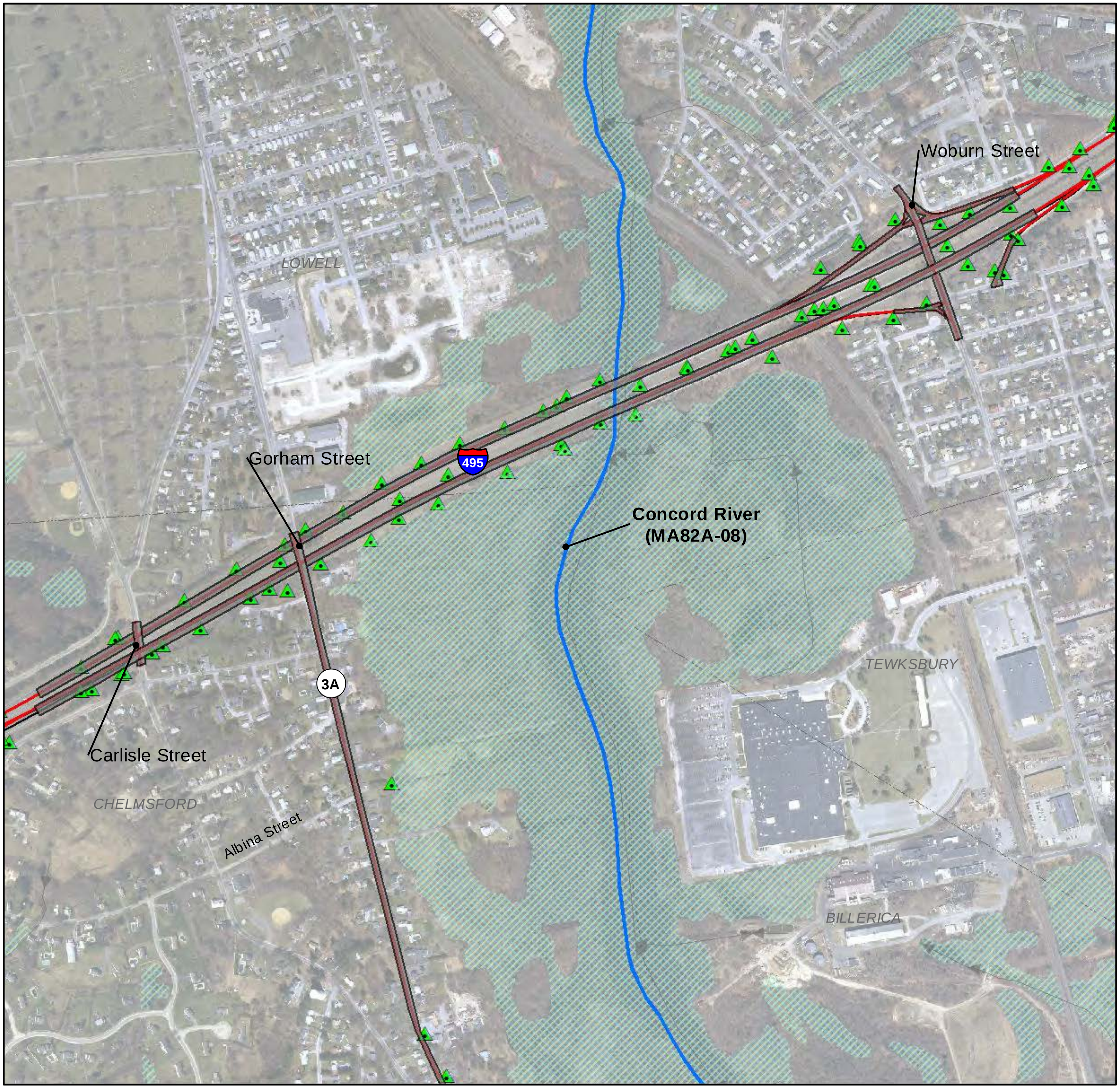
1 in = 1 miles

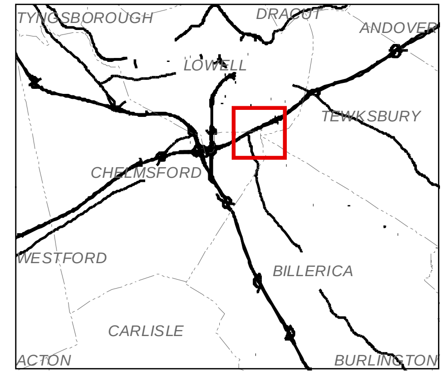
Figure 2

Concord River Subwatershed MA82A-08

June 2013

massDOT Massachusetts Department of Transportation Highway Division





Stormwater Outfalls
DOT Direct IC Watershed
Impaired Stream Segment
Impaired Water Bodies
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 400 800 1,600 Feet

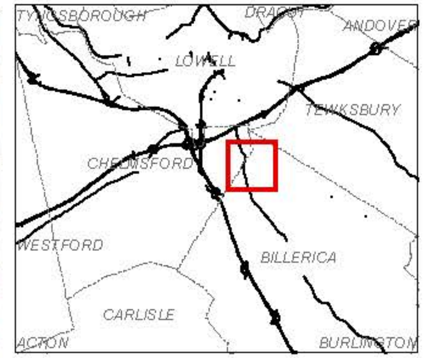
1 inch = 800 feet

Figure 3A

Concord River (MA82-08) MassDOTDirectly Contributing Watershed I-495, Carlisle Street, Rte. 3A and Woburn Street

June 2013

massDOT Massachusetts Department of Transportation Highway Division



Stormwater Outfalls

DOT Direct IC Watershed

Impaired Stream Segment

Impaired Water Bodies

Non-Impaired Stream Segment

NWI Wetland Areas

MassDOT Roads in Urban Areas

MassDOT Roads

Town Boundaries

N

0 400 800 1,600 Feet

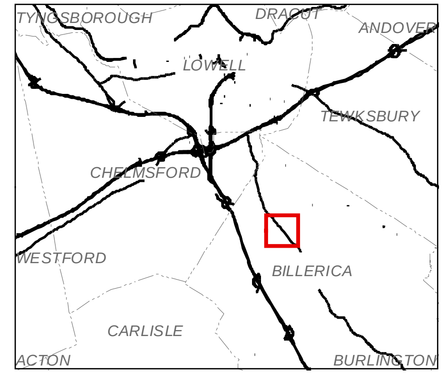
1 inch = 800 feet

Figure 3B

Concord River (MA82-08)
MassDOT Directly Contributing Watershed
Rte. 3A

June 2013

massDOT
Massachusetts Department of Transportation
Highway Division



Stormwater Outfalls
DOT Direct IC Watershed
Impaired Stream Segment
Impaired Water Bodies
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 250 500 1,000 Feet

1 inch = 500 feet

Figure 3C

Concord River (MA82-08)
MassDOTDirectly
Contributing Watershed
Rte. 3A

June 2013

massDOT
Massachusetts Department of Transportation
Highway Division

Impaired Waters Assessment for Assabet River (MA82B-02) – Progress Report

Impaired Water Body

Name: Assabet River

Location: Westborough and Northborough, MA

Water Body ID: MA82B-02

Impairments

Assabet River (MA82B-02) is listed under Category 5, "Waters Requiring a TMDL" on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). The following impairments for the Assabet River segment (MA82B-02) have not been addressed through the development of a TMDL:

- aquatic macroinvertebrate bioassessments
- fecal coliform

The *Assabet River TMDL for Total Phosphorus (CN 201.0)* (MassDEP, 2004) was developed to address impairments related to phosphorus within the Assabet River. The following additional impairments for the Assabet River segment (MA82B-02) have been addressed through the development of a TMDL:

- nutrient/eutrophication biological indicators
- total phosphorus
- dissolved oxygen

Additionally, MassDEP's *SuAsCo Watershed Year 2001 Water Quality Assessment Report* (MassDEP, 2001) states that known pollution sources include municipal point source discharges and impacts from hydrostructure/flow regulation/modification; and suspected pollution sources include golf courses, yard maintenance, discharges from municipal separate storm sewer systems, and internal nutrient recycling. Assabet River is also covered by a draft Total Maximum Daily Load (TMDL) for pathogens according to MassDEP's Draft Pathogen TMDL for the Concord River Watershed (MassDEP, no date).

Relevant Water Quality Standards

Water Body Classification: Class B, Warm Water Fishery

Applicable State Regulations:

- *314 CMR 4.05 (3)(b) 1 Dissolved Oxygen*. Shall not be less than 6.0 mg/l in cold water fisheries and not less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.
- *314 CMR 4.05 (3)(b)2 Temperature.*
    - *a.* Shall not exceed 68°F (20°C) based on the mean of the daily maximum temperature over a seven day period in cold water fisheries, unless naturally occurring. Where a reproducing

cold water aquatic community exists at a naturally occurring higher temperature, the temperature necessary to protect the community shall not be exceeded and the natural daily and seasonal temperature fluctuations necessary to protect the community shall be maintained. Temperature shall not exceed 83°F (28.3°C) in warm water fisheries. The rise in temperature due to a discharge shall not exceed 3°F (1.7°0C) in rivers and streams designated as cold water fisheries nor 5°F (2.8°C) in rivers and streams designated as warm water fisheries (based on the minimum expected flow for the month); in lakes and ponds the rise shall not exceed 3°F (1.7°0C) in the epilimnion (based on the monthly average of maximum daily temperature);

b. natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained. There shall be no changes from natural background conditions that would impair any use assigned to this Class, including those conditions necessary to protect normal species diversity, successful migration, reproductive functions or growth of aquatic organisms;

- *314 CMR 4.05 (3)(b) 3 pH*. Shall be in the range of 6.5 through 8.3 standard units but not more than 0.5 units outside of the natural background range. There shall be no change from natural background conditions that would impair any use assigned to this Class.
- *314 CMR 4.05 (3)(b) 5 Solids.* These waters shall be free from floating, suspended and settleable solids in concentrations or combinations that would impair any use assigned to this class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.
- *314 CMR 4.05 (5) (b) Bottom Pollutants or Alterations*. All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.
- *314 CMR 4.05 (5) (c) Nutrients*. Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established by the Department pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.
- *314 CMR 4.05 (5)(e) Toxic Pollutants.* All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife. For pollutants not otherwise listed in 314 CMR 4.00, the National Recommended Water Quality Criteria: 2002, EPA 822R-02-047, November 2002 published by EPA pursuant to Section 304(a) of the Federal Water Pollution Control Act, are the allowable receiving water concentrations for the affected waters, unless the Department either establishes a site specific criterion or determines that naturally occurring background concentrations are higher. Where the Department determines that naturally occurring background concentrations are higher, those concentrations shall be the allowable receiving water concentrations. The Department shall use the water quality criteria for the protection of aquatic life expressed in terms of the dissolved fraction of metals when EPA's 304(a) recommended criteria provide for use of the dissolved fraction. The EPA recommended criteria based on total recoverable metals shall be converted to dissolved metals using EPA's published conversion factors. Permit limits will be written in terms of total recoverable metals. Translation from dissolved metals criteria to total recoverable metals permit limits will be based on EPA's conversion

factors or other methods approved by the Department. The Department may establish site specific criteria for toxic pollutants based on site specific considerations.

- *314 CMR 4.05 (3)(b) 4 Bacteria*.
  - *a.* At bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: where E. coli is the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml; alternatively, where enterococci are the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no single sample taken during the bathing season shall exceed 61 colonies per 100 ml;
  - *b.* For other waters and, during the non bathing season, for waters at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: the geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml; alternatively, the geometric mean of all enterococci samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 61 colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department;

Site Description

The Assabet River Segment MA82B-02 flows for 3.8 miles from the Westborough Wastewater Plant discharge to the Route 20 Dam in Northborough. The segment is classified as impaired according to the *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). The segment watershed and subwatershed are both shown on Figure 1. The subwatershed also includes portions of Assabet River Segment MA82B-01 since that is part of the USGS hydrounit containing segment MA82B-02.

Stomwater runoff from MassDOT property is conveyed to the Assabet River through a system of catchbasins, drainage pipes, ditches, and unnamed streams. The MassDOT property directly contributing stormwater runoff to the Assabet River Segment MA82B-02 is illustrated on Figure 2 and described below.

The Assabet River crosses under Rte 9 to the west of Rte 135. On the west side of the Assabet, Rte 9 is relatively flat and runoff flows to roadside ditches via catchbasins or curb openings. Appoximately 800 feet of Rte 9 on the west side of the Assabet contributes direct discharge to impaired waters. On the east side of the Assabet, the surface grade pitches up significantly. Runoff from Rte 9 and the Rte 9/Rte 135 interchange is directed to the Assabet via catchbasins, storm drains, and unnamed streams.

Assessment under BMP 7U

Two of the impairments for Assabet River Segment (MA82B-02) have not been addressed by a TMDL. Therefore, MassDOT assessed the impairments using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of stormwater on many impairments. For this water body, MassDOT used the IC method to assess following impairment:

- aquatic macroinvertebrate bioassessments

The impairment for fecal coliform is assessed separately in the section titled Assessment of Pathogen Impairment.

MassDOT's Application of the Impervious Cover Method

MassDOT's application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction required to ensure that stormwater is not the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. IC data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer.

In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for Assabet River (MA82B-02):

Table 1. Site Parameters for Assabet River (MA82B-02)

Total Watershed		
Watershed Area	12,800	acres
Impervious Cover (IC) Area	1,850	acres
Percent Impervious	14.5	%
Subwatershed		
Subwatershed Area	7,750	acres
Impervious Cover (IC) Area	987	acres
Percent Impervious	12.7	%
IC Area at 9% Goal	698	acres
Target Reduction % in IC	29.3	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	9.8	acres
MassDOT's Target Reduction in Effective IC (29.3% of DOT Directly Contributing IC)	2.9	acres

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 29.3%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 2.9 acres.

Assessment under BMP 7R

The *Assabet River Total Maximum Daily Load for Total Phosphorus [CN 201.0]* addresses the following impairments for this water body:

- nutrient/eutrophication biological indicators
- total phosphorus
- dissolved oxygen

Therefore, MassDOT assessed the contribution of total phosphorus from MassDOT urban areas to this water body using the approach described in BMP 7R (TMDL Watershed Review).

TMDL

The Massachusetts Department of Environmental Protection's (MassDEP) TMDL report titled *Assabet River Total Maximum Daily Load for Total Phosphorus [CN 201.0]* can be summarized as follows:

- Pollutant of Concern: Total Phosphorus
- Impairments for Assabet River Addressed in TMDL: total phosphorus, dissolved oxygen, excess algal growth, and aquatic plants (macrophytes)
- Applicable Waste Load Allocation (WLA):

- o Description of Associated Land Use: Urban. The landuse for this TMDL was based on MassGIS data from 1990 – 1991. For the purposes of this assessment, urban landuse was used to represent roadway.
- o Urban Land Use Current Load (TP): No information provided
- o Urban Land Use Target WLA (TP): 1.0 lbs/day or 365 lb/yr. The TMDL identifies a target of 1.0 lbs/day for watershed non-point sources, specifically runoff combined with groundwater that is not from the natural background of the watershed (page 40 of TMDL). Therefore, the assumption that urban landuse has a TMDL of 1.0 lbs/day is conservative because it not only includes phosphorus sources from runoff but also from groundwater.
- o Urban Area in Watershed: 17,289 acres. The urban area was calculated by combining the urban area (10.5% of watershed) and commercial area (5% of watershed). The total Assabet River watershed area is 111,542 acres (page 3 of the TMDL).
- o Urban Land Use Target Areal WLA (TP): 0.02 lb/acre/yr.

Estimated Loading from MassDOT

The loading of total phosphorus (TP) from MassDOT property directly contributing stormwater runoff to Assabet River was estimated using the following assumptions and calculations:

- MassDOT estimates the TP loading from its impervious areas as 1.6 lb/acre/yr. This loading rate is based on data collected in a study of stormwater runoff conducted by the United States Geological Survey (USGS) (Smith and Granato, 2010). The study analyzed stormwater samples from 12 sites located on highways operated by MassDOT across Massachusetts between September 2005 and September 2007. Samples were taken under a variety of weather conditions during this period.
- MassDOT estimates the TP loading from its pervious areas as 0.6 lb/acre/yr. This loading rate is based on the loading rate for hayland provided in the United States Environmental Protection Agency's (EPA) document EPA 440/5-80-011, "Modeling phosphorus loading and Pond response under uncertainty: a manual and compilation of export coefficients" (Reckhow, 1980). Hayland was chosen to represent the pervious right-of-way areas which are typically cleared areas that are mowed only once per year.
- MassDOT calculated its total estimated TP loading rate using the estimated loading rates listed above. MassDOT property contributing stormwater directly to Assabet River is 9.8 acres of impervious area and 5.7 acres of pervious area. The TP loading is 19.1 lb/yr without accounting for existing BMPs or treatment throughout the watershed.
- MassDOT calculated its target TP WLA using the TMDL target areal WLA of 0.02 lb/ac/yr and the total area of MassDOT property within the TMDL watershed directly draining to Assabet River (15.5 acres). The target TP WLA for MassDOT runoff is 0.3 lb/yr.

Assessment

MassDOT calculated its current TP loading rate (19.1 lb/yr) and its target TP WLA (0.3 lb/yr) using values provided in MassDEP's TMDL report. The difference between these two values represents the target reduction in TP that MassDOT will aim to achieve to comply with the WLA. For the watershed directly contributing to Assabet River, this target reduction is 18.8 lb/yr. As explained in BMP 7R, MassDOT's pollutant loading analysis provides only a preliminary estimate of the level of pollutant reductions that may be recommended. In light of the variability of data on stormwater discharges, MassDOT will rely on a variety of other factors apart from numeric guidelines, including site constraints, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

There are no existing BMPs in the Assabet River (MA82B-02) directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to Assabet River. Thus, there is currently no TP reduction being provided.

Table 2: Loading from MassDOT's Directly Contributing Property Relative to TMDL WLA

Total Area	15.5	ac
Target Areal WLA	0.02	lb/ac/yr
Total Estimated Load	19.1	lb/yr
WLA for MassDOT's Directly Contributing Property	0.3	lb/yr
MassDOT's Required Load Reduction	18.8	lb/yr

<u>Existing BMPs</u>

Based on the site visit, there are no existing BMPs within MassDOT's directly contributing watershed to segment MA82B-02 that are mitigating potential storm water quality impacts. Therefore, no effective IC reduction or phosphorus loading reduction is provided by existing MassDOT BMPs.

Mitigation Plan

Because there are no existing BMPs mitigating impervious surface or reducing total phosphorus loading, MassDOT will consider the implementation of new BMPs to meet the 2.9 acre target reduction in impervious cover and 18.8 lb/yr in total phosphorus loading. A potential location for new BMPs is the Route 135 median area at the intersection with Route 9.

Assessment of Pathogen Impairment

MassDOT assessed the pathogen impairment using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by an order of magnitude within a given storm event at a single location (MassDEP, 2009b). Therefore, it is difficult to predict pathogen concentrations in stormwater with accuracy. Due to this difficulty, MassDOT generally will not conduct site specific assessments of loading at each location impaired for pathogens. Instead these sites will be assessed collectively based on available information on pathogen loading from highways, MassDOT actions, and information available from EPA and DEP. Based on this information MassDOT developed an approach to be consistent with relevant TMDL and permit condition requirements and an iterative adaptive management approach to stormwater management.

In addition, while there is a positive relationship between IC and pathogen loading, the relationship is not as direct as other impairments. According to the Center for Watershed Protection "…Other studies show that concentrations of bacteria are typically higher in urban areas than rural areas (USGS, 1999), but they are not always directly related to IC (CWP, 2003)." Therefore, DOT did not rely solely on the IC method to assess pathogen impairments. Instead, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

Pathogens in MassDOT Discharge

A study conducted on MassDOT's South East Expressway measured bacterial concentrations in stormwater runoff (Smith, 2002). This study found a geometric mean of 186 fecal coliforms/100 ml. Concentrations of pathogens in stormwater runoff from roadways can vary widely and pathogen concentrations in runoff across the state likely deviate significantly from this stretch of roadway's specific estimate. Event mean concentrations of fecal coliform bacteria in urban stormwater from other sources ranging between 14,000 and 17,000 fecal coliform organisms/100 mL have been reported (MassDEP, 2009b). These data suggest that pathogen loading from highways may be lower than other urban areas.

Consideration of the potential sources of pathogens supports the idea that pathogens are present in lower concentrations in highway runoff since potential pathogen sources are likely to be less prevalent in the highway environment than along other urban roadways:

- Illicit discharges: Due to the typical setback of highways from residential and commercial developments and the stand alone nature of the drainage system, the potential for illicit discharges (e.g. sewer connections, laundry tie-ins) is much lower than in other stormwater systems. This has been confirmed by MassDOT's illicit discharge detection on many miles of urban roadways within a broad range of areas across Massachusetts. After assessment of almost 140 miles, and investigation of more than 2,500 stormwater features, MassDOT's consultant performing the broad scope reviews has found no confirmed illicit discharges.
- Limited Sewer Utilities in Road Right of Ways: Since DOT does not provide sewer services, many MassDOT roads do not have sewer utilities within the road's right of way; thereby eliminating the chance of cross-connections or leaking pipes as a source of pathogens into the stormwater system.
- Pet waste: Pets are only present on highways in rare instances. In urban residential areas pets and their associated waste are much more common. MassDOT is aware that pet waste at road side rest stops may represent a potential source of pathogens to stormwater in certain situations.
- Wildlife: Highways are not generally an attractive place for wildlife. Wildlife generally avoids highways and only occasionally crosses them.

The dearth of pathogen sources on highways and the relatively low concentrations of pathogens measured in the South East Expressway study together suggest that pathogen loading from stormwater runoff from highways is lower than other urban sources.

Furthermore, in almost all cases the contribution of pathogens from MassDOT to a specific water body is likely to be very small relative to other sources of pathogens in the watershed. Since MassDOT urban roadways are linear and usually cross watersheds, they represent a small fraction of the receiving water body's watershed. The water quality within these water bodies is dependent on discharge from various sources, including discharges from other stormwater systems and a large number of other factors.

Assessment

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

TMDLs for pathogen impairments in Massachusetts recognize that pathogens are highly variable and difficult to address and emphasize the need for an iterative adaptive management approach to address pathogens. Examples of relevant language from these TMDLs are included below:

- "given the vast potential number of bacteria sources and the difficulty of identifying and removing them from some sources such as stormwater require an iterative process and will take some time to accomplish. While the stated goal in the TMDL is to meet the water quality standard at the point of discharge it also attempts to be clear that MassDEP's expectation is that for stormwater an iterative approach is needed…" (MassDEP, 2009a)
- "The NPDES permit does not, however, establish numeric effluent limitations for stormwater discharges. Maximum extent practicable (MEP) is the statutory standard that establishes the level of pollutant reductions that regulated municipalities must achieve. The MEP standard is a narrative

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- "Although the TMDL presents quantified WLAs for stormwater that are set equivalent to the criteria in the Massachusetts Water Quality Standards, the Phase II NPDES permits will not include numeric effluent limitations. Phase II permits are intended to be BMP based permits that will require communities to develop and implement comprehensive stormwater management programs involving the use of BMPs. Massachusetts and EPA believe that BMP based Phase II permits involving comprehensive stormwater management together with specific emphasis on pollutants contributing to existing water quality problems can be consistent with the intent of the quantitative WLAs for stormwater discharges in TMDLs." (MassDEP, 2002).

This language clearly indicates that an iterative adaptive management approach is the appropriate way to address discharges to pathogen impaired waters. The recommendations in pathogen TMDLs for waters in Massachusetts generally require development and implementation of stormwater management programs, illicit discharge detection and elimination efforts, and in some cases installing BMPs to the maximum extent practicable

The draft North Coastal Watershed General MS4 permit and the draft Interstate, Merrimack, and South Coastal (IMS) watershed permits contain specific requirements for compliance with pathogen TMDLs (in Appendix G). While these permits are still in draft form, MassDOT believes they represent the best available guidance on what EPA believes is appropriate for addressing stormwater discharges to pathogen-impaired waters. Section 2.2.1(c) of the permit states "For any discharge from its MS4 to impaired waters with an approved TMDL, the permittee shall comply with the specific terms of Part 2.1 of this permit. In addition, where an approved TMDL establishes a WLA that applies to its MS4 discharges, the permittee shall implement the specific BMPs and other permit requirements identified in Appendix G to achieve consistency with the WLA." Appendix G references a number of programmatic BMPs that are necessary to address pathogen loading. These cover the following general topics:

- Residential educational program
- Illicit connection identification, tracking and removal
- Pet waste management.

Mitigation Plan

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Stormwater Management Plan (SWMP) including educational programs, illicit connection review and source control. The specific BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In
- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

In addition, the structural BMPs that will be considered to reduce the IC will also have the effect of reducing pathogen loads.

MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations. MassDOT's existing stormwater management plan outlines BMPs that include education and illicit discharge detection and elimination. MassDOT will be implementing a pet waste management program at its rest stops that have discharges to pathogen impaired waters.

Conclusions

MassDOT used both the IC Method and the TMDL Method to assess Assabet River (MA82B-02) for the impairments identified in MassDEP's final *Massachusetts Year 2012 Integrated List of Waters*. To meet target reductions in impervious cover to meet the 9% goal MassDOT should reduce impervious cover within the urban area directly contributing watershed to Assabet River by 2.9 acres. To meet guidelines set forth in the TMDL for total phosphorus MassDOT should reduce its TP loading within the urban area directly contributing watershed by 18.8 lb/yr to achieve the targeted reduction. MassDOT evaluated its property within the directly contributing watershed to the Assabet River to identify existing BMPs and found that no BMPs exist to reduce effective IC and total phosphorus loading.

MassDOT should reduce impervious cover and TP loading to the Assabet River to meet target impervious cover reduction and guidelines set forth in the TMDL. MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs to treat directly contributing IC as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide the target IC reduction or treatment to the maximum extent practicable.

MassDOT has concluded based on review of the draft North Coastal Watershed General MS4 permit, the draft Interstate, Merrimack, and South Coastal watershed permits, and pathogen TMDLs for Massachusetts waters, that the BMPs outlined in the stormwater management plan and those under consideration for reducing effective IC from MassDOT areas are consistent with its existing permit requirements. MassDOT believes that these measures achieve pathogen reductions (including fecal coliform) to the maximum extent practicable and are consistent with the intent of its existing stormwater permit and the applicable Pathogen TMDLs.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of additional BMPs, and finalized assessments including reductions achieved by finalized BMP designs. MassDOT will also continue to implement non-structural BMPs that reduce the impacts of stormwater.

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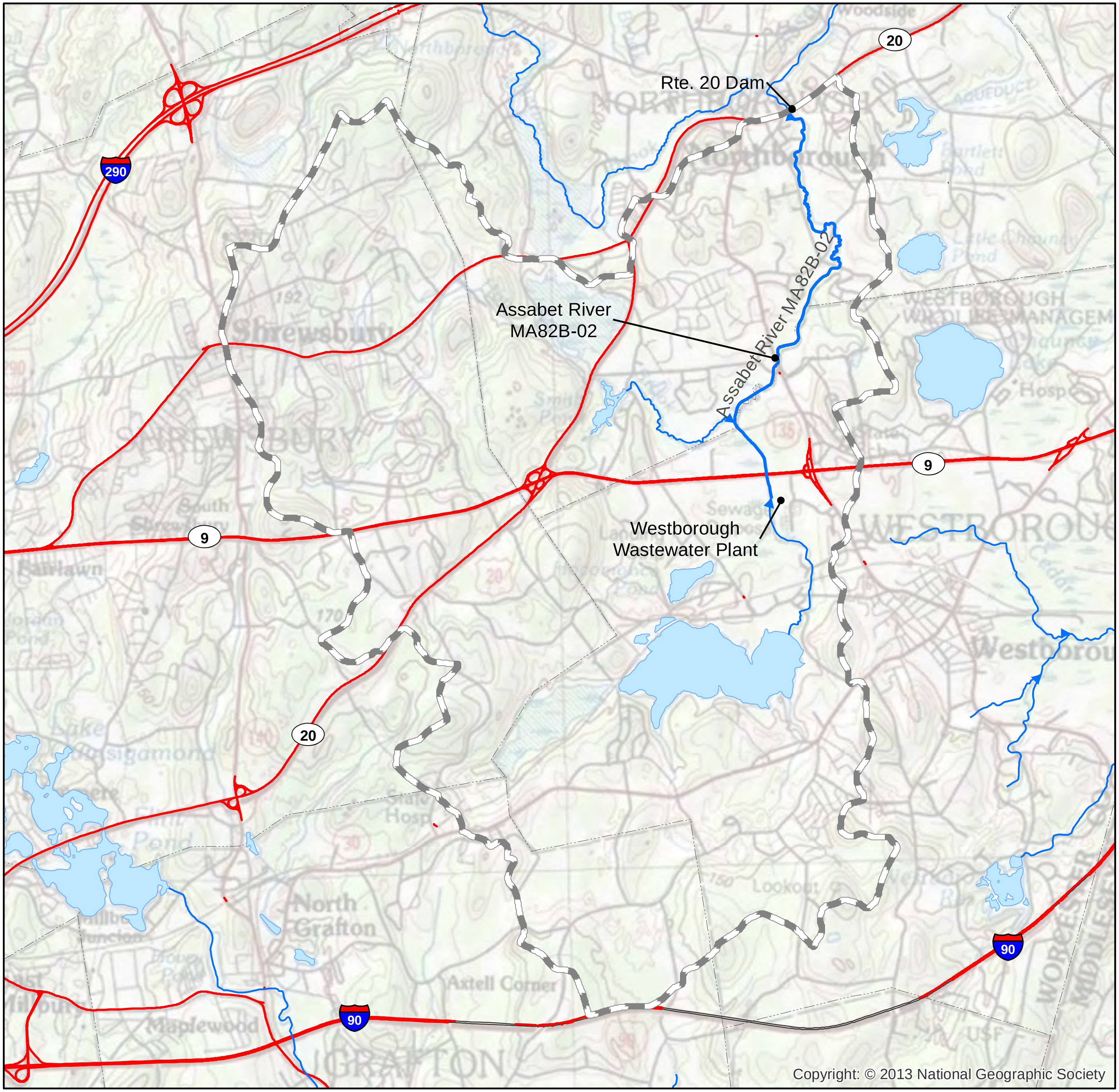


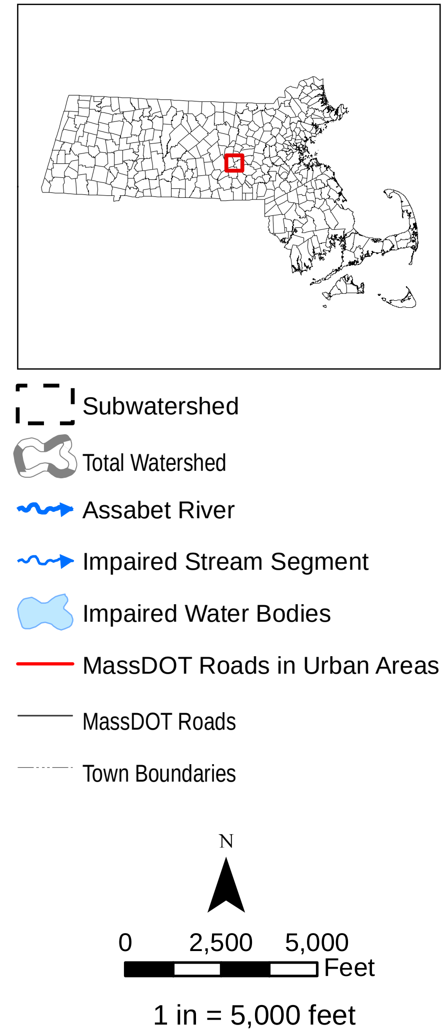
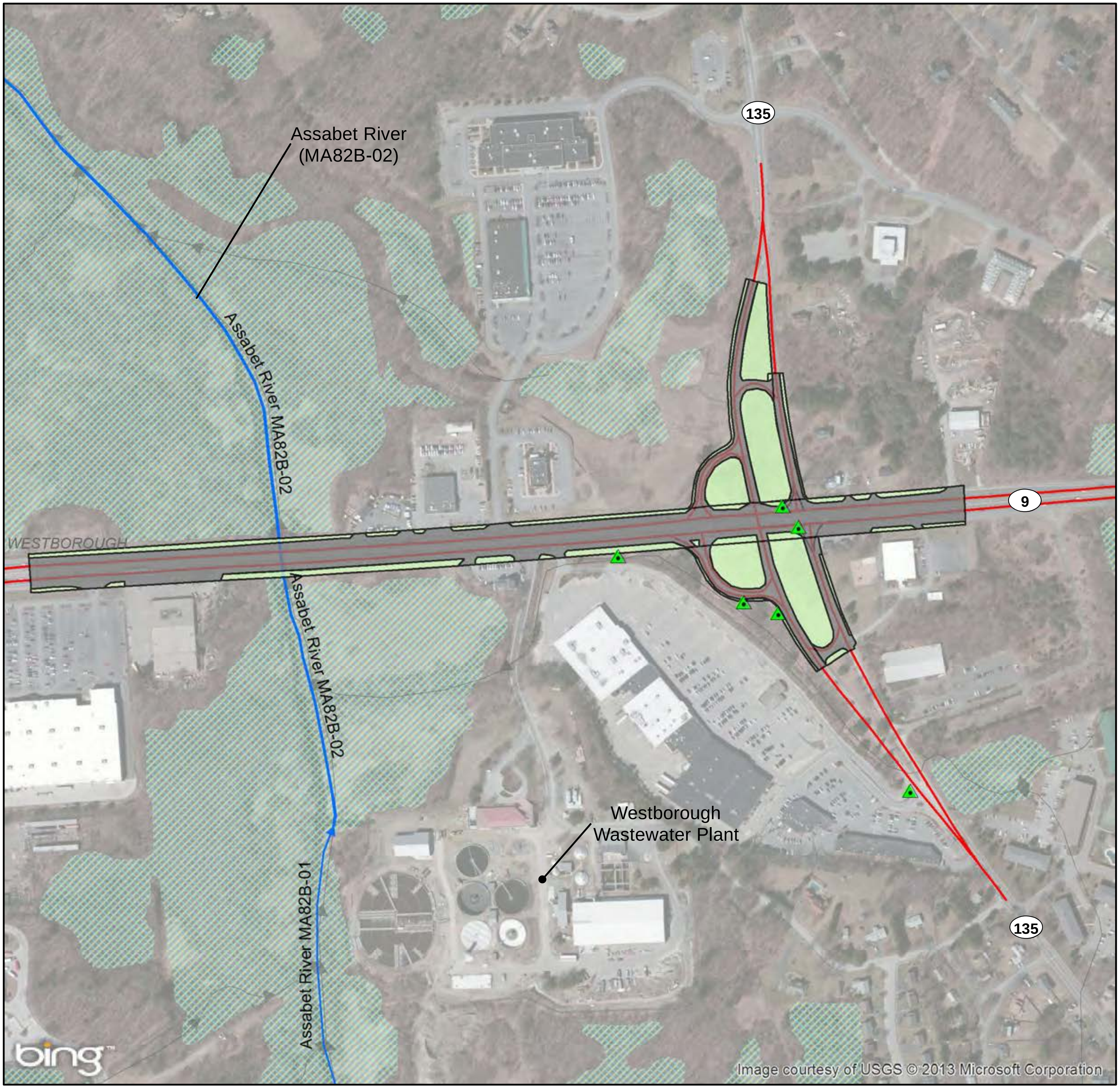


Figure 1

Assabet River Total Watershed and Subwatershed MA82B-02

June 2013

massDOT
Massachusetts Department of Transportation
Highway Division



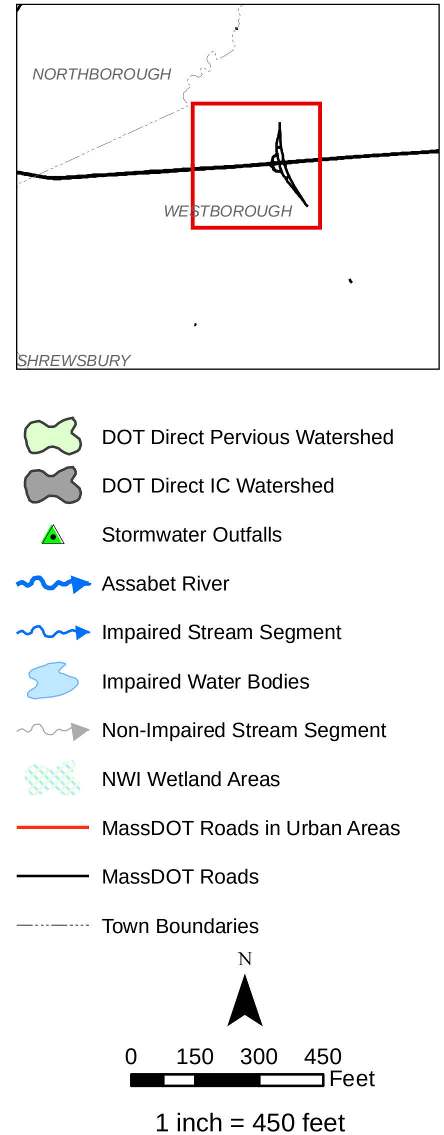


Figure 2

Assabet River (MA82B-02) MassDOT Directly Contributing Watershed

June 2013

Moving Massachusetts Forward massDOT

Impaired Waters Assessment for Rogers Brook (MA83-04) – Progress Report

Impaired Water Body

Name: Rogers Brook

Location: Andover, MA

Water Body ID: MA83-04

Impairments

Rogers Brook (MA83-04) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). Rogers Brook is impaired for the following:

- fecal coliform
- (physical substrate habitat alterations*)
- turbidity

According to MassDEP's *Shawsheen River Watershed 2000 Water Quality Assessment Report* (MassDEP, 2003), a 1.3-mile reach of Rogers Brook, which flows from the outlet of an unnamed pond in Andover to the confluence with the Shawsheen River, is impaired due to pathogens and turbidity. The primary and secondary contact designated uses and the aquatic life designated uses were assessed and considered impaired due to fecal coliform bacteria and channelization, respectively. Shawsheen River is covered by the *Bacteria TMDL for the Shawsheen River Basin* (MassDEP, 2002a).

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- 314 CMR 4. 05 (3)(b) 6 *Color and Turbidity.* These waters shall be free from color and turbidity in concentrations or combinations that are aesthetically objectionable or would impair any use assigned to this class.
- *314 CMR 4.05 (5) (b) Bottom Pollutants or Alterations*. All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.
- *314 CMR 4.05 (3)(b) 4 Bacteria*.
    - a. At bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: where E. coli is the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml; alternatively, where enterococci are

the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no single sample taken during the bathing season shall exceed 61 colonies per 100 ml;

- b. For other waters and, during the non bathing season, for waters at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: the geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml; alternatively, the geometric mean of all enterococci samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 61 colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department;

Site Description

Rogers Brook originates from a wetland area located east of Route 28 (Main Street), south of the Philips Academy Ice Rink in Andover (Figure 1). The Brook flows north to an unnamed impoundment upstream of Morton Street. From the outlet of the unnamed impoundment, Rogers Brook (MA83-04) flows approximately 1.3 miles to its confluence with the Shawsheen River in Andover. This 1.3 mile segment of Rogers Brook is classified as impaired according to the *Shawsheen River Watershed 2000 Water Quality Assessment Report*. Approximately 0.6 miles of this stretch is culverted under the downtown section of Andover.

The total and subwatershed of Rogers Brook is shown in Figure 1. MassDOT owns a portion of Rte 28 that extends to the intersection with Wheeler Street. Although the property is approximately 0.5 miles from Rogers Brook (MA83-04), drainage from the roadway enters a drainage system that flows toward downtown Andover and discharges to the Brook. Therefore, the portion of MassDOT's property directly contributing stormwater runoff to Rogers Brook is comprised of portions of Rte 28 shown in Figure 2.

Assessment under BMP 7U

Of the impairments listed for Rogers Brook, one is potentially linked to stormwater runoff and has not been addressed by a TMDL. Therefore, MassDOT assessed the impairment using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of storm water on many impairments. For this waterbody, MassDOT used the IC method to assess the following impairments:

- turbidity

According to MassDEP's final *Massachusetts Year 2012 Integrated List of Waters*, the impairment of physical substrate habitat alterations is not caused by pollutants. Therefore, these impairments are not considered further.

The impairment for fecal coliform is assessed separately in the section titled Assessment of Pathogen Impairment.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction necessary to attain the percent imperviousness in the watershed at which stormwater is not likely the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. IC data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer.

In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for Rogers Brook (MA51-01):

Table 1. Site Parameters for Rogers Brook (MA93-04)

Total and Subwatershed		
Watershed Area	861	acres
Impervious Cover (IC) Area	237	acres
Percent Impervious	27.5	%
IC Area at 9% Goal	77.5	acres
Target Reduction % in IC	67.5	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	2.4	acres
MassDOT's Target Reduction in Effective IC (67.5% of DOT Directly Contributing IC)	1.6	acres

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 67.5%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 1.6 acres.

Existing BMPs

Based on the site visit, there are no existing BMPs in the Rogers Brook directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to Rogers Brook.

Mitigation Plan

Because there is no mitigation of impervious surface by MassDOT's is less than the target reduction of 1.9 acres, MassDOT will consider the implementation of additional BMPs.

Assessment of Pathogen Impairment under BMP 7R

MassDOT assessed the pathogen impairment using the approach described in BMP 7R of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body covered by a final TMDL. Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by an order of magnitude within a given storm event at a single location (MassDEP, 2009b). Therefore, it is difficult to predict pathogen concentrations in stormwater with accuracy. Due to this difficulty, MassDOT generally will not conduct site specific assessments of loading at each location impaired for pathogens. Instead these sites will be assessed collectively based on available information on pathogen loading from highways, MassDOT actions, and information available from EPA and DEP. Based on this information MassDOT developed an approach to be consistent with relevant TMDL and permit condition requirements and an iterative adaptive management approach to stormwater management.

In addition, while there is a positive relationship between IC and pathogen loading, the relationship is not as direct as other impairments. According to the Center for Watershed Protection "…Other studies show that concentrations of bacteria are typically higher in urban areas than rural areas (USGS, 1999), but they are not always directly related to IC (CWP, 2003)." Therefore, DOT did not rely solely on the IC method to assess pathogen impairments. Instead, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

Pathogens in MassDOT Discharge

A study conducted on MassDOT's South East Expressway measured bacterial concentrations in stormwater runoff (Smith, 2002). This study found a geometric mean of 186 fecal coliforms/100 ml. Concentrations of pathogens in stormwater runoff from roadways can vary widely and pathogen concentrations in runoff across the state likely deviate significantly from this stretch of roadway's specific estimate. Event mean concentrations of fecal coliform bacteria in urban stormwater from other sources ranging between 14,000 and 17,000 fecal coliform organisms/100 mL have been reported (MassDEP, 2009b). These data suggest that pathogen loading from highways may be lower than other urban areas.

Consideration of the potential sources of pathogens supports the idea that pathogens are present in lower concentrations in highway runoff since potential pathogen sources are likely to be less prevalent in the highway environment than along other urban roadways:

- Illicit discharges: Due to the typical setback of highways from residential and commercial developments and the stand alone nature of the drainage system, the potential for illicit discharges (e.g. sewer connections, laundry tie-ins) is much lower than in other stormwater systems. This has been confirmed by MassDOT's illicit discharge detection on many miles of urban roadways within a broad range of areas across Massachusetts. After assessment of almost 140 miles, and investigation of more than 2,500 stormwater features, MassDOT's consultant performing the broad scope reviews has found no confirmed illicit discharges.
- Limited Sewer Utilities in Road Right of Ways: Since DOT does not provide sewer services, many MassDOT roads do not have sewer utilities within the road's right of way; thereby eliminating the chance of cross-connections or leaking pipes as a source of pathogens into the stormwater system.
- Pet waste: Pets are only present on highways in rare instances. In urban residential areas pets and their associated waste are much more common. MassDOT is aware that pet waste at road side rest stops may represent a potential source of pathogens to stormwater in certain situations.
- Wildlife: Highways are not generally an attractive place for wildlife. Wildlife generally avoids highways and only occasionally crosses them.

The dearth of pathogen sources on highways and the relatively low concentrations of pathogens measured in the South East Expressway study together suggest that pathogen loading from stormwater runoff from highways is lower than other urban sources.

Furthermore, in almost all cases the contribution of pathogens from MassDOT to a specific water body is likely to be very small relative to other sources of pathogens in the watershed. Since MassDOT urban roadways are linear and usually cross watersheds, they represent a small fraction of the receiving water body's watershed. The water quality within these water bodies is dependent on discharge from various sources, including discharges from other stormwater systems and a large number of other factors.

Assessment

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

TMDLs for pathogen impairments in Massachusetts recognize that pathogens are highly variable and difficult to address and emphasize the need for an iterative adaptive management approach to address pathogens. Examples of relevant language from these TMDLs are included below:

- "given the vast potential number of bacteria sources and the difficulty of identifying and removing them from some sources such as stormwater require an iterative process and will take some time to accomplish. While the stated goal in the TMDL is to meet the water quality standard at the point of discharge it also attempts to be clear that MassDEP's expectation is that for stormwater an iterative approach is needed…" (MassDEP, 2009a)
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This language clearly indicates that an iterative adaptive management approach is the appropriate way to address discharges to pathogen impaired waters. The recommendations in pathogen TMDLs for waters in Massachusetts generally require development and implementation of stormwater management programs, illicit discharge detection and elimination efforts, and in some cases installing BMPs to the maximum extent practicable

The draft North Coastal Watershed General MS4 permit and the draft Interstate, Merrimack, and South Coastal (IMS) watershed permits contain specific requirements for compliance with pathogen TMDLs (in Appendix G). While these permits are still in draft form, MassDOT believes they represent the best available guidance on what EPA believes is appropriate for addressing stormwater discharges to pathogen-impaired waters. Section 2.2.1(c) of the permit states "For any discharge from its MS4 to impaired waters with an approved TMDL, the permittee shall comply with the specific terms of Part 2.1 of this permit. In addition, where an approved TMDL establishes a WLA that applies to its MS4 discharges, the permittee shall implement the specific BMPs and other permit requirements identified in Appendix G to achieve consistency with the WLA." Appendix G references a number of programmatic BMPs that are necessary to address pathogen loading. These cover the following general topics:

- Residential educational program
- Illicit connection identification, tracking and removal
- Pet waste management

Mitigation Plan

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Stormwater Management Plan (SWMP) including educational programs, illicit connection review and source control. The specific BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
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In addition, the structural BMPs that will be considered to reduce the IC will also have the effect of reducing pathogen loads.

MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations. MassDOT's existing stormwater management plan outlines BMPs that include education and illicit discharge detection and elimination. MassDOT will be implementing a pet waste management program at its rest stops that have discharges to pathogen impaired waters.

Conclusions

MassDOT used the IC Method to assess Rogers Brook for the impairments identified in MassDEP's final *Massachusetts Year 2012 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed by 1.6 acres to achieve the targeted reduction in effective IC.

MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs to treat directly contributing IC as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide the target IC reduction or treatment to the maximum extent practicable.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of additional BMPs, and finalized assessments including reductions achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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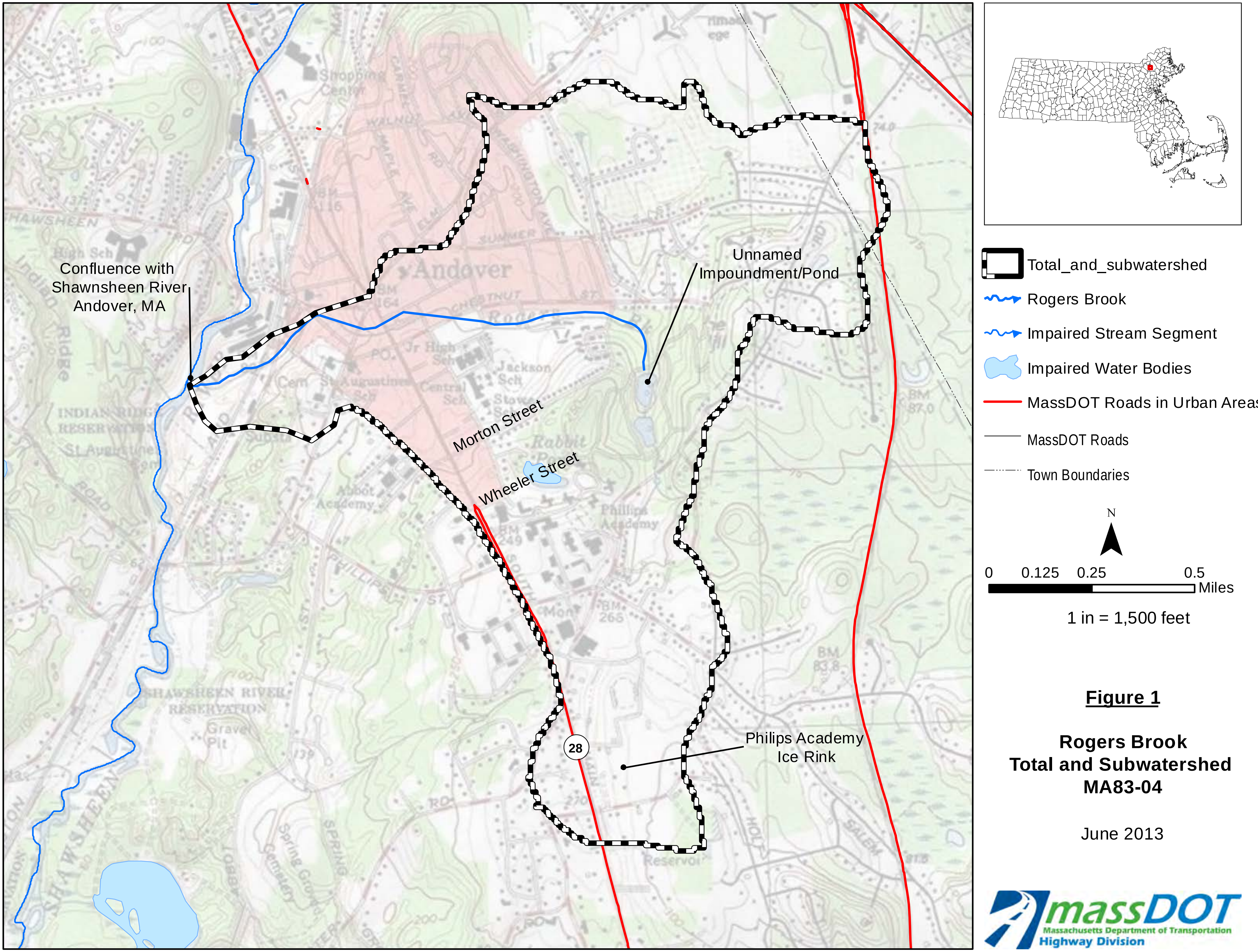

Figure 1

Rogers Brook
Total and Subwatershed
MA83-04

June 2013

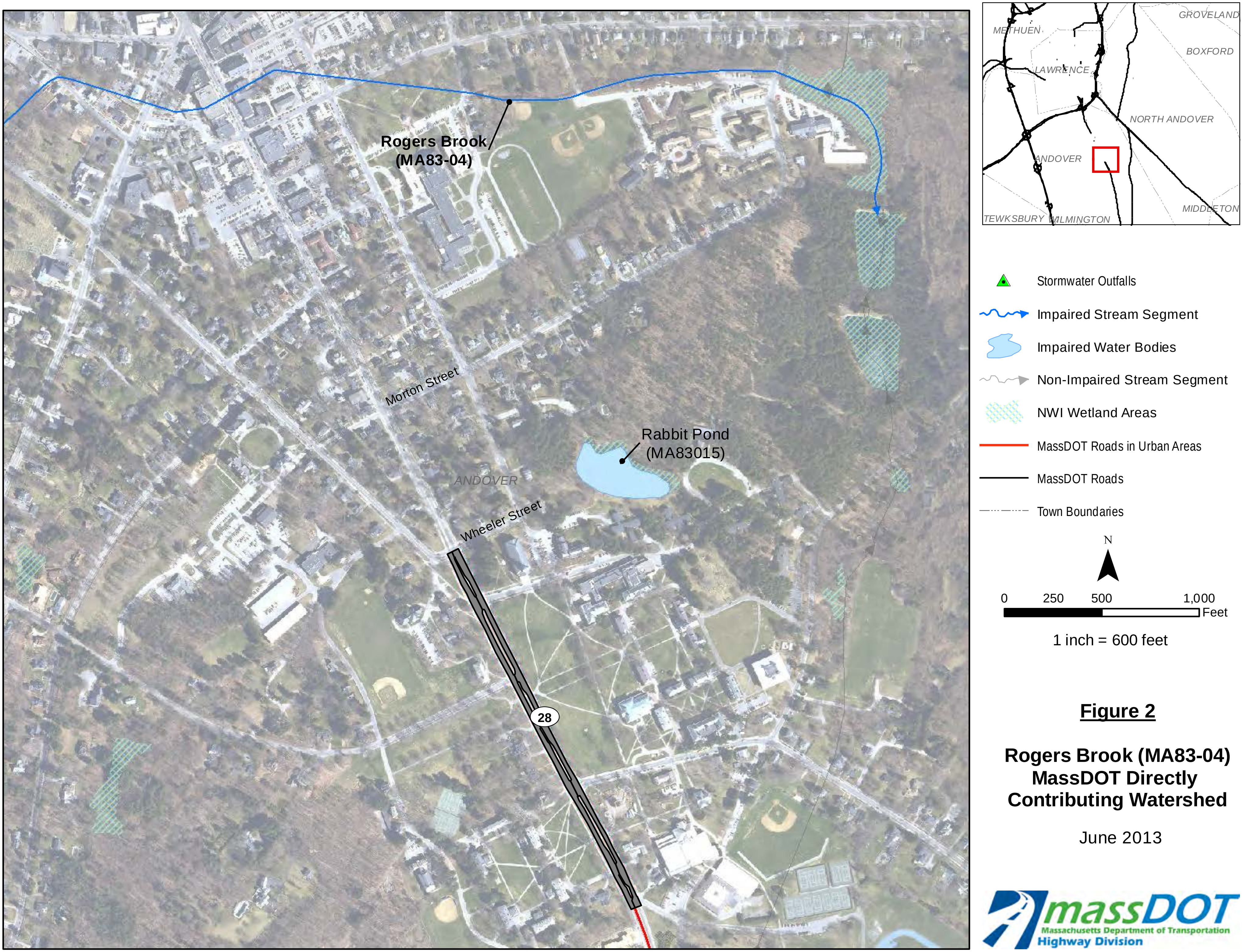

Figure 2

Rogers Brook (MA83-04)
MassDOT Directly Contributing Watershed

June 2013

massDOT Massachusetts Department of Transportation Highway Division

Impaired Waters Assessment for Elm Brook (MA83-05) – Progress Report

Impaired Water Body

Name: Elm Brook

Location: Bedford, Concord, and Lincoln, MA

Water Body ID: MA83-05

Impairments

Elm Brook (MA83-05) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). Elm Brook is impaired for the following:

- (physical substrate habitat alterations*)
- fecal coliform
- turbidity

According to MassDEP's *Shawsheen River Watershed 2000 Water Quality Assessment Report* (MassDEP, 2003), Elm Brook (MA83-05) is impaired for pathogens and turbidity. The report recommends additional monitoring of storm drain discharges to the brook to confirm sources of bacteria, restorative actions along the riparian corridor and the brook itself, continued monitoring of bacteria levels, and additional monitoring of water quality (including turbidity). Elm Brook is covered by the final *Bacteria TMDL for the Shawsheen River Basin* (MassDEP, 2002a).

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *314 CMR 4.05 (3)(b) 6 Color and Turbidity*. These waters shall be free from color and turbidity in concentrations or combinations that are aesthetically objectionable or would impair any use assigned to this class.
- *314 CMR 4.05 (3)(b) 4 Bacteria*.
  - a. At bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: where E. coli is the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml; alternatively, where enterococci are the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no single sample taken during the bathing season shall exceed 61 colonies per 100 ml;

- b. For other waters and, during the non bathing season, for waters at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: the geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml; alternatively, the geometric mean of all enterococci samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 61 colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department.

Site Description

Elm Brook (MA83-05) is a 5.04 mile brook beginning in Lincoln, MA and flowing northward through Concord and into Bedford where it joins the Shawsheen River. Elm Brook begins in a wetland area north of State Road (SR) 2 after which it flows approximately 0.6 miles and crosses under SR 2A, continuing 4.3 miles until crossing under SR 4 as shown in Figure 1. After crossing under SR 4, the brook flows approximately 0.2 miles to join the Shawsheen River. Elm Brook flows through several wetland areas and is joined by five smaller, nonimpaired streams; this segment of the brook does not intersect with any other impaired water bodies prior to its confluence with the Shawsheen River.

The subwatershed of Elm Brook, which is equivalent to the total watershed, is shown in Figure 1. MassDOT's property directly contributing stormwater runoff to Elm Brook is comprised of portions of SR 2A and SR 4 (see Figures 2a and 2b). The directly contributing area on SR 2A contains areas without curbing that are subject to country drainage, as well as areas served by stormwater infrastructure. Because the exact delineations between areas with country drainage and areas served by stormwater infrastructure vary depending on storm size, the entire area was considered directly contributing to provide for the most conservative estimate of impervious cover. In the directly contributing area on SR 4, no stormwater manholes were observed, only catch basins and outfalls.

Assessment under BMP 7U

Of the impairments listed for Elm Brook, one is potentially linked to stormwater runoff and has not been addressed by a TMDL. Therefore, MassDOT assessed the impairment using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of storm water on many impairments. For this water body, MassDOT used the IC method to assess the following impairments:

- turbidity

According to MassDEP's final *Massachusetts Year 2012 Integrated List of Waters*, the physical substrate habitat alterations impairment is not caused by pollutants (MassDEP, 2013). Therefore, this impairment is not considered further.

The impairment for fecal coliform is assessed separately in the section titled Assessment of Pathogen Impairment Under BMP 7R.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction necessary to attain the percent imperviousness in the watershed at which stormwater is not likely the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document (MassDOT, 2011).

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. IC data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer.

In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for Elm Brook (MA83-05):

Table 1. Site Parameters for Elm Brook (MA83-05)

Total and Subwatershed		
Watershed Area	4,150	acres
Impervious Cover (IC) Area	629	acres
Percent Impervious	15.2	%
IC Area at 9% Goal	373	acres
Target Reduction % in IC	40.7	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	4.4	acres
MassDOT's Target Reduction in Effective IC (40.7% of DOT Directly Contributing IC)	1.8	acres

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 40.7%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 1.8 acres.

Existing BMPs

Based on the site visit, there are no existing BMPs in the Elm Brook directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to Elm Brook.

Mitigation Plan

Because there are currently no BMPs mitigating MassDOT's impervious surfaces, MassDOT will consider the implementation of BMPs to achieve a reduction of 1.8 acres of impervious cover.

Assessment of Pathogen Impairment Under BMP 7R

MassDOT assessed the pathogen impairment using the approach described in BMP 7R of MassDOT's Storm Water Management Plan (*TMDL Watershed Review*), which applies to impairments that have been assigned to a water body covered by a final TMDL. Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by an order of magnitude within a given storm event at a single location (MassDEP, 2009b). Therefore, it is difficult to predict pathogen concentrations in stormwater with accuracy. Due to this difficulty, MassDOT generally will not conduct site specific assessments of loading at each location impaired for pathogens. Instead these sites will be assessed collectively based on available information on pathogen loading from highways, MassDOT actions, and information available from EPA and DEP. Based on this information MassDOT developed an approach to be consistent with relevant TMDL and permit condition requirements and an iterative adaptive management approach to stormwater management.

In addition, while there is a positive relationship between IC and pathogen loading, the relationship is not as direct as other impairments. According to the Center for Watershed

Protection "…Other studies show that concentrations of bacteria are typically higher in urban areas than rural areas (USGS, 1999), but they are not always directly related to IC (CWP, 2003)." Therefore, DOT did not rely solely on the IC method to assess pathogen impairments. Instead, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

Pathogens in MassDOT Discharge

A study conducted on MassDOT's South East Expressway measured bacterial concentrations in stormwater runoff (Smith, 2002). This study found a geometric mean of 186 fecal coliforms/100 ml. Concentrations of pathogens in stormwater runoff from roadways can vary widely and pathogen concentrations in runoff across the state likely deviate significantly from this stretch of roadway's specific estimate. Event mean concentrations of fecal coliform bacteria in urban stormwater from other sources ranging between 14,000 and 17,000 fecal coliform organisms/100 mL have been reported (MassDEP, 2009b). These data suggest that pathogen loading from highways may be lower than other urban areas.

Consideration of the potential sources of pathogens supports the idea that pathogens are present in lower concentrations in highway runoff since potential pathogen sources are likely to be less prevalent in the highway environment than along other urban roadways:

- Illicit discharges: Due to the typical setback of highways from residential and commercial developments and the stand alone nature of the drainage system, the potential for illicit discharges (e.g. sewer connections, laundry tie-ins) is much lower than in other stormwater systems. This has been confirmed by MassDOT's illicit discharge detection on many miles of urban roadways within a broad range of areas across Massachusetts. After assessment of almost 140 miles, and investigation of more than 2,500 stormwater features, MassDOT's consultant performing the broad scope reviews has found no confirmed illicit discharges.
- Limited Sewer Utilities in Road Right of Ways: Since DOT does not provide sewer services, many MassDOT roads do not have sewer utilities within the road's right of way; thereby eliminating the chance of cross-connections or leaking pipes as a source of pathogens into the stormwater system.
- Pet waste: Pets are only present on highways in rare instances. In urban residential areas pets and their associated waste are much more common. MassDOT is aware that pet waste at road side rest stops may represent a potential source of pathogens to stormwater in certain situations.
- Wildlife: Highways are not generally an attractive place for wildlife. Wildlife generally avoids highways and only occasionally crosses them.

The dearth of pathogen sources on highways and the relatively low concentrations of pathogens measured in the South East Expressway study together suggest that pathogen loading from stormwater runoff from highways is lower than other urban sources.

Furthermore, in almost all cases the contribution of pathogens from MassDOT to a specific water body is likely to be very small relative to other sources of pathogens in the watershed. Since MassDOT urban roadways are linear and usually cross watersheds, they represent a small fraction of the receiving water body's watershed. The water quality within these water bodies is dependent on discharge from various sources, including discharges from other stormwater systems and a large number of other factors.

Assessment

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

TMDLs for pathogen impairments in Massachusetts recognize that pathogens are highly variable and difficult to address and emphasize the need for an iterative adaptive management approach to address pathogens. Examples of relevant language from these TMDLs are included below:

- "given the vast potential number of bacteria sources and the difficulty of identifying and removing them from some sources such as stormwater require an iterative process and will take some time to accomplish. While the stated goal in the TMDL is to meet the water quality standard at the point of discharge it also attempts to be clear that MassDEP's expectation is that for stormwater an iterative approach is needed…" (MassDEP, 2009a)
- "The NPDES permit does not, however, establish numeric effluent limitations for stormwater discharges. Maximum extent practicable (MEP) is the statutory standard that establishes the level of pollutant reductions that regulated municipalities must achieve. The MEP standard is a narrative effluent limitation that is satisfied through implementation of SWMPs and achievement of measurable goals."(MassDEP, 2009b)
- "Although the TMDL presents quantified WLAs for stormwater that are set equivalent to the criteria in the Massachusetts Water Quality Standards, the Phase II NPDES permits will not include numeric effluent limitations. Phase II permits are intended to be BMP based permits that will require communities to develop and implement comprehensive stormwater management programs involving the use of BMPs. Massachusetts and EPA believe that BMP based Phase II permits involving comprehensive stormwater management together with specific emphasis on pollutants contributing to existing water quality problems can be consistent with the intent of the quantitative WLAs for stormwater discharges in TMDLs." (MassDEP, 2002b).

This language clearly indicates that an iterative adaptive management approach is the appropriate way to address discharges to pathogen impaired waters. The recommendations in pathogen TMDLs for waters in Massachusetts generally require development and implementation of stormwater management programs, illicit discharge detection and elimination efforts, and in some cases installing BMPs to the maximum extent practicable

The draft North Coastal Watershed General MS4 permit and the draft Interstate, Merrimack, and South Coastal (IMS) watershed permits contain specific requirements for compliance with pathogen TMDLs (in Appendix G). While these permits are still in draft form, MassDOT believes they represent the best available guidance on what EPA believes is appropriate for addressing stormwater discharges to pathogen-impaired waters. Section 2.2.1(c) of the permit states "For any discharge from its MS4 to impaired waters with an approved TMDL, the permittee shall comply with the specific terms of Part 2.1 of this permit. In addition, where an approved TMDL establishes a WLA that applies to its MS4 discharges, the permittee shall implement the specific BMPs and other permit requirements identified in Appendix G to achieve consistency with the WLA." Appendix G references a number of programmatic BMPs that are necessary to address pathogen loading. These cover the following general topics:

- Residential educational program
- Illicit connection identification, tracking and removal
- Pet waste management

Mitigation Plan

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Stormwater Management Plan (SWMP) including educational programs, illicit connection review and source control. The specific BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In
- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

In addition, the structural BMPs that will be considered to reduce the IC will also have the effect of reducing pathogen loads.

MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations. MassDOT's existing stormwater management plan outlines BMPs that include education and illicit discharge detection and elimination. MassDOT will be implementing a pet waste management program at its rest stops that have discharges to pathogen impaired waters.

Conclusions

MassDOT used the IC Method to assess Elm Brook for the impairments identified in MassDEP's final *Massachusetts Year 2012 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed by 1.8 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Elm Brook to identify existing BMPs and found that there are currently no existing BMPs providing reduction.

MassDOT should reduce its effective IC within the directly contributing watershed by 1.8 acres to achieve the targeted reduction in IC. MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs to treat directly contributing IC as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide the target IC reduction or treatment to the maximum extent practicable.

MassDOT has concluded based on review of the draft North Coastal Watershed General MS4 permit, the draft Interstate, Merrimack, and South Coastal watershed permits, and pathogen TMDLs for Massachusetts waters, that the BMPs outlined in the stormwater management plan and those under consideration for reducing effective IC from MassDOT areas are consistent with its existing permit requirements. MassDOT believes that these measures achieve pathogen reductions (including fecal coliform) to the maximum extent practicable and are consistent with the intent of its existing stormwater permit and the applicable Pathogen TMDLs.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of additional BMPs, and finalized assessments including reductions achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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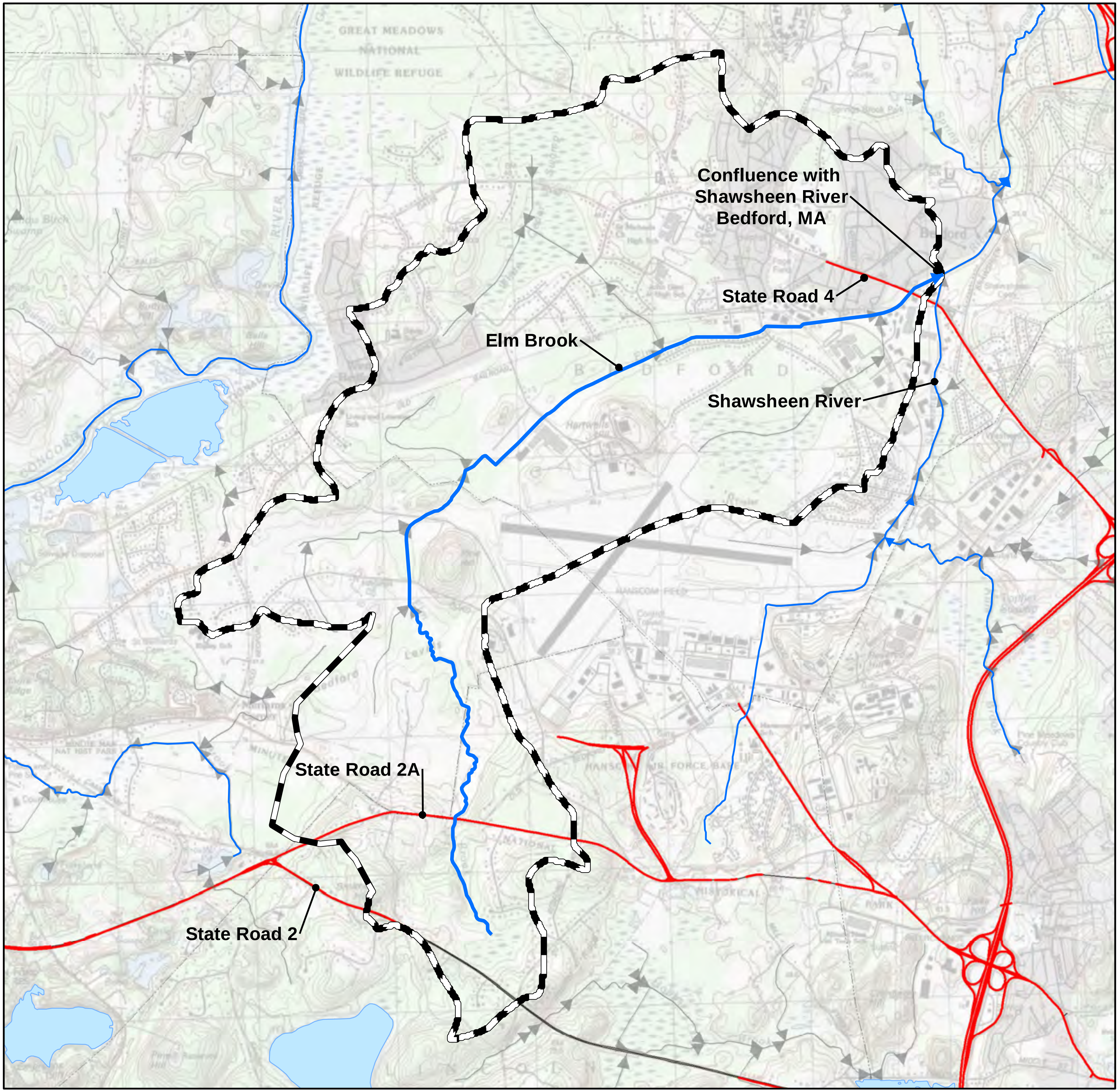
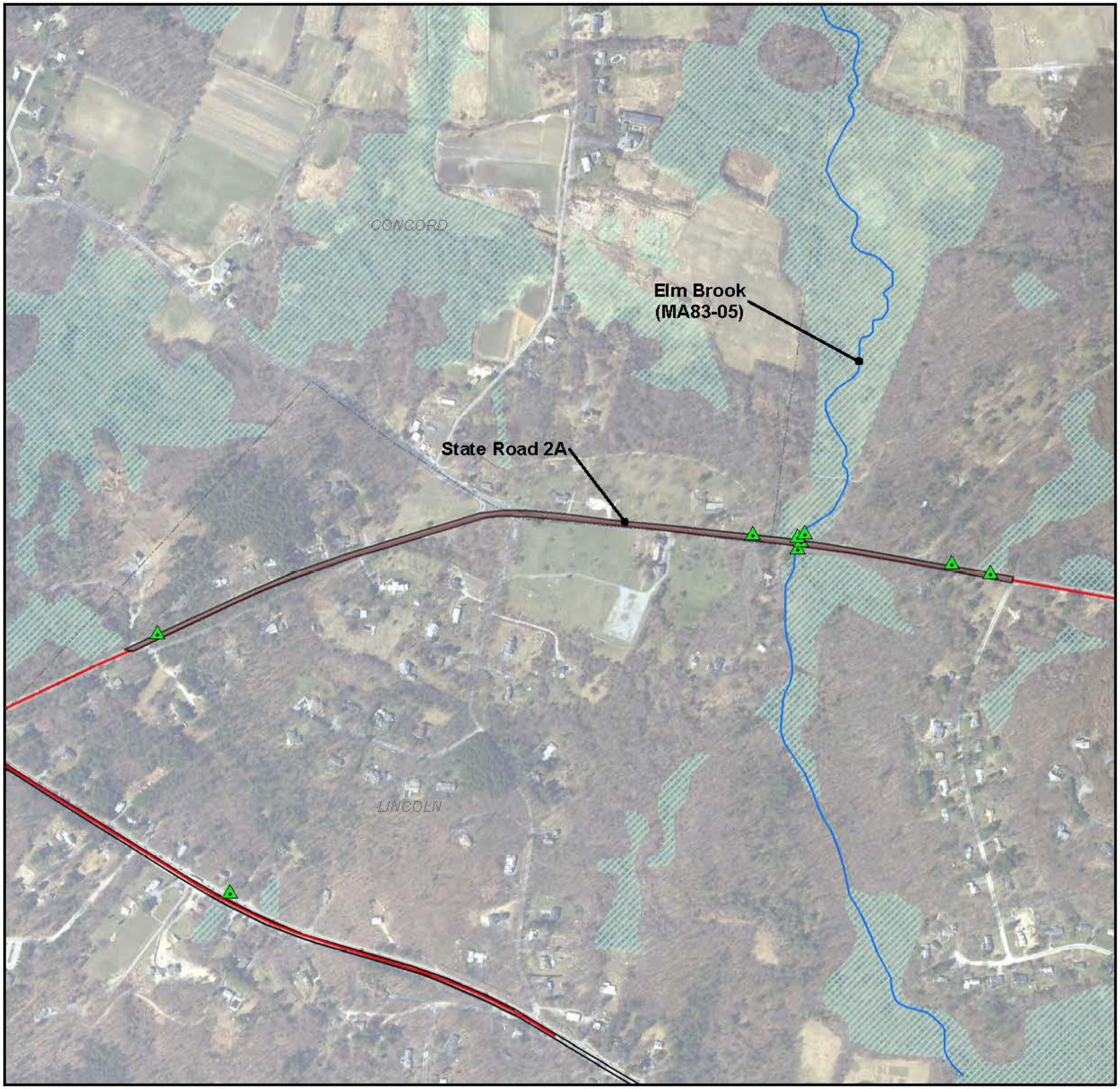


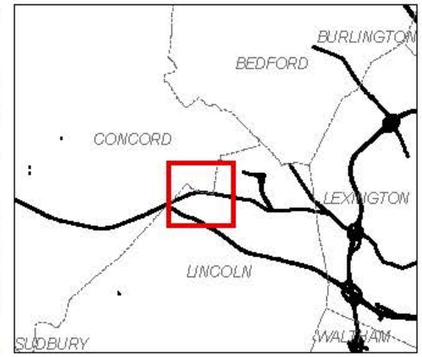
Figure 1

Elm Brook
Total and Subwatershed
MA83-05

June 2013

massDOT
Massachusetts Department of Transportation
Highway Division





Stormwater Outfalls
DOT Direct IC Watershed
Impaired Stream Segment
Impaired Water Bodies
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 125250 500 750 1,000 Feet

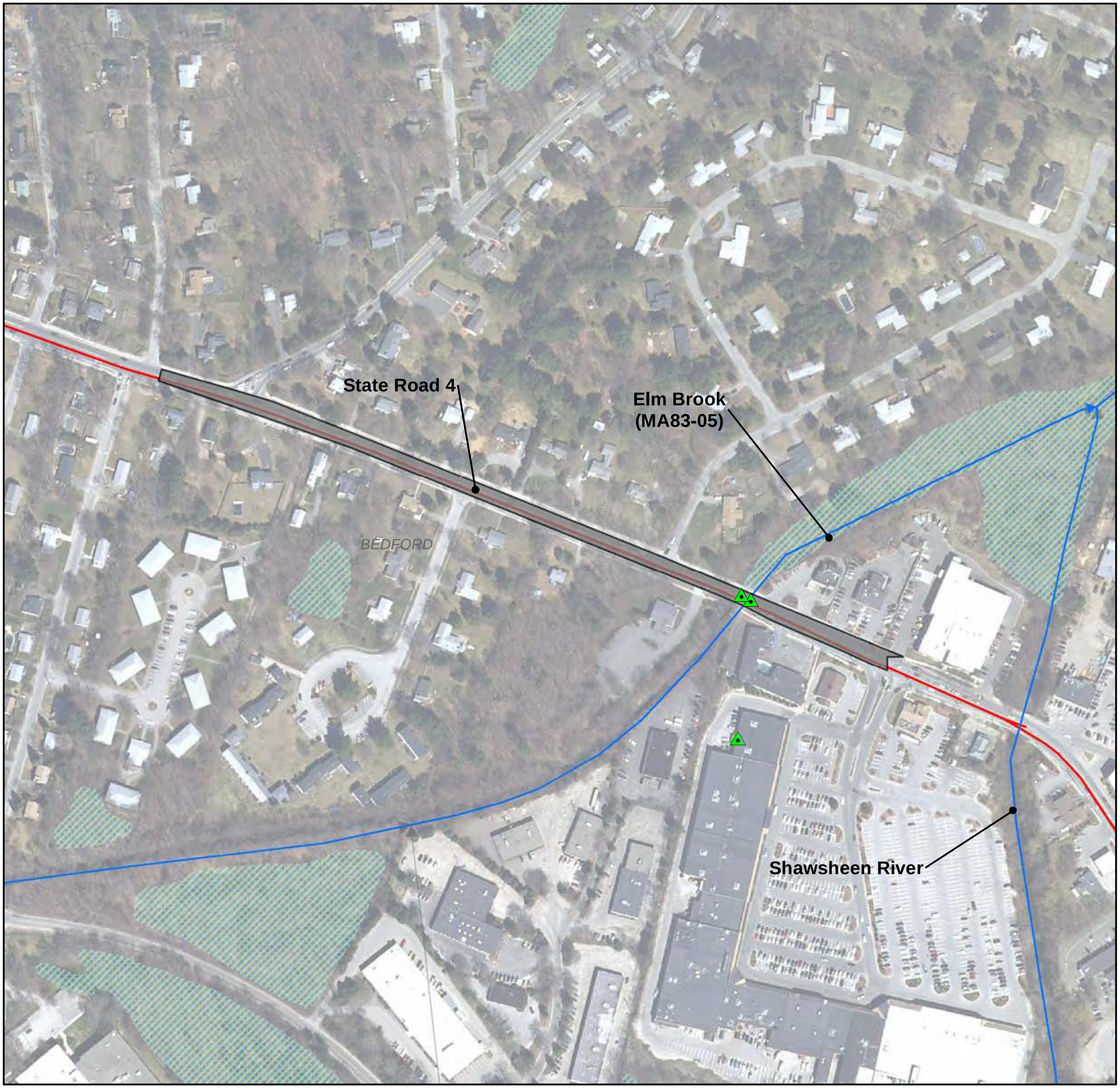
1 inch = 700 feet

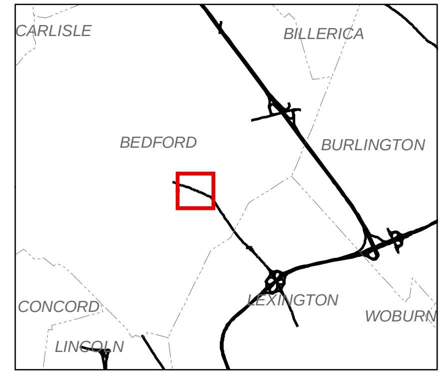
Figure 2a

Elm Brook (MA83-05)
Directly Contributing
MassDOT Watershed
State Road 2A

June 2013

massDOT Massachusetts Department of Transportation Highway Division





Stormwater Outfalls
DOT Direct IC Watershed
Impaired Stream Segment
Impaired Water Bodies
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 125 250 500 Feet

1 inch = 300 feet

Figure 2b

Elm Brook (MA83-05)
Directly Contributing
MassDOT Watershed
State Road 4

June 2013

massDOT
Massachusetts Department of Transportation
Highway Division

Impaired Waters Assessment for Shawsheen River (MA83-19) – Progress Report

Impaired Waterbody

Name: Shawsheen River

Location: Lawrence, North Andover and Andover, MA

Water Body ID: MA83-19

Impairments

Shawsheen River (MA83-19) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). Shawsheen River (MA83-19) is impaired for the following:

- fecal coliform
- oxygen, dissolved

According to MassDEP's *Shawsheen River Watershed 2000 Water Quality Assessment Report* (MassDEP, 2003), the primary contact recreational use is impaired downstream from the confluence with Rogers Brook to the confluence with the Merrimack River due to elevated bacteria counts. Shawsheen River is covered by the *Bacteria TMDL for the Shawsheen River Basin* (MassDEP, 2002).

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *314 CMR 4.05 (3)(b) 1 Dissolved Oxygen*. Shall not be less than 6.0 mg/l in cold water fisheries and not less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.
- *314 CMR 4.05 (3)(b) 4 Bacteria*.
    - a. At bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: where E. coli is the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml; alternatively, where enterococci are the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no single sample taken during the bathing season shall exceed 61 colonies per 100 ml.

- b. For other waters and, during the non bathing season, for waters at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: the geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml; alternatively, the geometric mean of all enterococci samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 61 colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department.

Site Description

Segment MA83-19 of the Shawsheen River begins at the outlet of the Ballardvale Impoundment in Andover, MA and continues north approximately 2.5 miles to the confluence with Rogers Brook; continues 1.7 miles to the confluence with Hussey Brook in Andover; and continues approximately 4 miles before it flows through a culvert for approximately 0.1 miles and merges with the Merrimack River in Lawrence, MA. The 5.8 mile reach of Shawsheen River (MA83-19) from the confluence with Rogers Brook to the confluence with the Merrimack River is classified as impaired due to elevated bacteria counts according to the *Shawsheen River Watershed 2000 Water Quality Assessment Report*. The total length of MA83-19 of the Shawsheen River is approximately 8.3 miles; refer to Figure 1 for the total watershed and Figure 2 for the subwatershed of Segment MA83-19.

MassDOT’s property directly contributing stormwater runoff to the Shawsheen River is comprised of (but not limited to) portions of Merrimack Street, Massachusetts Avenue, Rte 114 (Winthrop Avenue), Rte 28 (North Main Street), and I-495 (see Figure 2). Refer to Figures 3a through 3e for the location of these (and additional) roadways within the subwatershed to Segment MA83-19 of Shawsheen River. An overview and details of the direct drainage watersheds and outfalls are presented in greater detail below. Chickering Road, Rte. 28 (south of Rogers Brook), and the portion of I-495 west of Corbett Street do not directly contribute to the Shawsheen River (see Figure 2 for locations of these roadways).

<u>Merrimack Street to location where Shawsheen River crosses under I-495</u>

As shown on Figure 3a, the ramps underneath I-495 South that connect to Merrimack Street are located directly above and adjacent to the area where the Shawsheen River flows through a 0.1 mile culvert before its confluence with the Merrimack River. Runoff from the ramps, the I-495 bridge over Merrimack Street, and Merrimack Street appears to be hydraulically connected and ultimately discharge to the Shawsheen River immediately before it flows through the culvert. Runoff from I-495 (closest to the northern subwatershed boundary of Segment MA83-19 of the Shawsheen River) and entrance ramps to I-495 from Sutton Street does not appear to directly discharge to Segment MA83-19 of the Shawsheen River.

Runoff from the span of I-495 North and South between Merrimack Street and Massachusetts Avenue, including the exit ramp from I-495 South to Massachusetts Avenue and the first 300 feet of the entrance ramp from Massachusetts Avenue to I-495 North, is collected and piped to a series of outfalls along an existing right-of-way adjacent to I-495 South and the exit ramp from I-495 South to Massachusetts Avenue. Two stormwater basins are located within this right-of-way (Figure 3a), as described further in the *Existing BMPs* section below; however, neither appears to be functioning as an effective BMP. The remainder of the entrance ramp from Massachusetts Avenue to I-495 North does not directly discharge to the river; runoff is discharged via an outfall adjacent to the ramp in the vicinity of Middlesex Street in North Andover. In addition, portions of I-495 South and North discharge to outfalls adjacent to the highway in this area and do not directly discharge to the river (Figure 3a).

South of Massachusetts Avenue, the entrance ramp from Massachusetts Avenue to I-495 South runs parallel and drains directly to the Shawsheen River until the location where the river flows through a culvert under I-495. Runoff from I-495 North and South is collected via an approximately 800 ft long drainage ditch that runs parallel to the exit ramp from I-495 North to Massachusetts Avenue and drains to the Shawsheen River on the I-495 North side, immediately before the river crosses under I-495.

Location where Shawsheen River crosses under I-495 to Rte. 114 interchange

The majority of MassDOT property, from the location where the river crosses under I-495 to the Rte. 114 interchange, drains to ditches that extend along either side of the highway (Figure 3b). South of the location where the river crosses under I-495, runoff is collected from I-495 South via a ditch on the western side of the highway that flows north for approximately 800 ft along I-495 South and then continues under I-495 North and South and collects runoff for approximately 300 additional feet on the eastern side of I-495 North before it discharges to the Shawsheen River just upstream of the location where the river is culverted under I-495.

An approximately 500 ft ditch running parallel to the exit ramp from I-495 South to Rte. 114 collects runoff from the exit ramp and I-495 South and North; pipes convey runoff under I-495 South and North to this ditch and then from the ditch to the Shawsheen River via an outfall along I-495 North (Figure 3b). Runoff to the north of this ditch does not directly discharge to the Shawsheen River; runoff from I-495 South and the western lanes of I-495 North discharge to an outfall adjacent to I-495 North, on the opposite side of the highway from the river.

Runoff from the cloverleaves at the Rte. 114/I-495 exchange and the portion of Rte. 114 west of I-495 are hydraulically connected and ultimately discharge to the northbound drainageway, where runoff flows through a ditch within the northbound cloverleaf and ultimately discharges via an outfall to the northeast of the northbound cloverleaf (Figure 3b).

Outfalls capture drainage from the entrance ramp to I-495 North from Rte. 114 and directly discharge to the river on the I-495 North side of the highway (Figure 3b).

Rte. 114

Stormwater from Rte. 114 east of I-495 is collected by catch basins and then discharges to the river where it crosses under Rte. 114 (Rte. 114 bridge) (Figure 3c). Rte. 114 appears to directly discharge to the river southeast of the Rte. 114 bridge for approximately 400 ft to the high point in elevation (Figure 3c). A non-impaired stream segment flows northwest and parallel to Rte. 114, as shown on Figure 3c; this stream merges with the Shawsheen River downstream of the Rte. 114 bridge. Runoff from the area of Rte. 114 closest to the non-impaired stream (Rte. 114 West) is directed to the stream via catch basins and overland flow; therefore, runoff in this area does not appear to directly discharge to the Shawsheen River. Runoff from Rte. 114 East on the other side of the road drains to a wetland area on this side of the road and does not appear to directly discharge to the Shawsheen River.

South of Rte. 114 interchange to Rte. 28 interchange

Between the Rte. 114 and Rte. 28 interchanges, most runoff directly discharges to Shawsheen River along I-495 North via catch basins connected to outfalls, ditches, or culverts, as described below.

A series of outfalls along the exit ramp from I-495 North to Rte. 114 capture drainage from both directions of the highway and the exit ramp and directly discharge to the river on the I-495 North side of the highway (Figure 3d). Further south along the highway, a series of outfalls captures highway drainage and similarly discharges to the river on the I-495 North side of the highway.

Approximately 600 ft north of the railroad, a culvert directs highway drainage below I-495 and directly to the river (Figure 3d). Runoff from the portion of I-495 South in the vicinity of the railroad discharges to a wetland area adjacent to the highway and does not directly discharge to the river (as shown in Figure 3d).

Runoff from MassDOT property north of the Rte. 28 interchange (including South Broadway, South Street, North Main Street and South Union Street) and a portion of I-495 South and North, northeast of the Rte. 28 cloverleaf, is collected in a paved ditch along Binney Street in Andover which directs flow to a drop inlet. Drainage is then directed underneath the highway to an outfall in the vicinity of the I-495 entrance ramp from Rte. 28.

Drainage from the Rte. 28 interchange appears to be hydraulically connected; a portion of the northwest cloverleaf section is directed via pipe to the southeast cloverleaf (the remaining section of the cloverleaf discharges to an outfall adjacent to the ramp and does not directly contribute to the Shawsheen River, as shown in Figure 3d). There is a drainage swale area in the southeast cloverleaf that collects drainage, which then flows to an outfall to the southeast of the cloverleaf; this outfall directly discharges to the Shawsheen River.

Rte. 28 and I-495 (west of the Rte.28/I-495 interchange)

Runoff from the MassDOT owned portion of Rte. 28 south of the Rte. 28/I-495 interchange directly discharges to the Shawsheen River via a catch basin collection system (Figure 3e).

Runoff from I-495 west of the Rte.28/I-495 interchange is collected via catch basins connected via a long pipe system that ultimately drains to the southeast cloverleaf in the Rte. 28/I-495 interchange. As described above, this outfall directly discharges to the Shawsheen River.

Assessment under BMP 7U

Of the impairments listed for Segment MA83-19 of Shawsheen River, one is potentially linked to stormwater runoff and has not been addressed by a TMDL. Therefore, MassDOT assessed this impairment using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of stormwater on many impairments. For this water body, MassDOT used the IC method to assess the following impairments:

- oxygen, dissolved

The impairment for fecal coliform has been addressed by the *Bacteria TMDL for the Shawsheen River Basin* (MassDEP, 2002). MassDOT has assessed its contribution to this impairment and compliance with the corresponding TMDL separately in the section titled "Assessment under BMP 7R."

The following sections describe the methodology used by MassDOT to assess the one impairment potentially linked to stormwater that has not been addressed by a TMDL.

MassDOT’s Application of the Impervious Cover Method

MassDOT’s Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I’s Impervious Cover Method described in EPA’s *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT’s program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction required to ensure that stormwater is not the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT’s Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body’s entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. IC data was available as part of the USGS data layers Data Series 451 and MassGIS’s impervious surfaces data layer.

In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT’s target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT’s properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1’s *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for Segment MA83-19 of Shawsheen River:

Table 1. Site Parameters for Shawsheen River (MA83-19)

Total Watershed		
Watershed Area	50,100	acres
Impervious Cover (IC) Area	10,700	acres
Percent Impervious	21.3*	%
Subwatershed		
Subwatershed Area	8,140	acres
Impervious Cover (IC) Area	2,240	acres
Percent Impervious	27.6*	%
IC Area at 9% Goal	732	acres
Target Reduction % in IC	67.4*	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	58.3	acres
MassDOT's Target Reduction in Effective IC (67.4% of DOT Directly Contributing IC)	39.3	acres

*Rounding accounts for differences in calculations.

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 67.4%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 39.3 acres.

Existing BMPs

MassDOT has two stormwater basins along I-495 South (between Merrimack Street and Massachusetts Avenue and the exit ramp from I-495 South) within the directly contributing watershed to Shawsheen River (Figure 3a) (accessible behind People's United Bank on Massachusetts Avenue in Lawrence). Although these stormwater basins intercept and infiltrate stormwater that would otherwise flow directly into Shawsheen River, they do not fully meet the design criteria to be considered infiltration basins. Furthermore, the detention basins have no form of pretreatment. During large storms, the potential exists for these basins to overflow into Shawsheen River.

For these reasons, no IC effective reduction credits have been assigned to these stormwater basins. Further action to reduce effective IC within the directly contributing watershed to Shawsheen River may include rehabilitation of these structures to restore their original design functionality.

Therefore, based on the site visit, there are no existing BMPs in the Shawsheen River directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to Shawsheen River."

Stormwater basin along I-495 South; south of Merrimack Street and north of Mass Avenue.

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 39.3 acres, MassDOT will consider the implementation of new BMPs. In conjunction with the proposed FY15 resurfacing of Interstate 495, a desktop analysis for potential BMP locations was recently completed. The March 2013 memorandum recommended the construction and maintenance of structural BMPs to reduce effective impervious cover within the watershed of Shawsheen River (MA83-19), and noted that there is available, open land within the highway median where three linear, structural BMPs could potentially be constructed. There is also open land within an interchange cloverleaf that could potentially be available for the construction of an infiltration BMP. This impaired waters assessment coupled with the preliminary BMP siting analysis will provide the basis for future detailed BMP design.

Assessment of Pathogen Impairment under BMP 7R

MassDOT assessed the pathogen impairment using the approach described in BMP 7R of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body covered by a final TMDL. Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by an order of magnitude within a given storm event at a single location (MassDEP, 2009b). Therefore, it is difficult to predict pathogen concentrations in stormwater with accuracy. Due to this difficulty, MassDOT generally will not conduct site specific assessments of loading at each location impaired for pathogens. Instead these sites will be assessed collectively based on available information on pathogen loading from highways, MassDOT actions, and information available from EPA and DEP. Based on this information MassDOT developed an approach to be consistent with relevant TMDL and permit condition requirements and an iterative adaptive management approach to stormwater management.

In addition, while there is a positive relationship between IC and pathogen loading, the relationship is not as direct as other impairments. According to the Center for Watershed Protection "…Other studies show that concentrations of bacteria are typically higher in urban areas than rural areas (USGS, 1999), but they are not always directly related to IC (CWP, 2003)." Therefore, DOT did not rely solely on the IC method to assess pathogen impairments. Instead, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

Pathogens in MassDOT Discharge

A study conducted on MassDOT's South East Expressway measured bacterial concentrations in stormwater runoff (Smith, 2002). This study found a geometric mean of 186 fecal coliforms/100 ml. Concentrations of pathogens in stormwater runoff from roadways can vary widely and pathogen concentrations in runoff across the state likely deviate significantly from this stretch of roadway's specific estimate. Event mean concentrations of fecal coliform bacteria in urban stormwater from other sources ranging between 14,000 and 17,000 fecal coliform organisms/100 mL have been reported (MassDEP, 2009b). These data suggest that pathogen loading from highways may be lower than other urban areas.

Consideration of the potential sources of pathogens supports the idea that pathogens are present in lower concentrations in highway runoff since potential pathogen sources are likely to be less prevalent in the highway environment than along other urban roadways:

- Illicit discharges: Due to the typical setback of highways from residential and commercial developments and the stand alone nature of the drainage system, the potential for illicit discharges (e.g. sewer connections, laundry tie-ins) is much lower than in other stormwater systems. This has been confirmed by MassDOT's illicit discharge detection on many miles of urban roadways within a broad range of areas across Massachusetts. After assessment of almost 140 miles, and investigation of more than 2,500 stormwater features, MassDOT's consultant performing the broad scope reviews has found no confirmed illicit discharges.
- Limited Sewer Utilities in Road Right of Ways: Since DOT does not provide sewer services, many MassDOT roads do not have sewer utilities within the road's right of way; thereby eliminating the chance of cross-connections or leaking pipes as a source of pathogens into the stormwater system.
- Pet waste: Pets are only present on highways in rare instances. In urban residential areas pets and their associated waste are much more common. MassDOT is aware that pet waste at road side rest stops may represent a potential source of pathogens to stormwater in certain situations.
- Wildlife: Highways are not generally an attractive place for wildlife. Wildlife generally avoids highways and only occasionally crosses them.

The dearth of pathogen sources on highways and the relatively low concentrations of pathogens measured in the South East Expressway study together suggest that pathogen loading from stormwater runoff from highways is lower than other urban sources.

Furthermore, in almost all cases the contribution of pathogens from MassDOT to a specific water body is likely to be very small relative to other sources of pathogens in the watershed. Since MassDOT urban roadways are linear and usually cross watersheds, they represent a small fraction of the receiving water body's watershed. The water quality within these water bodies is dependent on discharge from various sources, including discharges from other stormwater systems and a large number of other factors.

Assessment

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

TMDLs for pathogen impairments in Massachusetts recognize that pathogens are highly variable and difficult to address and emphasize the need for an iterative adaptive management approach to address pathogens. Examples of relevant language from these TMDLs are included below:

- "given the vast potential number of bacteria sources and the difficulty of identifying and removing them from some sources such as stormwater require an iterative process and will take some time to accomplish. While the stated goal in the TMDL is to meet the water quality standard at the point of discharge it also attempts to be clear that MassDEP's expectation is that for stormwater an iterative approach is needed…" (MassDEP, 2009a)
- "The NPDES permit does not, however, establish numeric effluent limitations for stormwater discharges. Maximum extent practicable (MEP) is the statutory standard that establishes the level of pollutant reductions that regulated municipalities must achieve. The MEP standard is a narrative effluent limitation that is satisfied through implementation of SWMPs and achievement of measurable goals."(MassDEP, 2009b)
- "Although the TMDL presents quantified WLAs for stormwater that are set equivalent to the criteria in the Massachusetts Water Quality Standards, the Phase II NPDES permits will not include numeric effluent limitations. Phase II permits are intended to be BMP based permits that will require communities to develop and implement comprehensive stormwater management programs involving the use of BMPs. Massachusetts and EPA believe that BMP based Phase II permits involving comprehensive stormwater management together with specific emphasis on pollutants contributing to existing water quality problems can be consistent with the intent of the quantitative WLAs for stormwater discharges in TMDLs." (MassDEP, 2002).

This language clearly indicates that an iterative adaptive management approach is the appropriate way to address discharges to pathogen impaired waters. The recommendations in pathogen TMDLs for waters in Massachusetts generally require development and implementation of stormwater management programs, illicit discharge detection and elimination efforts, and in some cases installing BMPs to the maximum extent practicable

The draft North Coastal Watershed General MS4 permit and the draft Interstate, Merrimack, and South Coastal (IMS) watershed permits contain specific requirements for compliance with pathogen TMDLs (in Appendix G). While these permits are still in draft form, MassDOT believes they represent the best available guidance on what EPA believes is appropriate for addressing stormwater discharges to pathogen-impaired waters. Section 2.2.1(c) of the permit states "For any discharge from its MS4 to impaired waters with an approved TMDL, the permittee shall comply with the specific terms of Part 2.1 of this permit. In addition, where an approved TMDL establishes a WLA that applies to its MS4 discharges, the permittee shall implement the specific BMPs and other permit requirements identified in Appendix G to achieve consistency with the WLA." Appendix G references a number of programmatic BMPs that are necessary to address pathogen loading. These cover the following general topics:

- Residential educational program
- Illicit connection identification, tracking and removal
- Pet waste management

Mitigation Plan

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Stormwater Management Plan (SWMP) including educational programs, illicit connection review and source control. The specific BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In
- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

In addition, the structural BMPs that will be considered to reduce the IC will also have the effect of reducing pathogen loads.

MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations. MassDOT's existing stormwater management plan outlines BMPs that include education and illicit discharge detection and elimination. MassDOT will be implementing a pet waste management program at its rest stops that have discharges to pathogen impaired waters.

Conclusions

MassDOT used the IC Method to assess Shawsheen River for the impairments identified in MassDEP's final *Massachusetts Year 2010 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed by 39.3 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Shawsheen River to identify existing BMPs and found that existing BMPs provide 0% of the target reduction in effective IC. This information is summarized in Table 2 below.

Table 2. Effective IC Reductions under Existing & Proposed Conditions

IC in Directly Contributing Watershed	58.3	acres
Target Reduction in Effective IC	39.3	acres
IC Effectively Reduced by Existing BMPs	0	acres
IC Remaining to Mitigate with Proposed BMPs	**39.3**	**acres**

MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs to treat directly contributing IC as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide the target IC reduction or treatment to the maximum extent practicable.

MassDOT has concluded based on review of the draft North Coastal Watershed General MS4 permit, the draft Interstate, Merrimack, and South Coastal watershed permits, and pathogen TMDLs for Massachusetts waters, that the BMPs outlined in the stormwater management plan and those under consideration for reducing effective IC from MassDOT areas are consistent with its existing permit requirements. MassDOT believes that these measures achieve pathogen reductions (including fecal coliform) to the maximum extent practicable and are consistent with the intent of its existing stormwater permit and the applicable Pathogen TMDLs.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of additional BMPs, and finalized assessments including reductions achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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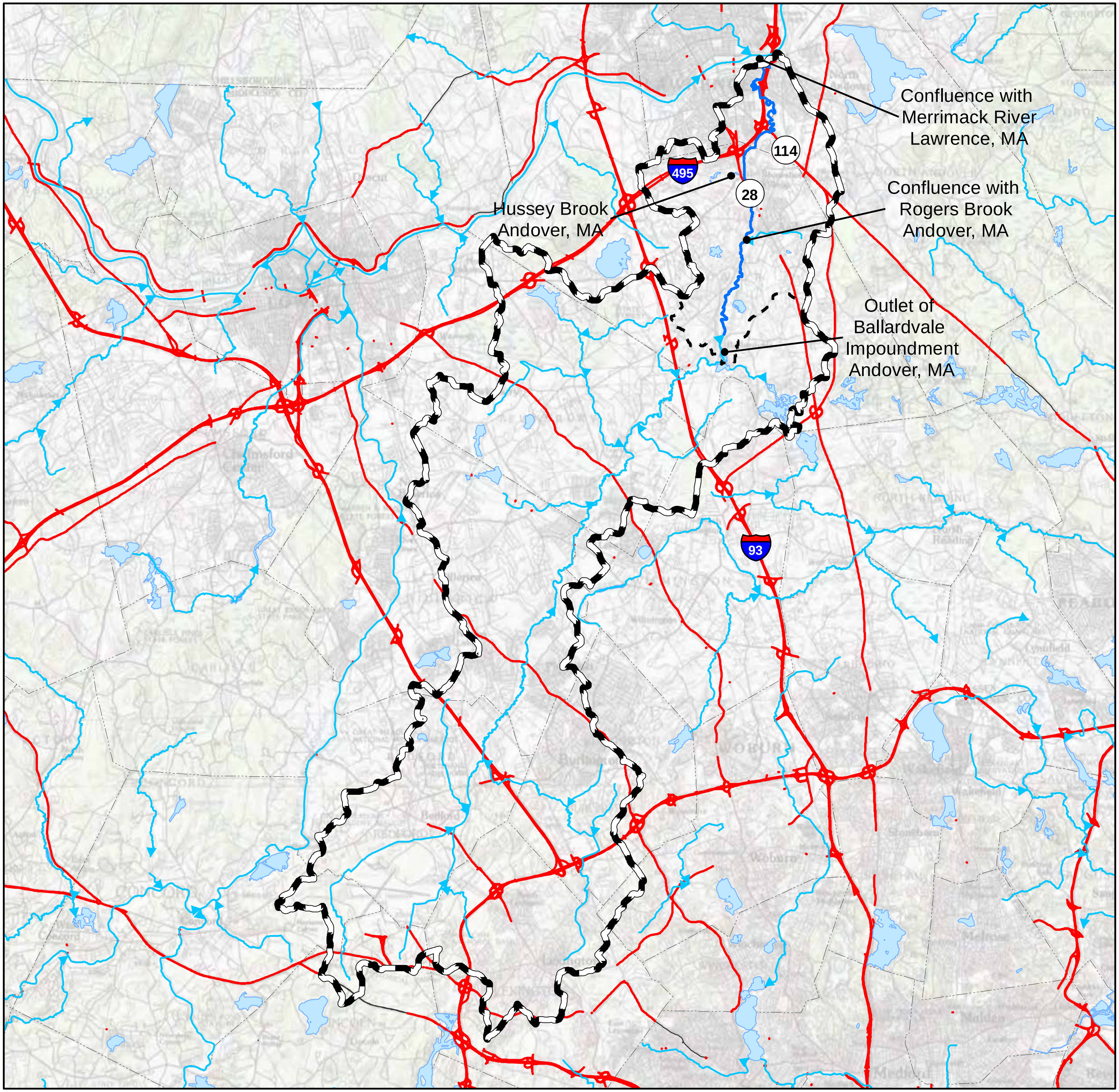


Total Watershed
Subwatershed
Shawsheen River (MA83-19)
Impaired Stream Segment
Impaired Water Bodies
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 0.5 1 2 3 4 Miles

1 in = 3 miles

Figure 1

Shawsheen River Total Watershed MA83-19

June 2013

massDOT Massachusetts Department of Transportation Highway Division

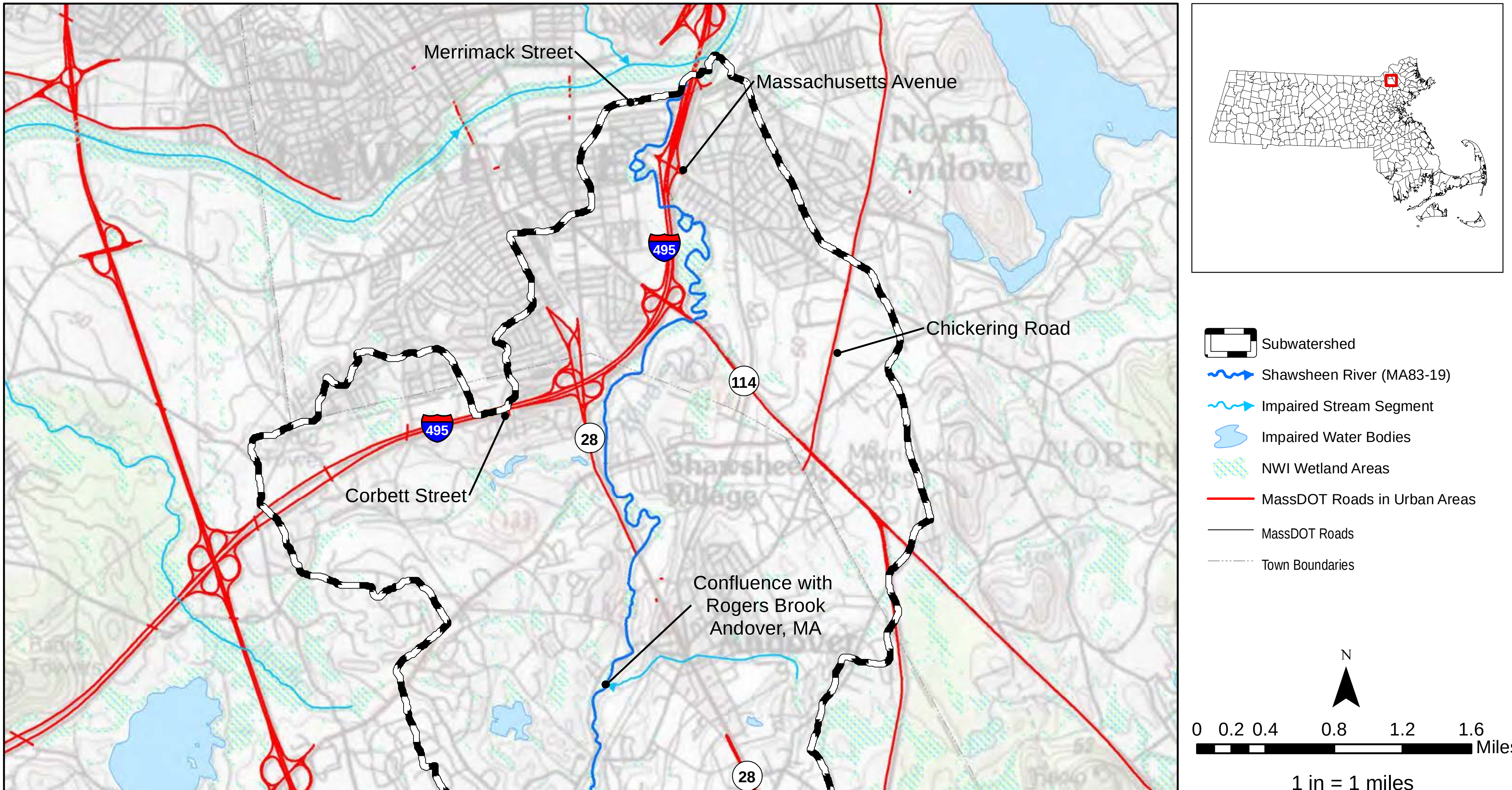


Figure 2

Shawsheen River Subwatershed MA83-19

June 2013

massDOT
Massachusetts Department of Transportation
Highway Division

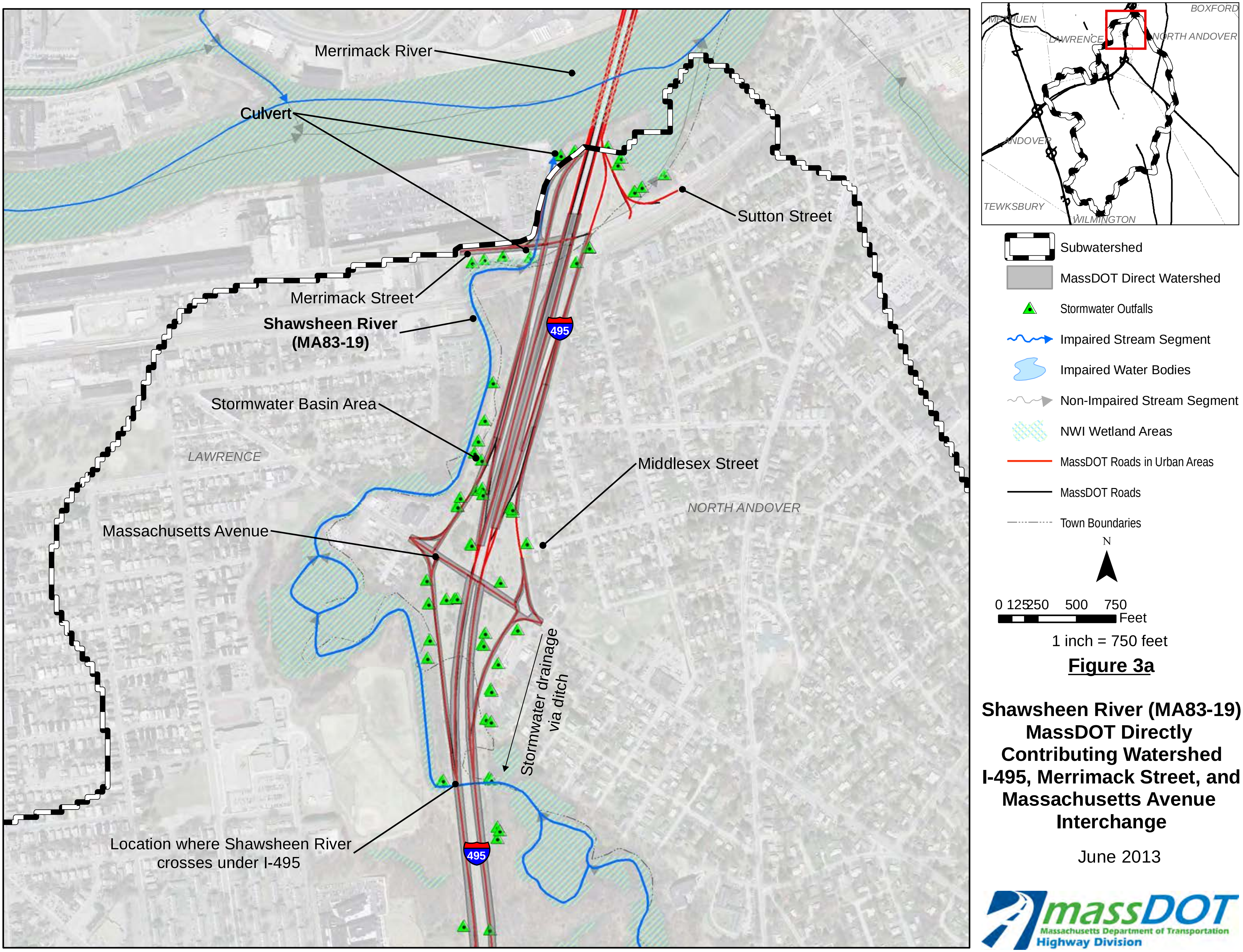
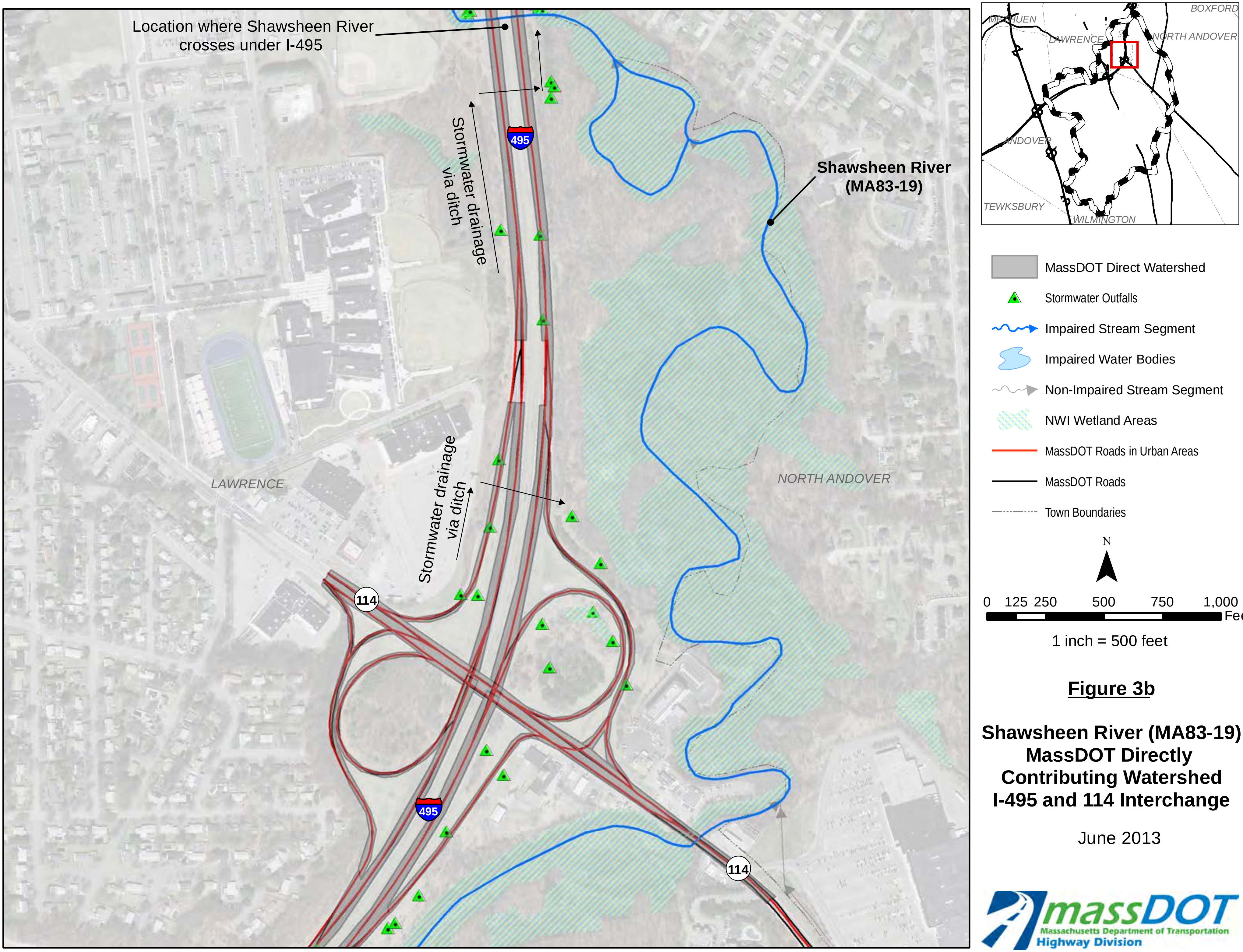


Figure 3a

Shawsheen River (MA83-19) MassDOT Directly Contributing Watershed I-495, Merrimack Street, and Massachusetts Avenue Interchange

June 2013

massDOT Massachusetts Department of Transportation Highway Division



MassDOT Direct Watershed

Stormwater Outfalls

Impaired Stream Segment

Impaired Water Bodies

Non-Impaired Stream Segment

NWI Wetland Areas

MassDOT Roads in Urban Areas

MassDOT Roads

Town Boundaries

N

0 125 250 500 750 1,000 Feet

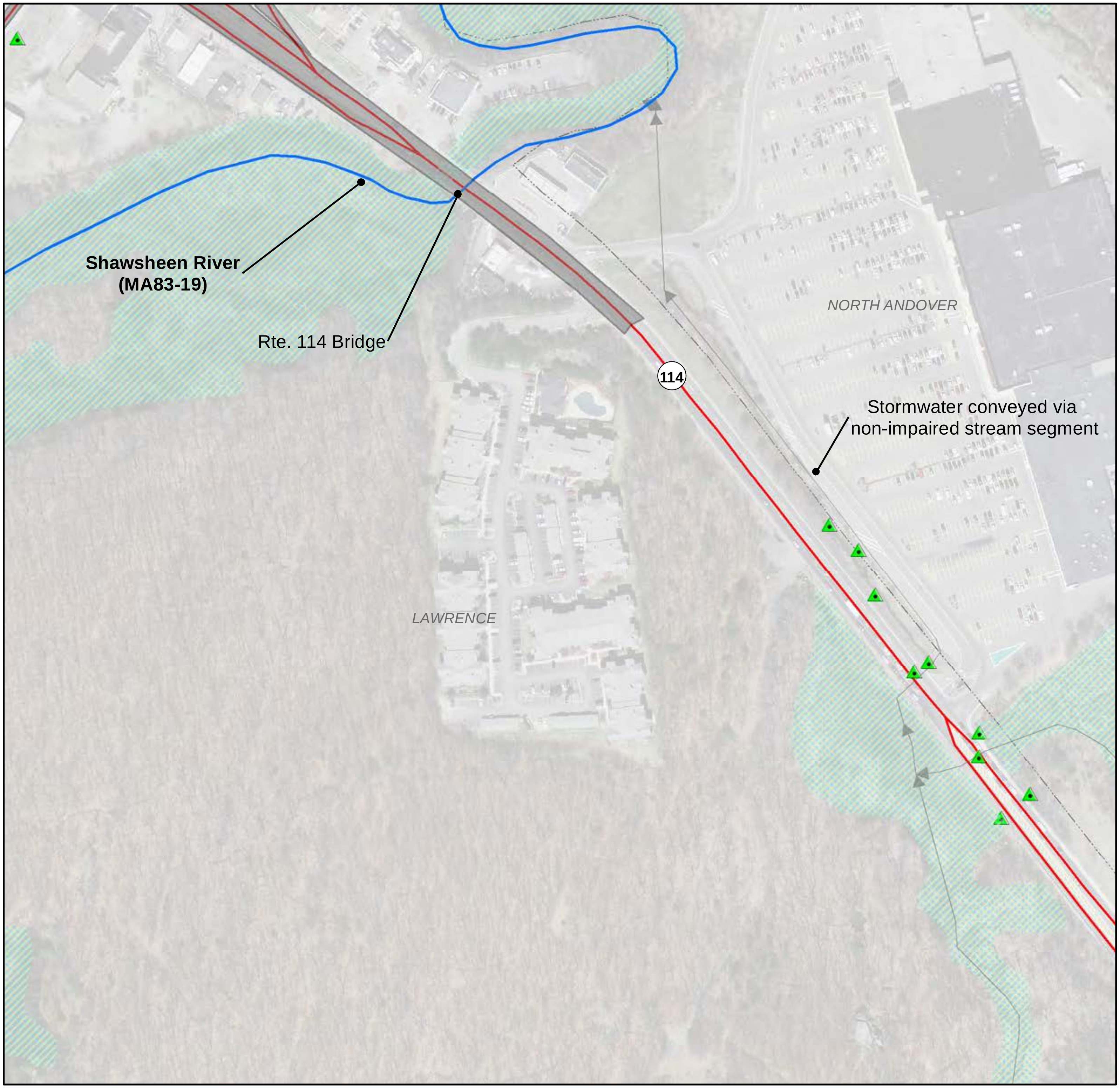
1 inch = 500 feet

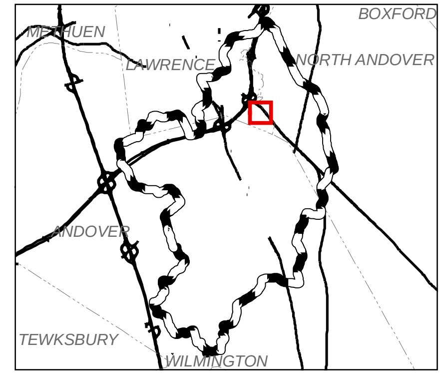
Figure 3b

Shawsheen River (MA83-19) MassDOT Directly Contributing Watershed I-495 and 114 Interchange

June 2013

massDOT Massachusetts Department of Transportation Highway Division





MassDOT Direct Watershed
Stormwater Outfalls
Impaired Stream Segment
Impaired Water Bodies
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
Town Boundaries

N

0 125 250 500 Feet

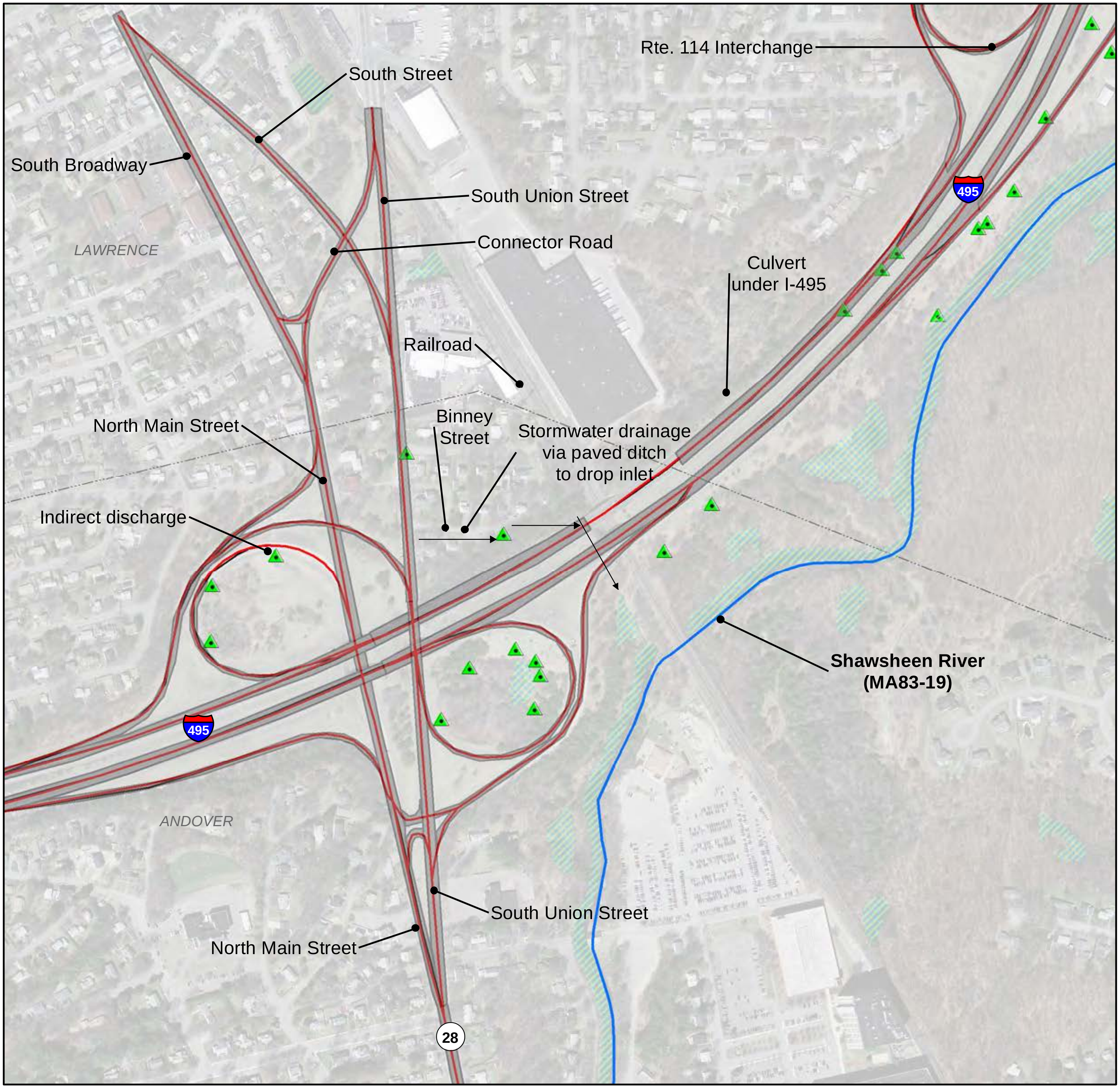
1 inch = 250 feet

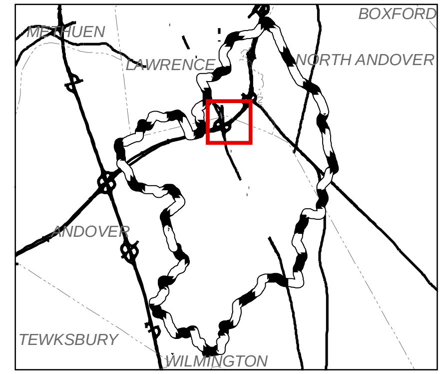
Figure 3c

Shawsheen River (MA83-19)
MassDOT Directly Contributing Watershed
Rte. 114

June 2013

massDOT Massachusetts Department of Transportation Highway Division





MassDOT Direct Watershed
Stormwater Outfalls
Impaired Stream Segment
Impaired Water Bodies
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 125 250 500 750 1,000 Feet

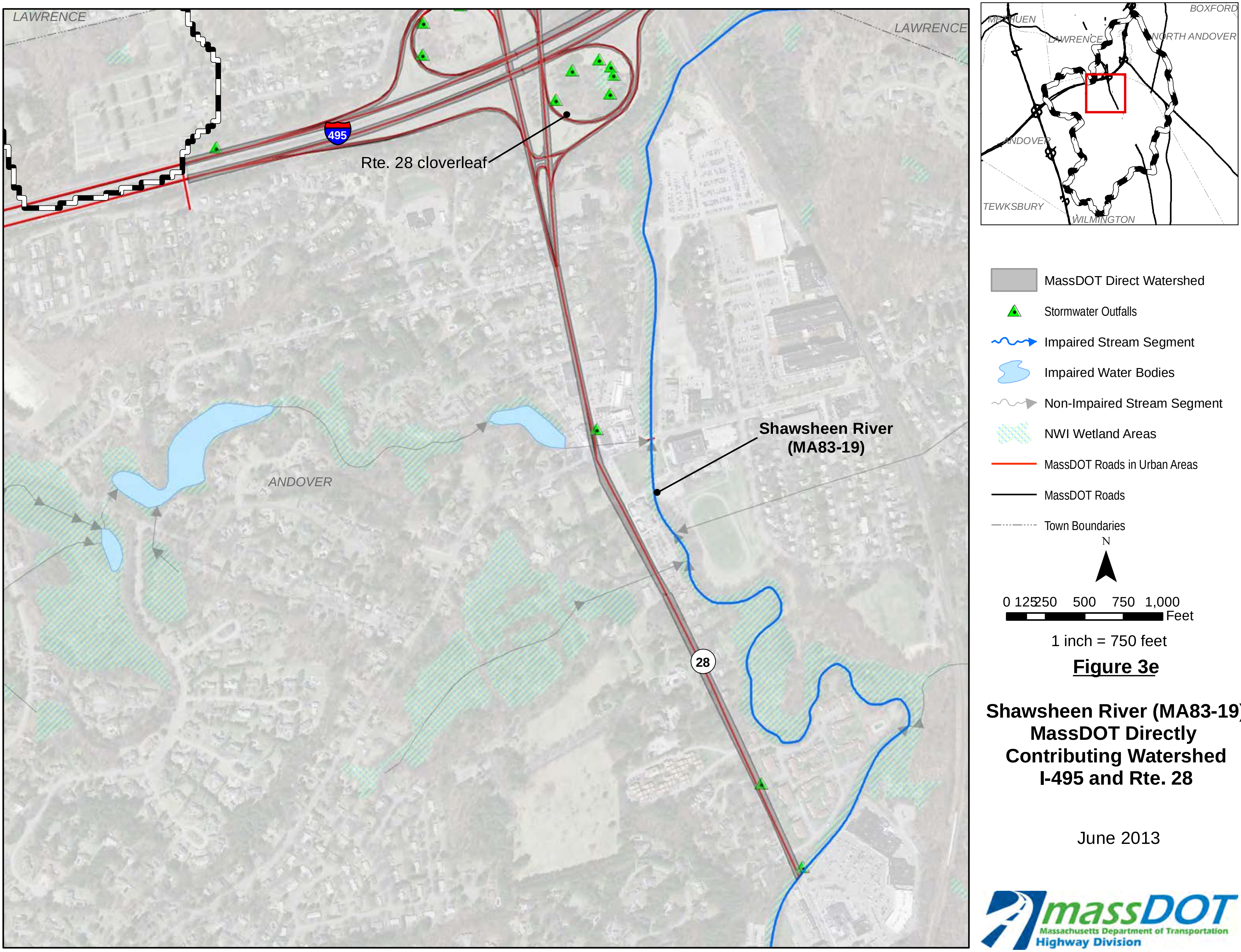
1 inch = 500 feet

Figure 3d

Shawsheen River (MA83-19)
MassDOT Directly Contributing Watershed
I-495 and Rte. 28 Interchange

June 2013

massDOT
Massachusetts Department of Transportation
Highway Division



1 inch = 750 feet

Figure 3e

Shawsheen River (MA83-19)
MassDOT Directly
Contributing Watershed
I-495 and Rte. 28

June 2013

massDOT
Massachusetts Department of Transportation
Highway Division

Impaired Waters Assessment for Newfield Pond (MA84046) – Progress Report

Impaired Waterbody

Name: Newfield Pond

Location: Chelmsford, MA

Water Body ID: MA84046

Impairments

Newfield Pond (MA84046) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters (MassDEP, 2013)*. Newfield Pond is impaired for the following:

- (non-native aquatic plants)
- (Eurasian Water Milfoil, Myriophyllum spicatum*)
- mercury in fish
- dissolved oxygen

According to MassDEP's *Merrimack River Watershed 2004- 2009 Water Quality Assessment Report* (MassDEP, 2010), Newfield Pond is 77 acres and impaired due to low dissolved oxygen, mercury in fish tissue and non-native aquatic plants such as Eurasian milfoil.

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *314 CMR 4.05 (3)(b) 1 Dissolved Oxygen*. Shall not be less than 6.0 mg/l in cold water fisheries and not less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.

- *314 CMR 4.05 (5) (a) Aesthetics*. All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.

Site Description

Newfield Pond is a 77-acre body of water body located between Route 3 and Route 3A, and east of Groton Road in Chelmsford Massachusetts. This pond is classified as impaired according to the *Merrimack River Watershed 2004-2009 Water Quality Assessment Report*. The total watershed for Newfield Pond is shown in Figure 1 and the subwatershed is shown in Figure 2.

MassDOT's property directly contributing stormwater runoff to Newfield Pond is comprised of portions of Route 3 (see Figure 3). Sheet flow from the crown to the outer edge of the roadway on the northbound and southbound sides of Route 3 drains to an unnamed tributary flowing into Newfield Pond. The roadway is approximately 500 feet south of Newfield Pond; therefore, the contribution to the unnamed tributary is considered directly contributing drainage to Newfield Pond. Sheet flow from the crown to the median flows into the median where it infiltrates into the ground, or in locations east of Newfield Pond, is directed to a drainage system which discharges to a location east of the unnamed tributary and does not directly contribute to Newfield Pond. There is no direct drainage from Route 3A.

Assessment under BMP 7U

None of the impairments for Newfield Pond have been addressed by a TMDL. Therefore, MassDOT assessed the impairments using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of storm water on many impairments. For this water body, MassDOT used the IC method to assess the following impairments:

- dissolved oxygen

According to MassDEP's final *Massachusetts Year 2012 Integrated List of Waters*, the impairment of non-native aquatic plants is not caused by pollutants (MassDEP, 2013). Therefore, this impairment is not considered further.

The *Northeast Regional Mercury TMDL* indicates that stormwater is a *de minimis* source of mercury contamination. According to the TMDL, the majority of mercury in stormwater comes from atmospheric deposition, and therefore the most effective reductions in mercury loading can be achieved through controls on atmospheric deposition (NEIWPCC, 2007). Accordingly, MassDOT has concluded that stormwater runoff from its roadways is a *de minimis* contributor to the mercury impairment.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction necessary to attain the percent imperviousness in the watershed at which stormwater is not likely the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. IC data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer.

In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for Newfield Pond (MA84046):

Table 1. Site Parameters for Newfield Pond (MA84046)

Total Watershed		
Watershed Area	18,800	acres
Impervious Cover (IC) Area	2,190	acres
Percent Impervious	11.7*	%
Subwatershed		
Subwatershed Area	643	acres
Impervious Cover (IC) Area	117	acres
Percent Impervious	18.2	%
IC Area at 9% Goal	58	acres
Target Reduction % in IC	50.4	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	0.8	acres
MassDOT's Target Reduction in Effective IC (50.4% of DOT Directly Contributing IC)	0.4	acres

*Rounding accounts for differences in calculations.

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 50.4%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 0.4 acres.

Existing BMPs

Based on the site visit, there are no existing BMPs in the Newfield Pond directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to Newfield Pond.

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 0.4 acres, MassDOT will consider the implementation of additional BMPs.

Conclusions

MassDOT used the IC Method to assess Newfield Pond for the impairments identified in MassDEP's final *Massachusetts Year 2012Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed by 0.4 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Newfield Pond to identify existing BMPs and found that there are no existing BMPs in the area.

MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs to treat directly contributing IC as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide the target IC reduction or treatment to the maximum extent practicable.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of additional BMPs, and finalized assessments including reductions achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

References

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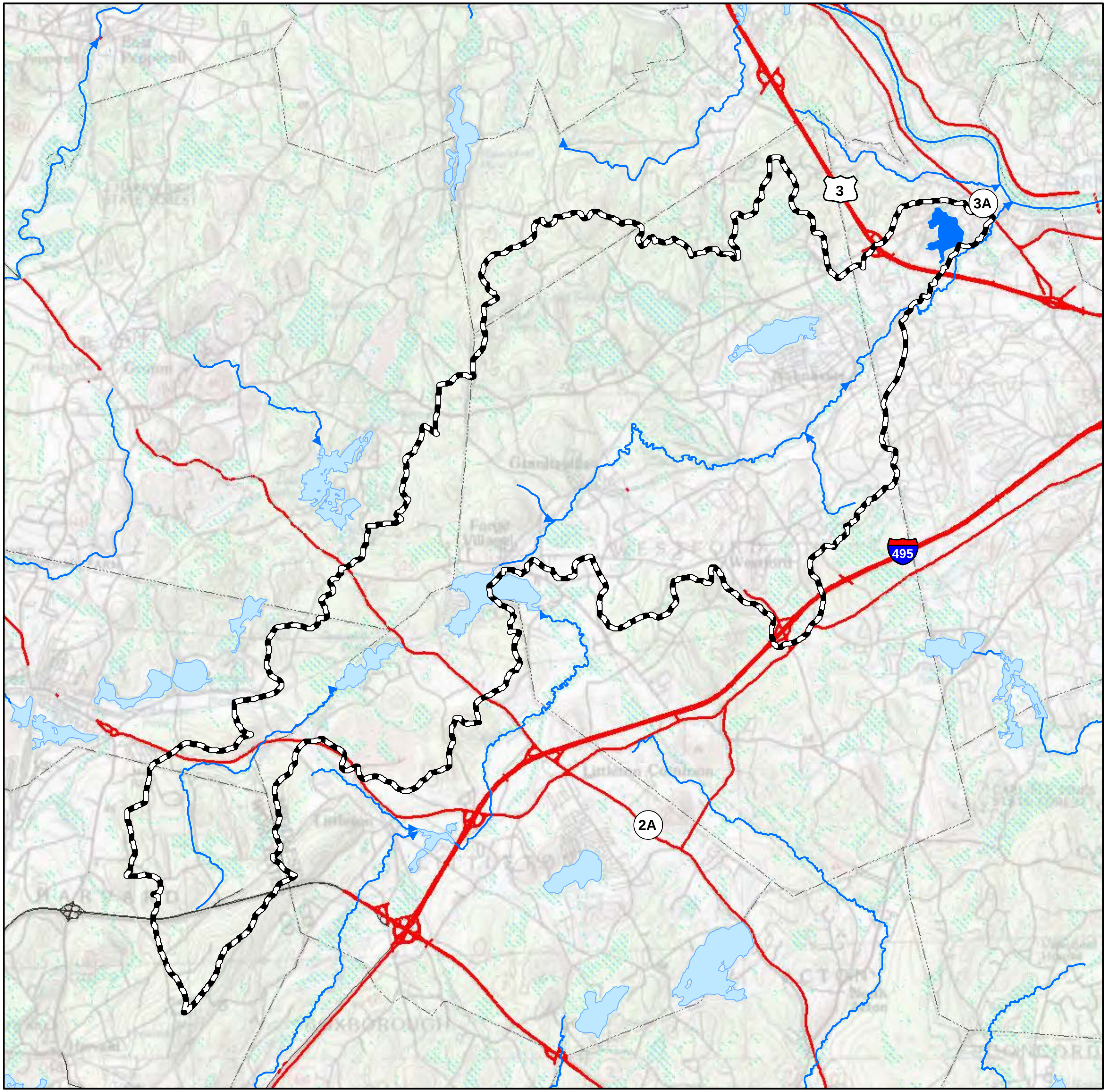
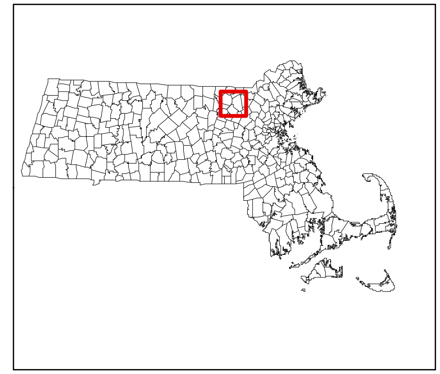




Total_Watershed

Newfield Pond

Impaired Water Bodies

Impaired Stream Segment

NWI Wetland Areas

MassDOT Roads in Urban Areas

MassDOT Roads

Town Boundaries

N

0 1 2 Miles

1 in = 1.5 miles

Figure 1

Newfield Pond
Total Watershed
MA84046

June 2013

massDOT
Massachusetts Department of Transportation
Highway Division

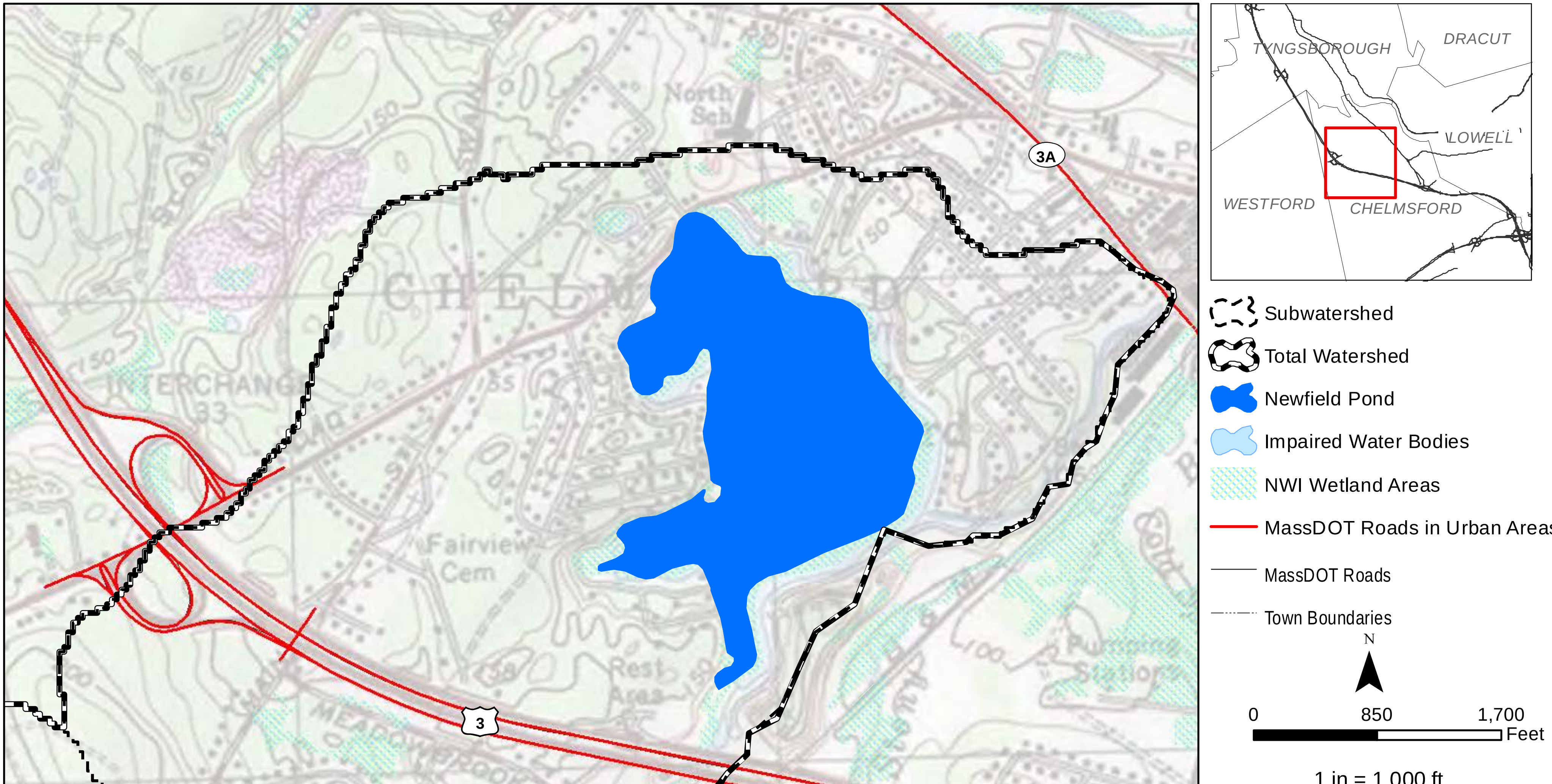
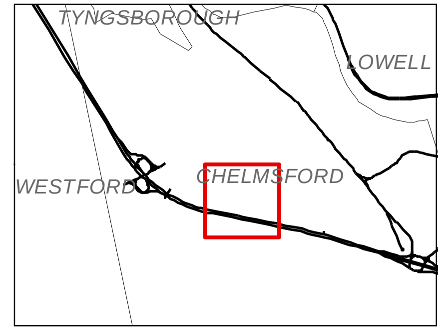


Figure 2

Newfield Pond Subwatershed MA84046

June 2013

massDOT Massachusetts Department of Transportation Highway Division



Stormwater Outfalls
DOT Direct IC Watershed
Newfield Pond
Impaired Water Bodies
Impaired Stream Segment
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 250 500 Feet

1 in = 350 feet

Figure 3

Newfield Pond (MA84046) MassDOT Directly Contributing Watershed

June 2013

massDOT Massachusetts Department of Transportation Highway Division

Impaired Waters Assessment for Spicket River (MA84A-10) – Progress Report

Impaired Water Body

Name: Spicket River

Location: Lawrence and Methuen, MA

Water Body ID: MA84A-10

Impairments

Spicket River (MA84A-10) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). Spicket River is impaired for the following:

- aquatic macroinvertebrate bioassessments
- copper
- (debris/floatables/trash*)
- Escherichia coli
- mercury in water column
- other
- (physical substrate habitat alterations*)

According to MassDEP's *Merrimack River Watershed 2004 Water Quality Assessment Report* (MassDEP, 2010), designated uses of primary and secondary contact of a 5.8-mile reach of Spicket River are impaired due to elevated E. coli levels as a result of unspecified urban stormwater of unknown source. The designated uses of aquatic life, fish consumption, and aesthetics were not assessed due to insufficient data. Spicket River is also covered by a draft Total Maximum Daily Load (TMDL) for pathogens according to MassDEP's *Draft Pathogen TMDL for the Merrimack River Watershed* (MassDEP, no date).

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *314 CMR 4.05 (3)(b) 1 Dissolved Oxygen.* Shall not be less than 6.0 mg/l in cold water fisheries and not less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.
- *314 CMR 4.05 (3)(b) 2 Temperature.*
    - a. Shall not exceed 68°F (20°C) based on the mean of the daily maximum temperature over a seven day period in cold water fisheries, unless naturally occurring. Where a reproducing cold water aquatic community exists at a naturally occurring higher temperature, the temperature necessary to protect the community

shall not be exceeded and the natural daily and seasonal temperature fluctuations necessary to protect the community shall be maintained. Temperature shall not exceed 83°F (28.3°C) in warm water fisheries. The rise in temperature due to a discharge shall not exceed 3°F (1.7°0C) in rivers and streams designated as cold water fisheries nor 5°F (2.8°C) in rivers and streams designated as warm water fisheries (based on the minimum expected flow for the month); in lakes and ponds the rise shall not exceed 3°F (1.7°0C) in the epilimnion (based on the monthly average of maximum daily temperature);

  - b. natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained. There shall be no changes from natural background conditions that would impair any use assigned to this Class, including those conditions necessary to protect normal species diversity, successful migration, reproductive functions or growth of aquatic organisms;

- *314 CMR 4.05 (3)(b) 3 pH.* Shall be in the range of 6.5 through 8.3 standard units but not more than 0.5 units outside of the natural background range. There shall be no change from natural background conditions that would impair any use assigned to this Class.
- *314 CMR 4.05 (3)(b) 5 Solids*. These waters shall be free from floating, suspended and settleable solids in concentrations or combinations that would impair any use assigned to this class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.
- *314 CMR 4.05 (5)(e) Toxic Pollutants*. All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife. For pollutants not otherwise listed in 314 CMR 4.00, the National Recommended Water Quality Criteria: 2002, EPA 822R-02-047, November 2002 published by EPA pursuant to Section 304(a) of the Federal Water Pollution Control Act, are the allowable receiving water concentrations for the affected waters, unless the Department either establishes a site specific criterion or determines that naturally occurring background concentrations are higher. Where the Department determines that naturally occurring background concentrations are higher, those concentrations shall be the allowable receiving water concentrations. The Department shall use the water quality criteria for the protection of aquatic life expressed in terms of the dissolved fraction of metals when EPA's 304(a) recommended criteria provide for use of the dissolved fraction. The EPA recommended criteria based on total recoverable metals shall be converted to dissolved metals using EPA's published conversion factors. Permit limits will be written in terms of total recoverable metals. Translation from dissolved metals criteria to total recoverable metals permit limits will be based on EPA's conversion factors or other methods approved by the Department. The Department may establish site specific criteria for toxic pollutants based on site specific considerations.
- *314 CMR 4.05 (3)(b) 4 Bacteria*.
  - a. At bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: where E. coli is the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml; alternatively, where enterococci are the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no single sample taken during the bathing season shall exceed 61 colonies per 100 ml;
  - b. For other waters and, during the non bathing season, for waters at bathing beaches as defined by the Massachusetts Department of Public Health in 105

CMR 445.010: the geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml; alternatively, the geometric mean of all enterococci samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 61 colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department;

- *314 CMR 4.05 (5) (b) Bottom Pollutants or Alterations.* All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.

Site Description

Spicket River (MA84A-10) begins at the Massachusetts/New Hampshire state line in Methuen, MA, and continues 5.8 miles southeast to the confluence with Merrimack River (MA84A-04) in Lawrence, MA. Spicket River is one of the three large tributaries within the Merrimack River watershed, and the most upstream segment of Spicket River begins at the outlet of Island Pond in Derry, NH. There are multiple dams within Spicket River, and the Spicket River Dam obstructs passage of anadromous fish upstream (MassDEP, 2010). The watershed for Spicket River is highly urban.

The total watershed to Spicket River is approximately 49,543 acres and is shown in Figure 1. The subwatershed to Spicket River is approximately 4,458 acres and is shown in Figure 2. MassDOT's property directly contributing stormwater runoff to Spicket River is comprised of approximately 1.3 miles of Interstate 93 (I-93) and the associated ramps to Pelham Street and Albert Slack highway (Route 213), 1.1 miles of Route 213, 0.5 miles of Swan and Jackson Street (Route 110), and seven bridges that cross Spicket River. Three bridges along Broadway, one bridge on Hampshire Rd, one bridge on Jackson St, and two bridges on Lowell St all drain directly to Spicket River. MassDOT's directly contributing watershed is shown in Figures 3A, 3B and 3C.

During a field visit on May 13, 2012 field engineers could not locate the outlet of drainage from Jackson Street (Route 110). Due to the highly urban area adjacent to Jackson Street, and the lack of nearby wetlands, it was assumed stormwater from this portion of MassDOT property drained either directly to Spicket River or to an unnamed culverted stream which flows from Pleasant St south directly to Spicket River (Figure 3B).

It was determined that drainage from the Route 213 ramps to Pleasant St (Route 113) on the northbound side ties into the Methuen town system and is piped south on Jackson Street towards Searles Pond, a non-impaired, national hydrography dataset (NHD) identified pond (Figure 3A). Due to the fact that the pond is non-impaired, and the outlet of the pond is approximately 1.2 miles upstream of the Spicket River, stormwater which drained upstream of and through this pond was considered to be an indirect discharge to Spicket River. Additional stormwater from the northeastern-most portion of the Spicket River watershed from Route 213 drains to the median and northbound shoulder of Route 213. Stormwater from this portion of MassDOT property drains to wetlands and a non-impaired, unnamed stream which flows south approximately 0.7 miles before it reaches Searles Pond (Figure 3A). Stormwater from this portion of the site was also considered to be an indirect discharge to Spicket River.

Stormwater draining from MassDOT property along Route 213 and the ramps to adjacent to Broadway (Route 28) drains through open channels and piped systems which outlet to the cloverleaf for the ramp from Route 28 to Route 213 eastbound (Figure 3C). This cloverleaf contains standing water within a wetland system. Defined drainage channels are evident from each of the

MassDOT stormwater outlets to the 36-in culvert which drains the cloverleaf to the wetland system adjacent to Spicket River. Due to the defined drainage channels, stormwater which drains from MassDOT property through this cloverleaf was considered direct to Spicket River.

Stormwater from Broadway, north of the Route 213 ramps, flows north where it discharges through a submerged 24-in pipe that drains to a wetland system that flows directly to an extension of Spicket River (Figure 3C). Stormwater draining from this portion of MassDOT property was considered to be a direct discharge to Spicket River.

Stormwater from the southbound lanes of I-93 south of Harris Brook, which crosses beneath I-93 and drains directly to Spicket River, discharges to the southbound shoulder of I-93 and flows to a river/wetland system. This river is unnamed and non-impaired and slowly meanders over 0.5 miles north before it reaches Spicket River. MassDOT considered stormwater that drains to this wetland system to be an indirect discharge to Spicket River due to sufficient retention time afforded by the slow-meandering flow path of this system. Consequently, all stormwater which drains from MassDOT property south of Harris Brook to wetlands west of I-93 was considered to be an indirect discharge to Spicket River. Similarly, MassDOT considered all stormwater that drained to Mystic Pond to be an indirect discharge to Spicket River because of the retention time provided by the pond, and due to the fact, that the pond is listed as a NHD named pond and is non-impaired. Stormwater from I-93 between the I-93 NB ramp to Pelham St and the state line discharges east to the wetland system north of Mystic Pond and adjacent to Spicket River. This discharge was considered direct. When it was not possible to determine the discharge location of stormwater from I-93 from review of plans and site visit investigation, it was conservatively assumed the drainage was a direct discharge to Spicket River.

Assessment under BMP 7U

None of the impairments for Spicket River have been addressed by a TMDL. Therefore, MassDOT assessed the impairments using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of storm water on many impairments. For this water body, MassDOT used the IC method to assess the following impairments:

- aquatic macroinvertebrate bioassessments
- copper
- other

The *Northeast Regional Mercury TMDL* indicates that stormwater is a *de minimis* source of mercury contamination. According to the TMDL, the majority of mercury in stormwater comes from atmospheric deposition, and therefore the most effective reductions in mercury loading can be achieved through controls on atmospheric deposition (NEIWPCC, 2007). Accordingly, MassDOT has concluded that stormwater runoff from its roadways is a *de minimis* contributor to the mercury impairment.

According to the final *Massachusetts Year 2012 Integrated List of Waters*, debris/floatables/trash and physical substrate habitat alterations are considered non-pollutants and unrelated to stormwater. Therefore, MassDOT has determined that further assessment of this impairment for the water bodies is not required under BMP 7U.

The impairment for Escherichia coli is assessed separately in the section titled Assessment of Pathogen Impairment.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction necessary to attain the percent imperviousness in the watershed at which stormwater is not likely the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. IC data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer.

In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for Spicket River (MA84A-10):

Table 1. Site Parameters for Spicket River (MA84A-10)

Total Watershed		
Watershed Area	49,500	acres
Impervious Cover (IC) Area	7,800	acres
Percent Impervious	15.7*	%
IC Area at 9% Goal	4,460	acres
Target Reduction % in IC	42.8	%
Subwatershed		
Subwatershed Area	4,460	acres
Impervious Cover (IC) Area	1,710	acres
Percent Impervious	38.3	%
IC Area at 9% Goal	401	acres
Target Reduction % in IC	76.5	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	41.6	acres
MassDOT's Target Reduction in Effective IC (76.5% of DOT Directly Contributing IC)	31.8	acres

*Rounding accounts for differences in calculations.

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 76.5%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 31.8 acres.

Existing BMPs

There are no existing BMPs in the Spicket River directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to the Spicket River.

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 31.8 acres, MassDOT will consider the implementation of additional BMPs.

The northern most portion of I-93 which drains stormwater to Spicket River, discharges to a rip-rap plunge pool at the base of the slope just south of Hampshire Rd. Sedimentation has filled the plunge pool, and evidence of standing water and drainage paths downstream of the plunge pool suggest little infiltration presently occurs. This area could potentially be retrofitted to provide reduction in effective impervious cover. This area is shown in **Photo 1**. Additional portions of MassDOT property adjacent to MassDOT roadways could potentially be retrofitted to provide treatment and these areas will be investigated by the design consultants.

Photo 1. Plunge Pool south of Hampshire Road

Assessment of Pathogen Impairment

MassDOT assessed the pathogen impairment using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by an order of magnitude within a given storm event at a single location (MassDEP, 2009b). Therefore, it is difficult to predict pathogen concentrations in stormwater with accuracy. Due to this difficulty, MassDOT generally will not conduct site specific assessments of loading at each location impaired for pathogens. Instead these sites will be assessed collectively based on available information on pathogen loading from highways, MassDOT actions, and information available from EPA and DEP. Based on this information MassDOT developed an approach to be consistent with relevant TMDL and permit condition requirements and an iterative adaptive management approach to stormwater management.

In addition, while there is a positive relationship between IC and pathogen loading, the relationship is not as direct as other impairments. According to the Center for Watershed Protection "…Other studies show that concentrations of bacteria are typically higher in urban areas than rural areas (USGS, 1999), but they are not always directly related to IC (CWP, 2003)." Therefore, DOT did not rely solely on the IC method to assess pathogen impairments. Instead, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

Pathogens in MassDOT Discharge

A study conducted on MassDOT's South East Expressway measured bacterial concentrations in stormwater runoff (Smith, 2002). This study found a geometric mean of 186 fecal coliforms/100 ml. Concentrations of pathogens in stormwater runoff from roadways can vary widely and pathogen concentrations in runoff across the state likely deviate significantly from this stretch of roadway's specific estimate. Event mean concentrations of fecal coliform bacteria in urban stormwater from other sources ranging between 14,000 and 17,000 fecal coliform organisms/100 mL have been reported (MassDEP, 2009b). These data suggest that pathogen loading from highways may be lower than other urban areas.

Consideration of the potential sources of pathogens supports the idea that pathogens are present in lower concentrations in highway runoff since potential pathogen sources are likely to be less prevalent in the highway environment than along other urban roadways:

- Illicit discharges: Due to the typical setback of highways from residential and commercial developments and the stand alone nature of the drainage system, the potential for illicit discharges (e.g. sewer connections, laundry tie-ins) is much lower than in other stormwater systems. This has been confirmed by MassDOT's illicit discharge detection on many miles of urban roadways within a broad range of areas across Massachusetts. After assessment of almost 140 miles, and investigation of more than 2,500 stormwater features, MassDOT's consultant performing the broad scope reviews has found no confirmed illicit discharges.
- Limited Sewer Utilities in Road Right of Ways: Since DOT does not provide sewer services, many MassDOT roads do not have sewer utilities within the road's right of way; thereby eliminating the chance of cross-connections or leaking pipes as a source of pathogens into the stormwater system.
- Pet waste: Pets are only present on highways in rare instances. In urban residential areas pets and their associated waste are much more common. MassDOT is aware that pet waste at road side rest stops may represent a potential source of pathogens to stormwater in certain situations.
- Wildlife: Highways are not generally an attractive place for wildlife. Wildlife generally avoids highways and only occasionally crosses them.

The dearth of pathogen sources on highways and the relatively low concentrations of pathogens measured in the South East Expressway study together suggest that pathogen loading from stormwater runoff from highways is lower than other urban sources.

Furthermore, in almost all cases the contribution of pathogens from MassDOT to a specific water body is likely to be very small relative to other sources of pathogens in the watershed. Since MassDOT urban roadways are linear and usually cross watersheds, they represent a small fraction of the receiving water body's watershed. The water quality within these water bodies is dependent on discharge from various sources, including discharges from other stormwater systems and a large number of other factors.

Assessment

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

TMDLs for pathogen impairments in Massachusetts recognize that pathogens are highly variable and difficult to address and emphasize the need for an iterative adaptive management approach to address pathogens. Examples of relevant language from these TMDLs are included below:

- "given the vast potential number of bacteria sources and the difficulty of identifying and removing them from some sources such as stormwater require an iterative process and will take some time to accomplish. While the stated goal in the TMDL is to meet the water quality standard at the point of discharge it also attempts to be clear that MassDEP's expectation is that for stormwater an iterative approach is needed…" (MassDEP, 2009a)
- "The NPDES permit does not, however, establish numeric effluent limitations for stormwater discharges. Maximum extent practicable (MEP) is the statutory standard that establishes the level of pollutant reductions that regulated municipalities must achieve. The MEP standard is a narrative effluent limitation that is satisfied through implementation of SWMPs and achievement of measurable goals."(MassDEP, 2009b)

- "Although the TMDL presents quantified WLAs for stormwater that are set equivalent to the criteria in the Massachusetts Water Quality Standards, the Phase II NPDES permits will not include numeric effluent limitations. Phase II permits are intended to be BMP based permits that will require communities to develop and implement comprehensive stormwater management programs involving the use of BMPs. Massachusetts and EPA believe that BMP based Phase II permits involving comprehensive stormwater management together with specific emphasis on pollutants contributing to existing water quality problems can be consistent with the intent of the quantitative WLAs for stormwater discharges in TMDLs." (MassDEP, 2002).

This language clearly indicates that an iterative adaptive management approach is the appropriate way to address discharges to pathogen impaired waters. The recommendations in pathogen TMDLs for waters in Massachusetts generally require development and implementation of stormwater management programs, illicit discharge detection and elimination efforts, and in some cases installing BMPs to the maximum extent practicable

The draft North Coastal Watershed General MS4 permit and the draft Interstate, Merrimack, and South Coastal (IMS) watershed permits contain specific requirements for compliance with pathogen TMDLs (in Appendix G). While these permits are still in draft form, MassDOT believes they represent the best available guidance on what EPA believes is appropriate for addressing stormwater discharges to pathogen-impaired waters. Section 2.2.1(c) of the permit states "For any discharge from its MS4 to impaired waters with an approved TMDL, the permittee shall comply with the specific terms of Part 2.1 of this permit. In addition, where an approved TMDL establishes a WLA that applies to its MS4 discharges, the permittee shall implement the specific BMPs and other permit requirements identified in Appendix G to achieve consistency with the WLA." Appendix G references a number of programmatic BMPs that are necessary to address pathogen loading. These cover the following general topics:

- Residential educational program
- Illicit connection identification, tracking and removal
- Pet waste management

Mitigation Plan

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Stormwater Management Plan (SWMP) including educational programs, illicit connection review and source control. The specific BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In
- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

In addition, the structural BMPs that will be considered to reduce the IC will also have the effect of reducing pathogen loads.

MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations. MassDOT's existing stormwater management plan outlines BMPs that include education and illicit discharge detection and elimination. MassDOT will be implementing a pet waste management program at its rest stops that have discharges to pathogen impaired waters.

Conclusions

MassDOT used the IC Method to assess Spicket River for the impairments identified in MassDEP's final *Massachusetts Year 2012 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed by 31.8 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Spicket River to identify existing BMPs and found that existing BMPs provide 0% of the target reduction in effective IC. This information is summarized in Table 3 below.

Table 3. Effective IC Reductions under Existing & Proposed Conditions

IC in Directly Contributing Watershed	41.6	acres
Target Reduction in Effective IC	31.8	acres
IC Effectively Reduced by Existing BMPs	0	acres
IC Remaining to Mitigate with Proposed BMPs	**31.8**	**acres**

MassDOT should reduce its effective IC within the directly contributing watershed by an additional 31.8 acres to achieve the targeted reduction in IC. MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs to treat directly contributing IC as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide the target IC reduction or treatment to the maximum extent practicable.

MassDOT has concluded based on review of the draft North Coastal Watershed General MS4 permit, the draft Interstate, Merrimack, and South Coastal watershed permits, and pathogen TMDLs for Massachusetts waters, that the BMPs outlined in the stormwater management plan and those under consideration for reducing effective IC from MassDOT areas are consistent with its existing permit requirements. MassDOT believes that these measures achieve pathogen reductions (including fecal coliform) to the maximum extent practicable and are consistent with the intent of its existing stormwater permit and the applicable Pathogen TMDLs.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of additional BMPs, and finalized assessments including reductions achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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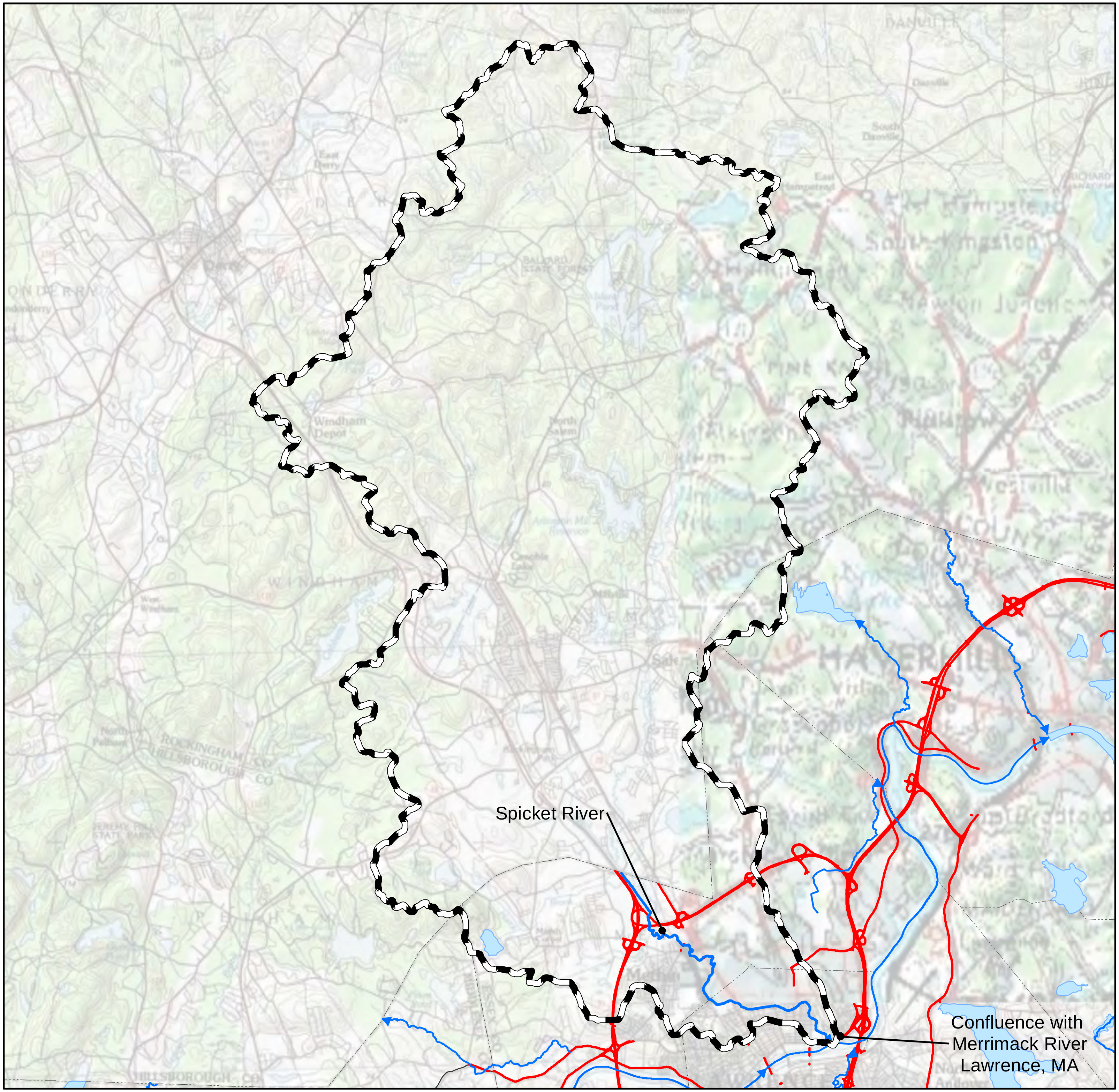
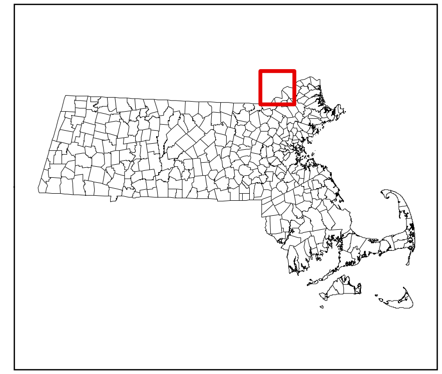




Total Watershed
Spicket River
Impaired Stream Segment
Impaired Water Bodies
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 0.5 1 2 3 4 Miles

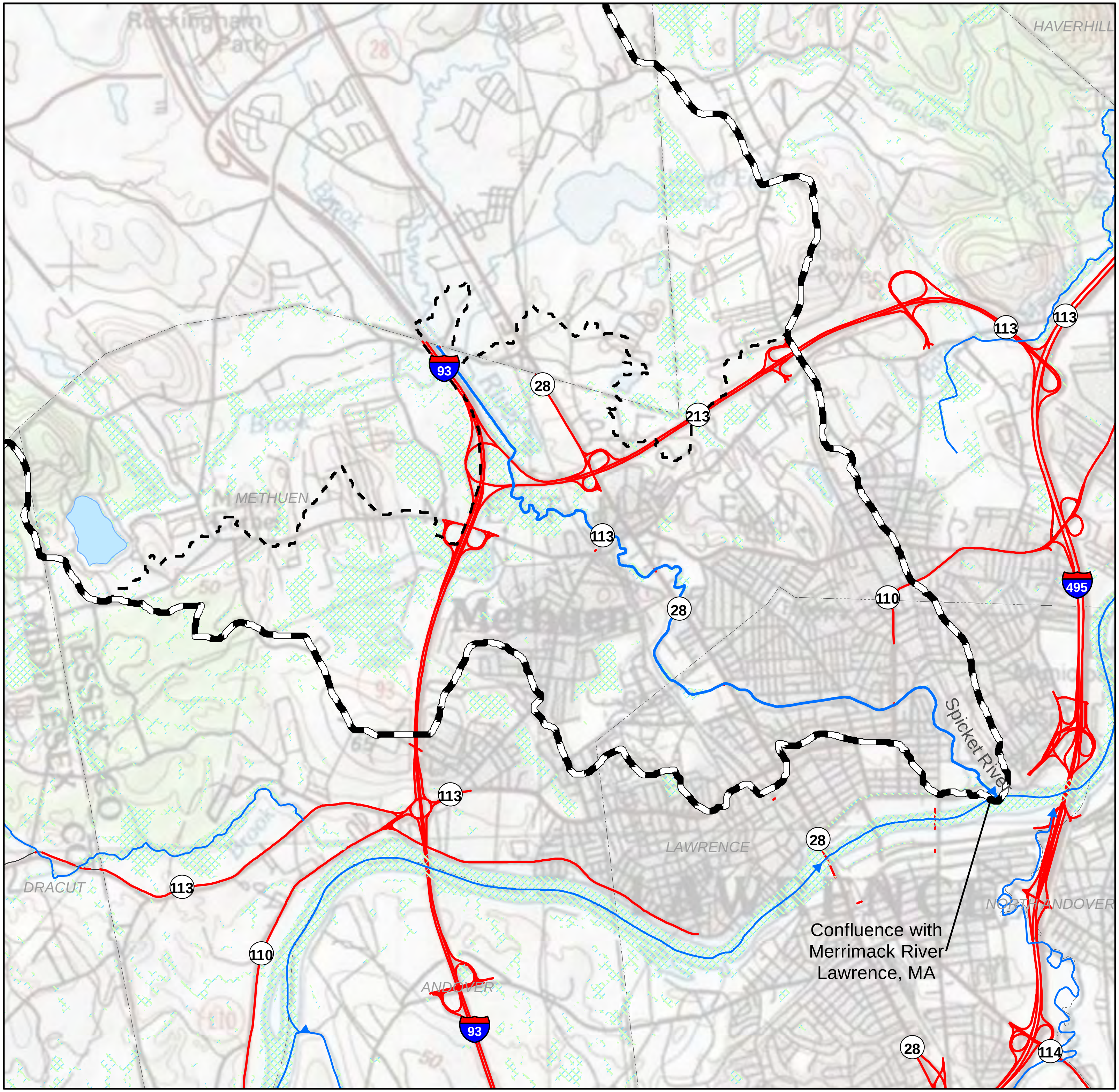
1 in = 2.00 miles

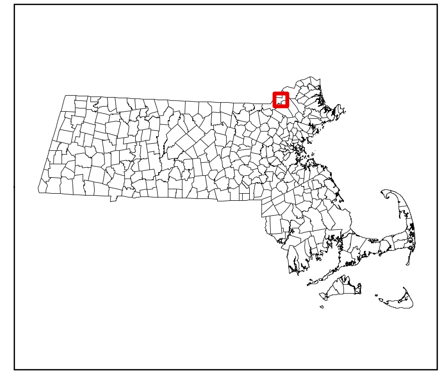
Figure 1

Spicket River
Total Watershed
MA84A-10

June 2013

massDOT Massachusetts Department of Transportation Highway Division





Total Watershed

Subwatershed

Spicket River

Impaired Stream Segment

Impaired Water Bodies

Wetland Area

MassDOT Roads in Urban Areas

MassDOT Roads

Town Boundaries

N

0 2,000 4,000 6,000 8,000 Feet

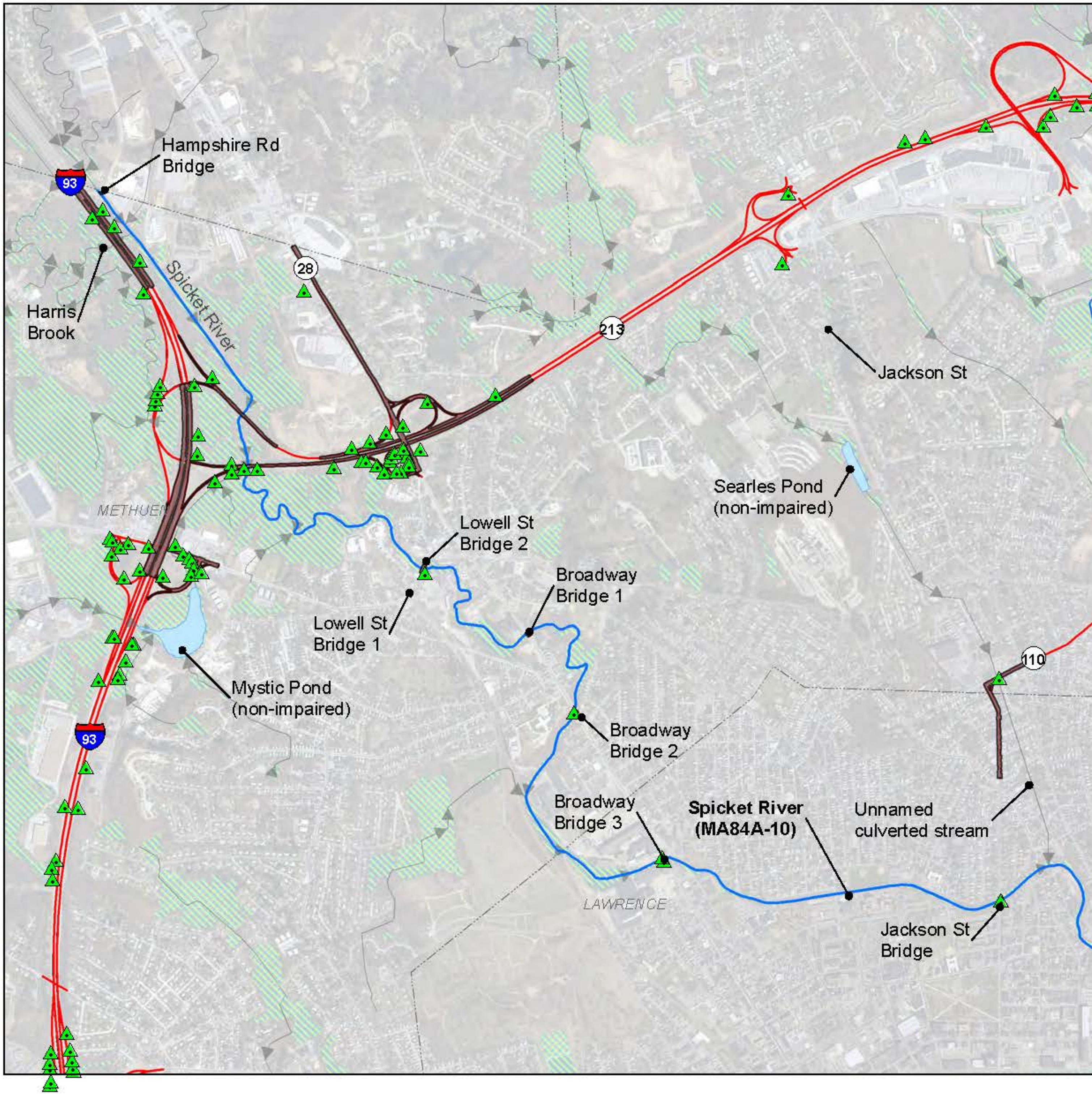
1 in = 4,000 feet

<u>**Figure 2**</u>

Spicket River Subwatershed MA84A-10

June 2013

massDOT
Massachusetts Department of Transportation
Highway Division



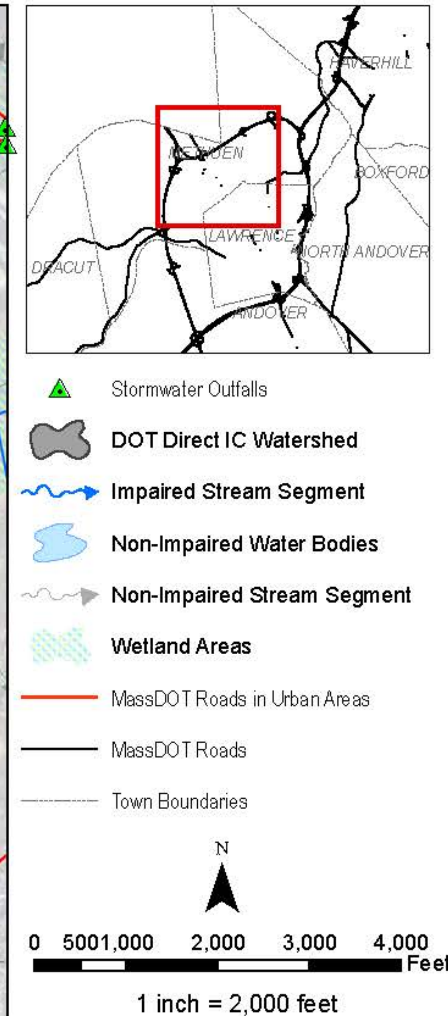


Figure 3A

Spicket River (MA84A-10) MassDOT Directly Contributing Watershed

June 2013

massDOT
Massachusetts Department of Transportation
Highway Division

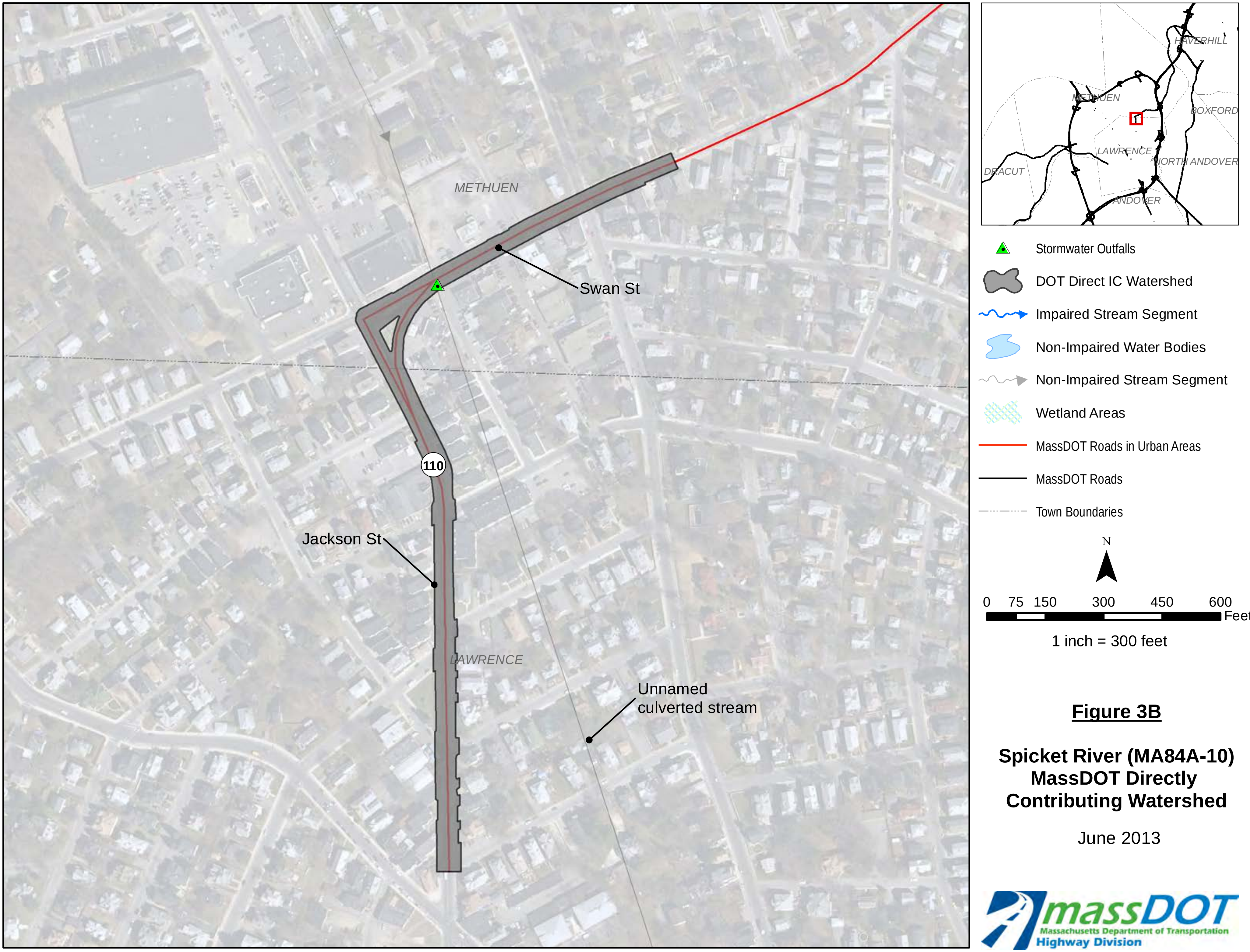
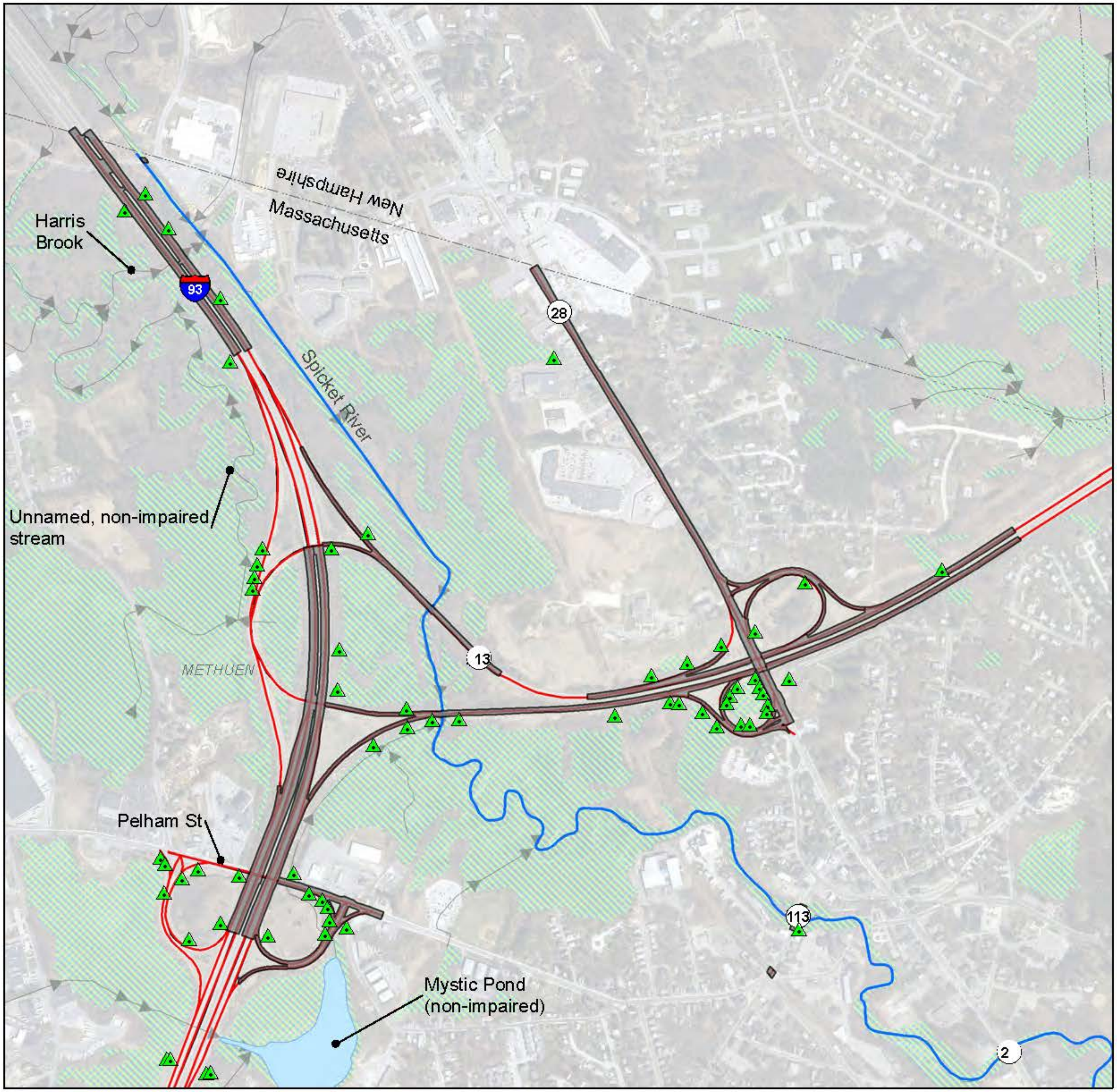


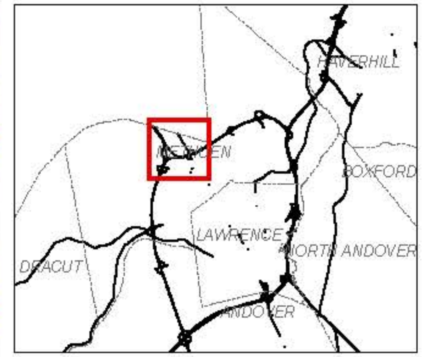
Figure 3B

Spicket River (MA84A-10)
MassDOT Directly
Contributing Watershed

June 2013

massDOT Massachusetts Department of Transportation Highway Division





Stormwater Outfalls

DOT Direct IC Watershed

Impaired Stream Segment

Non-Impaired Water Bodies

Non-Impaired Stream Segment

Wetland Areas

MassDOT Roads in Urban Areas

MassDOT Roads

Town Boundaries

N

0 250 500 1,000 1,500 2,000 Feet

1 inch = 1,000 feet

Figure 3C

Spicket River (MA84A-10) MassDOT Directly Contributing Watershed

June 2013

massDOT Massachusetts Department of Transportation Highway Division

Impaired Waters Assessment for Black Brook (MA84A-17) – Progress Report

Impaired Waterbody

Name: Black Brook

Location: Chelmsford and Lowell, MA

Water Body ID: MA84A-17

Impairments

Black Brook (MA84A-17) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters*. Black Brook is impaired for the following:

- sedimentation/siltation
- turbidity
- escherichia coli
- aquatic macroinvertebrate bioassessments
- fishes bioassessment
- (debris/floatables/trash*)
- (physical substrate habitat alterations*)

According to MassDEP's *Merrimack River Watershed 2004- 2009 Water Quality Assessment Report* (MassDEP, 2010), a 2.3-mile reach of Black Brook, which flows from the headwaters in Chelmsford to the confluence with the Merrimack, is impaired due to Fishes Bioassessment, Physical Substrate Alterations and Debris/Floatables/Trash. Black Brook is also covered by a draft Total Maximum Daily Load (TMDL) for pathogens according to MassDEP's Draft Pathogen TMDL for the Merrimack River Watershed (MassDEP, no date).

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *314 CMR 4.05 (3)(b) 5 Solids*. These waters shall be free from floating, suspended and settleable solids in concentrations or combinations that would impair any use assigned to this class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.

- *314 CMR 4.05 (3)(b) 6 Color and Turbidity*. These waters shall be free from color and turbidity in concentrations or combinations that are aesthetically objectionable or would impair any use assigned to this class.

- *314 CMR 4.05 (5)(e) Toxic Pollutants*. All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife. For pollutants not otherwise listed in 314 CMR 4.00, the National Recommended Water Quality

Criteria: 2002, EPA 822R-02-047, November 2002 published by EPA pursuant to Section 304(a) of the Federal Water Pollution Control Act, are the allowable receiving water concentrations for the affected waters, unless the Department either establishes a site specific criterion or determines that naturally occurring background concentrations are higher. Where the Department determines that naturally occurring background concentrations are higher, those concentrations shall be the allowable receiving water concentrations. The Department shall use the water quality criteria for the protection of aquatic life expressed in terms of the dissolved fraction of metals when EPA's 304(a) recommended criteria provide for use of the dissolved fraction. The EPA recommended criteria based on total recoverable metals shall be converted to dissolved metals using EPA's published conversion factors. Permit limits will be written in terms of total recoverable metals. Translation from dissolved metals criteria to total recoverable metals permit limits will be based on EPA's conversion factors or other methods approved by the Department. The Department may establish site specific criteria for toxic pollutants based on site specific considerations.

- *314 CMR 4.05 (3)(b) 1 Dissolved Oxygen.a*. Shall not be less than 6.0 mg/l in cold water fisheries and not less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.

- *314 CMR 4.05 (3)(b) 2 Temperature*.
    - a. Shall not exceed 68°F (20°C) based on the mean of the daily maximum temperature over a seven day period in cold water fisheries, unless naturally occurring. Where a reproducing cold water aquatic community exists at a naturally occurring higher temperature, the temperature necessary to protect the community shall not be exceeded and the natural daily and seasonal temperature fluctuations necessary to protect the community shall be maintained. Temperature shall not exceed 83°F (28.3°C) in warm water fisheries. The rise in temperature due to a discharge shall not exceed 3°F (1.7°0C) in rivers and streams designated as cold water fisheries nor 5°F (2.8°C) in rivers and streams designated as warm water fisheries (based on the minimum expected flow for the month); in lakes and ponds the rise shall not exceed 3°F (1.7°0C) in the epilimnion (based on the monthly average of maximum daily temperature);

    - b. natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained. There shall be no changes from natural background conditions that would impair any use assigned to this Class, including those conditions necessary to protect normal species diversity, successful migration, reproductive functions or growth of aquatic organisms;

- *314 CMR 4.05 (3)(b) 3 pH*. Shall be in the range of 6.5 through 8.3 standard units but not more than 0.5 units outside of the natural background range. There shall be no change from natural background conditions that would impair any use assigned to this Class.
- *314 CMR 4.05 (3)(b) 4 Bacteria*.
    - a. At bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: where E. coli is the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml; alternatively, where enterococci are the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no

single sample taken during the bathing season shall exceed 61 colonies per 100 ml;

- b. For other waters and, during the non bathing season, for waters at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: the geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml; alternatively, the geometric mean of all enterococci samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 61 colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department;

Site Description

Black Brook (MA84A-17) begins approximately 1,300 feet south of Route 3 in Chelmsford and continues for a 2.3 mile stretch to the confluence with the Merrimack River. This entire segment of stream is classified as impaired according to the *Merrimack River Watershed 2004-2009 Water Quality Assessment Report*.

MassDOT's property directly contributing stormwater runoff to Black Brook is comprised of portions of Route 3, Route 3A (Princeton Boulevard) and the Pawtucket Street Bridge (see Figure 2A and 2B). The total and subwatershed of Black Brook is shown in Figure 1.

Stormwater drainage from Route 3 in the vicinity of Black Brook is directed to Black Brook; however, two extended detention basins treat much of the stormwater before it is discharged to Black Brook. Details regarding the extended detention basins are provided under existing BMPs in the section titles 'Assessments under BMP7U' below.

Approximately 0.65 miles of Route 3A (Princeton Boulevard), extending from a high point near Wightman Street to the location where Black Brook flows under the roadway, drains directly to Black Brook. Roadway areas to the east of Black Brook enter catchbasins that direct flow to the municipal sewer system which is not considered direct drainage to Black Brook.

MassDOT owns a portion do Pawtucket Street approximately 700 feet east of the intersection with Middlesex Street, where it spans railroad tracks. Stormwater from the center of the bridge west flows into catchbasins which directly drain to Black Brook just prior to the confluence with the Merrimack River. The area from the center of the bridge and eastward does not drain to Black Brook.

Assessment under BMP 7U

None of the impairments for Black Brook have been addressed by a TMDL. MassDOT assessed the impairments using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of storm water on many impairments. For this water body, MassDOT used the IC method to assess the following impairments:

- sedimentation/siltation
- turbidity
- aquatic macroinvertebrate bioassessments
- fishes bioassessment

According to the final *Massachusetts Year 2012 Integrated List of Waters*, non-native aquatic plants and Eurasian Water Milfoil, *Myriophyllum spicatum*, debris/floatables/trash, and physical substrate habitat alterations are considered non-pollutants and unrelated to stormwater. Therefore, MassDOT has determined that further assessment of these impairments for the water bodies is not required under BMP 7U.

The impairment for Escherichia Coli is assessed separately in the section titled Assessment of Pathogen Impairment.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction necessary to attain the percent imperviousness in the watershed at which stormwater is not likely the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. IC data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer.

In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for Black Brook (MA84A-17):

Table 1. Site Parameters for Black Brook (MA84A-17)

Total and Sub Watershed		
Watershed Area	2,100	acres
Impervious Cover (IC) Area	626	acres
Percent Impervious	29.8	%
IC Area at 9% Goal	189	Acres
Target Reduction % in IC	69.8	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	14.8	acres
MassDOT's Target Reduction in Effective IC (69.8% of DOT Directly Contributing IC)	10.4	acres

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 69.8%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 10.4 acres.

Existing BMPs

MassDOT has two existing BMPs in the Black Brook directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to Black Brook. Figure 3 shows the BMP locations. In our analysis, existing BMPs receive credit for removing the effect of IC depending on their type, size relative to the IC that they process, and the local soil conditions. The soil in the area associated with the existing BMPs is characterized as hydrologic group A (loamy sand).

Ex-BMP-1: A stormwater drainage system has been constructed in the vicinity of Black Brook to collect much of the roadway drainage on Route 3 and the north half of the Stedman Street bridge and direct it to an extended detention basin located north of the roadway. The BMP watershed is shown on Figure 3. The detention basin forebay measures approximately 150 feet by 40 feet and the micropool was measured to be approximately 200 feet by 40 feet. Water would have to fill to a height of approximately 4.5 feet before flowing out over the overflow or spillway. Both were observed to have standing water and wetland vegetation. This area was characterized as an extended detention basin with an effective IC removal efficiency of 34%, providing a reduction of 2.4 acres of IC.


Ex-BMP-North. Extended Detention Basin.

Ex-BMP-2: A second extended detention basin is located south of Route 3 in the vicinity of Black Brook which treats drainage from a portion of the southbound roadway and the inner half of the north bound rowadway extending from the detention basin to where Route 3 passes over Parkhurst Road. The BMP watershed is shown on Figure 3. The detention basins forebay measures approximately 190 feet by 75 feet and the micropool was measured to be approximately 140 feet by 75 feet and water would have to fill to a height of approximately 3.75 feet before flowing out over the overflow or spillway. Both were observed to have standing water and wetland vegetation. This area was characterized as an extended detention basin with an effective IC removal efficiency of 74%, providing a reduction of 2.9 acres of IC.


Ex-BMP-South. Extended Detention Basin.

Table 2. Summary of Existing BMPs

BMP Name	BMP Type	Soil Type	Depth of Runoff Treated (inches)	IC Area Treated (acres)	Reduction of Effective IC* (%)	Reduction of Effective IC (acres)
Ex-BMP-north	Extended Detention Basin	A-Loamy Sand 2.41 in/hr	2.7	5.3	34	2.4
Ex-BMP-south	Extended Detention Basin	A-Loamy Sand 2.41 in/hr	5.3	3.9	74	2.9
Total						5.3

*Description of MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011)

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 10.4 acres, MassDOT will consider the implementation of additional BMPs.

Assessment of Pathogen Impairment under BMP 7U

MassDOT assessed the pathogen impairment using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by an order of magnitude within a given storm event at a single location (MassDEP, 2009b). Therefore, it is difficult to predict pathogen concentrations in stormwater with accuracy. Due to this difficulty, MassDOT generally will not conduct site specific assessments of loading at each location impaired for pathogens. Instead these sites will be assessed collectively based on available information on pathogen loading from highways, MassDOT actions, and information available from EPA and DEP. Based on this information MassDOT developed an approach to be consistent with relevant TMDL and permit condition requirements and an iterative adaptive management approach to stormwater management.

In addition, while there is a positive relationship between IC and pathogen loading, the relationship is not as direct as other impairments. According to the Center for Watershed Protection "…Other studies show that concentrations of bacteria are typically higher in urban areas than rural areas (USGS, 1999), but they are not always directly related to IC (CWP, 2003)." Therefore, DOT did not rely solely on the IC method to assess pathogen impairments. Instead, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

Pathogens in MassDOT Discharge

A study conducted on MassDOT's South East Expressway measured bacterial concentrations in stormwater runoff (Smith, 2002). This study found a geometric mean of 186 fecal coliforms/100 ml. Concentrations of pathogens in stormwater runoff from roadways can vary widely and pathogen concentrations in runoff across the state likely deviate significantly from this stretch of roadway's specific estimate. Event mean concentrations of fecal coliform bacteria in urban stormwater from other sources ranging between 14,000 and 17,000 fecal coliform organisms/100 mL have been reported (MassDEP, 2009b). These data suggest that pathogen loading from highways may be lower than other urban areas.

Consideration of the potential sources of pathogens supports the idea that pathogens are present in lower concentrations in highway runoff since potential pathogen sources are likely to be less prevalent in the highway environment than along other urban roadways:

- <u>Illicit discharges:</u> Due to the typical setback of highways from residential and commercial developments and the stand alone nature of the drainage system, the potential for illicit discharges (e.g. sewer connections, laundry tie-ins) is much lower than in other stormwater systems. This has been confirmed by MassDOT's illicit discharge detection on many miles of urban roadways within a broad range of areas across Massachusetts. After assessment of almost 140 miles, and investigation of more than 2,500 stormwater features, MassDOT's consultant performing the broad scope reviews has found no confirmed illicit discharges.
- <u>Limited Sewer Utilities in Road Right of Ways:</u> Since DOT does not provide sewer services, many MassDOT roads do not have sewer utilities within the road's right of way; thereby eliminating the chance of cross-connections or leaking pipes as a source of pathogens into the stormwater system.
- <u>Pet waste:</u> Pets are only present on highways in rare instances. In urban residential areas pets and their associated waste are much more common. MassDOT is aware that pet waste at road side rest stops may represent a potential source of pathogens to stormwater in certain situations.
- <u>Wildlife:</u> Highways are not generally an attractive place for wildlife. Wildlife generally avoids highways and only occasionally crosses them.

The dearth of pathogen sources on highways and the relatively low concentrations of pathogens measured in the South East Expressway study together suggest that pathogen loading from stormwater runoff from highways is lower than other urban sources.

Furthermore, in almost all cases the contribution of pathogens from MassDOT to a specific water body is likely to be very small relative to other sources of pathogens in the watershed. Since MassDOT urban roadways are linear and usually cross watersheds, they represent a small fraction of the receiving water body's watershed. The water quality within these water bodies is dependent on discharge from various sources, including discharges from other stormwater systems and a large number of other factors.

Assessment

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

TMDLs for pathogen impairments in Massachusetts recognize that pathogens are highly variable and difficult to address and emphasize the need for an iterative adaptive management approach to address pathogens. Examples of relevant language from these TMDLs are included below:

- “given the vast potential number of bacteria sources and the difficulty of identifying and removing them from some sources such as stormwater require an iterative process and will take some time to accomplish. While the stated goal in the TMDL is to meet the water quality standard at the point of discharge it also attempts to be clear that MassDEP’s expectation is that for stormwater an iterative approach is needed…” (MassDEP, 2009a)
- “The NPDES permit does not, however, establish numeric effluent limitations for stormwater discharges. Maximum extent practicable (MEP) is the statutory standard that establishes the level of pollutant reductions that regulated municipalities must achieve. The MEP standard is a narrative effluent limitation that is satisfied through implementation of SWMPs and achievement of measurable goals.”(MassDEP, 2009b)
- “Although the TMDL presents quantified WLAs for stormwater that are set equivalent to the criteria in the Massachusetts Water Quality Standards, the Phase II NPDES permits will not include numeric effluent limitations. Phase II permits are intended to be BMP based permits that will require communities to develop and implement comprehensive stormwater management programs involving the use of BMPs. Massachusetts and EPA believe that BMP based Phase II permits involving comprehensive stormwater management together with specific emphasis on pollutants contributing to existing water quality problems can be consistent with the intent of the quantitative WLAs for stormwater discharges in TMDLs.” (MassDEP, 2002).

This language clearly indicates that an iterative adaptive management approach is the appropriate way to address discharges to pathogen impaired waters. The recommendations in pathogen TMDLs for waters in Massachusetts generally require development and implementation of stormwater management programs, illicit discharge detection and elimination efforts, and in some cases installing BMPs to the maximum extent practicable

The draft North Coastal Watershed General MS4 permit and the draft Interstate, Merrimack, and South Coastal (IMS) watershed permits contain specific requirements for compliance with pathogen TMDLs (in Appendix G). While these permits are still in draft form, MassDOT believes they represent the best available guidance on what EPA believes is appropriate for addressing stormwater discharges to pathogen-impaired waters. Section 2.2.1(c) of the permit states “For any discharge from its MS4 to impaired waters with an approved TMDL, the permittee shall comply with the specific terms of Part 2.1 of this permit. In addition, where an approved TMDL establishes a WLA that applies to its MS4 discharges, the permittee shall implement the specific BMPs and other permit requirements identified in Appendix G to achieve consistency with the WLA.” Appendix G references a number of programmatic BMPs that are necessary to address pathogen loading. These cover the following general topics:

- Residential educational program
- Illicit connection identification, tracking and removal
- Pet waste management

Mitigation Plan

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Stormwater Management Plan (SWMP) including educational programs, illicit connection review and source control. The specific BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review

- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In
- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

In addition, the structural BMPs that will be considered to reduce the IC will also have the effect of reducing pathogen loads.

MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations. MassDOT's existing stormwater management plan outlines BMPs that include education and illicit discharge detection and elimination. MassDOT will be implementing a pet waste management program at its rest stops that have discharges to pathogen impaired waters.

Conclusions

MassDOT used the IC Method to assess Black Brook for the impairments identified in MassDEP's final *Massachusetts Year 2012 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed by 10 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Black Brook to identify existing BMPs and found that existing BMPs provide 52.7% of the target reduction in effective IC. This information is summarized in Table 3 below.

Table 3. Effective IC Reductions under Existing & Proposed Conditions

IC in Directly Contributing Watershed	14.8	acres
Target Reduction in Effective IC	10.4	acres
IC Effectively Reduced by Existing BMPs	5.3	acres
IC Remaining to Mitigate with Proposed BMPs	**5.1**	**acres**

MassDOT should reduce its effective IC within the directly contributing watershed by an additional 5.1 acres to achieve the targeted reduction in IC. MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs to treat directly contributing IC as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide the target IC reduction or treatment to the maximum extent practicable.

MassDOT has concluded based on review of the draft North Coastal Watershed General MS4 permit, the draft Interstate, Merrimack, and South Coastal watershed permits, and pathogen TMDLs for Massachusetts waters, that the BMPs outlined in the stormwater management plan and those under consideration for reducing effective IC from MassDOT areas are consistent with its existing permit requirements. MassDOT believes that these measures achieve pathogen reductions (including fecal coliform) to the maximum extent practicable and are consistent with the intent of its existing stormwater permit and the applicable Pathogen TMDLs.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of additional BMPs, and finalized assessments including reductions achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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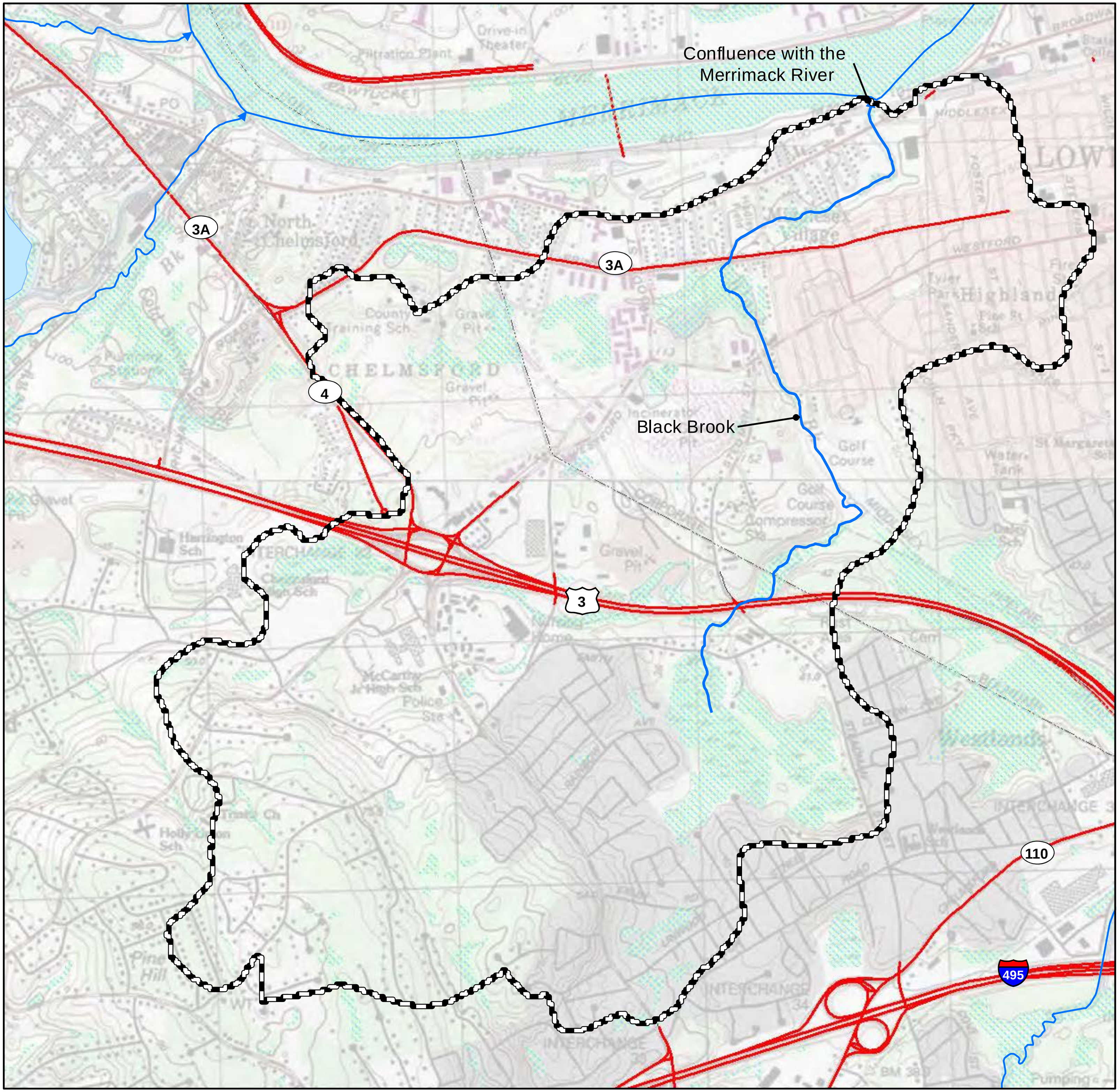


Total and Subwatershed

Black Brook

Impaired Water Bodies

Impaired Stream Segment

NWI Wetland Areas

MassDOT Roads in Urban Areas

MassDOT Roads

Town Boundaries

N

0 0.25 0.5 Miles

1 in = 1,800 feet

Figure 1

Black Brook Total and Subwatershed MA84A-17

June 2013

massDOT Massachusetts Department of Transportation Highway Division

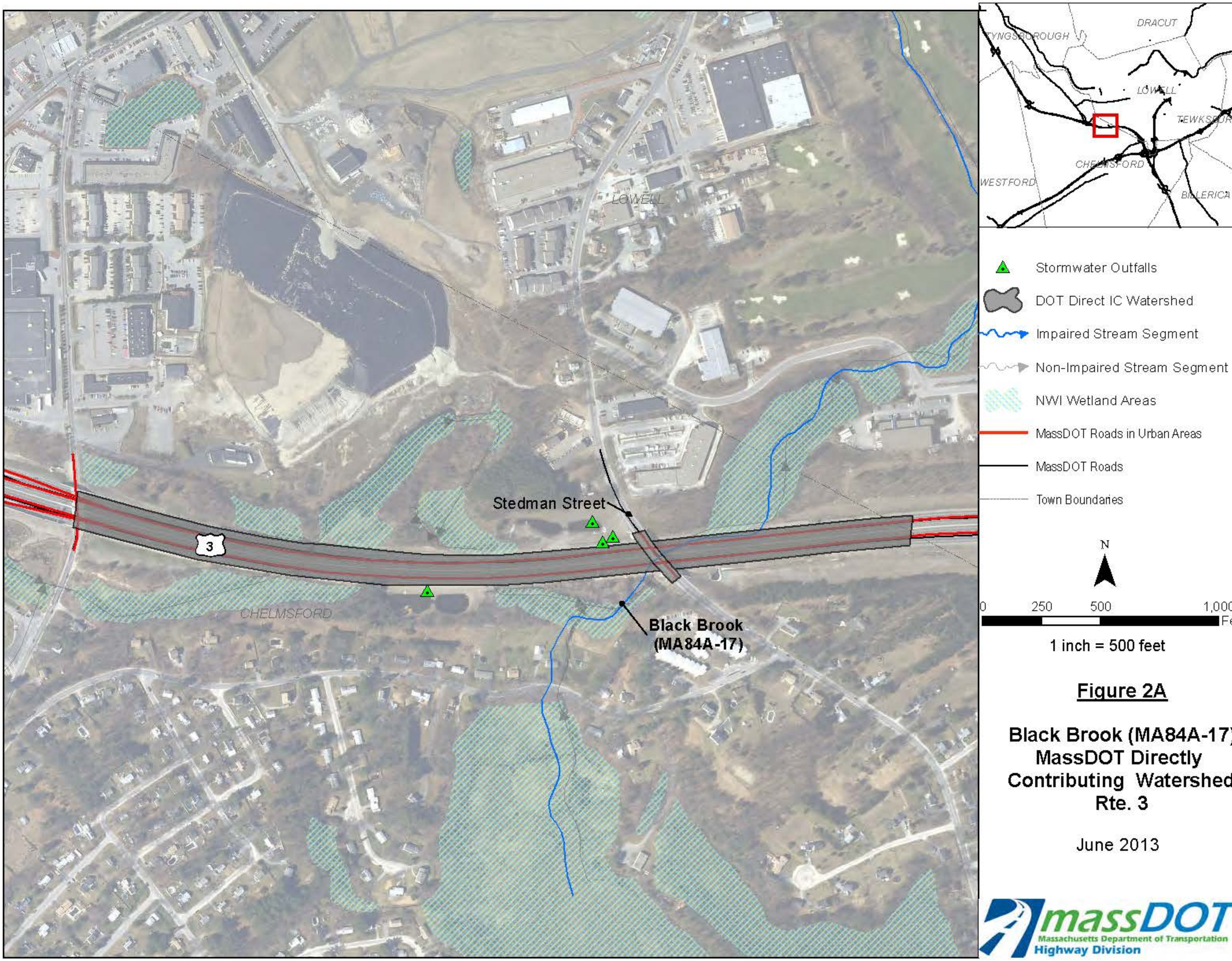
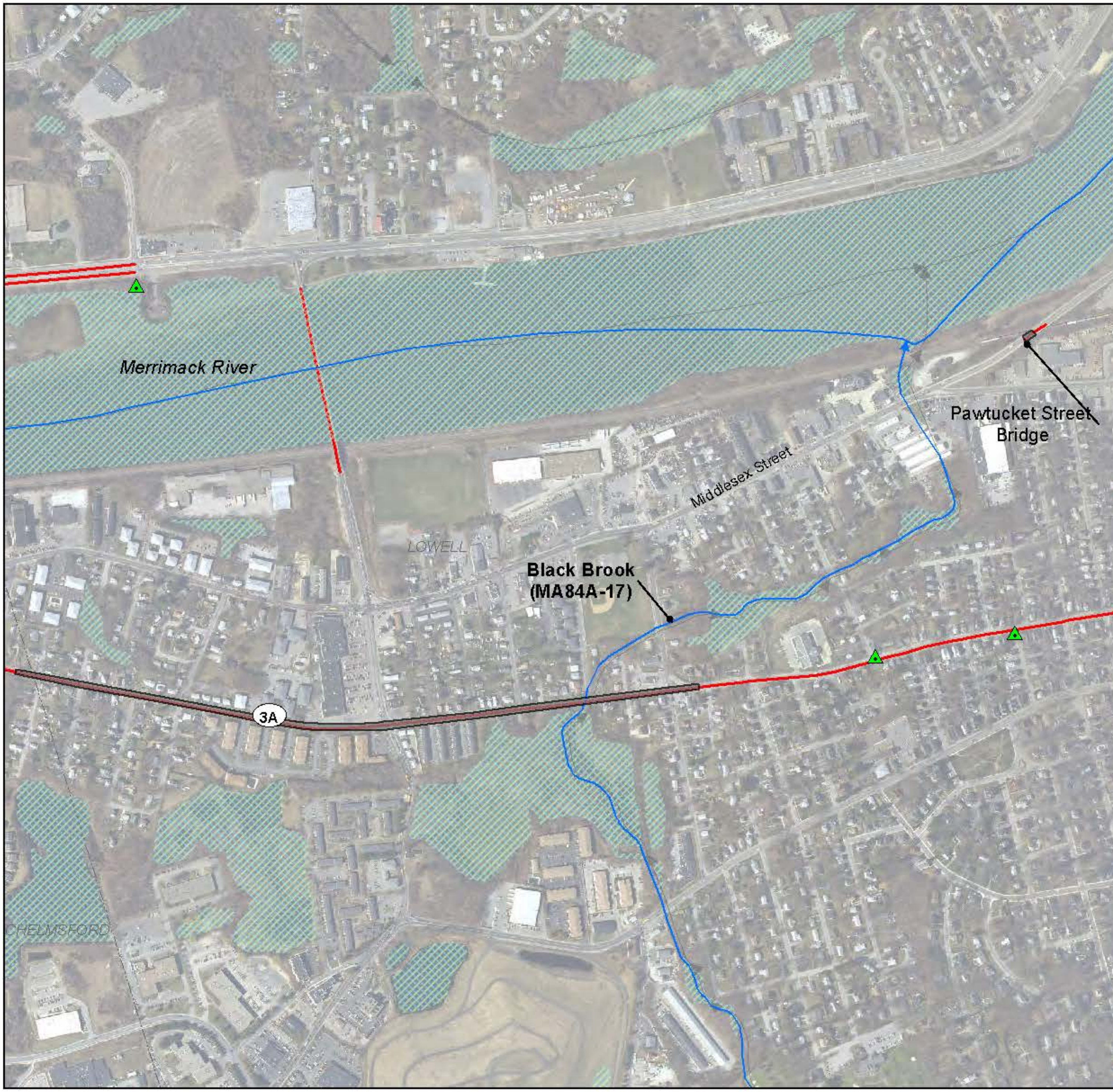


Figure 2A

Black Brook (MA84A-17)
MassDOT Directly Contributing Watershed
Rte. 3

June 2013

massDOT
Massachusetts Department of Transportation
Highway Division



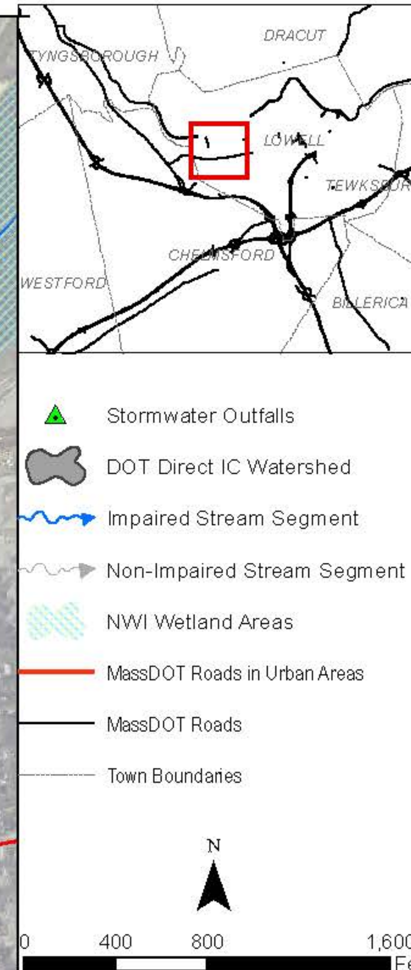
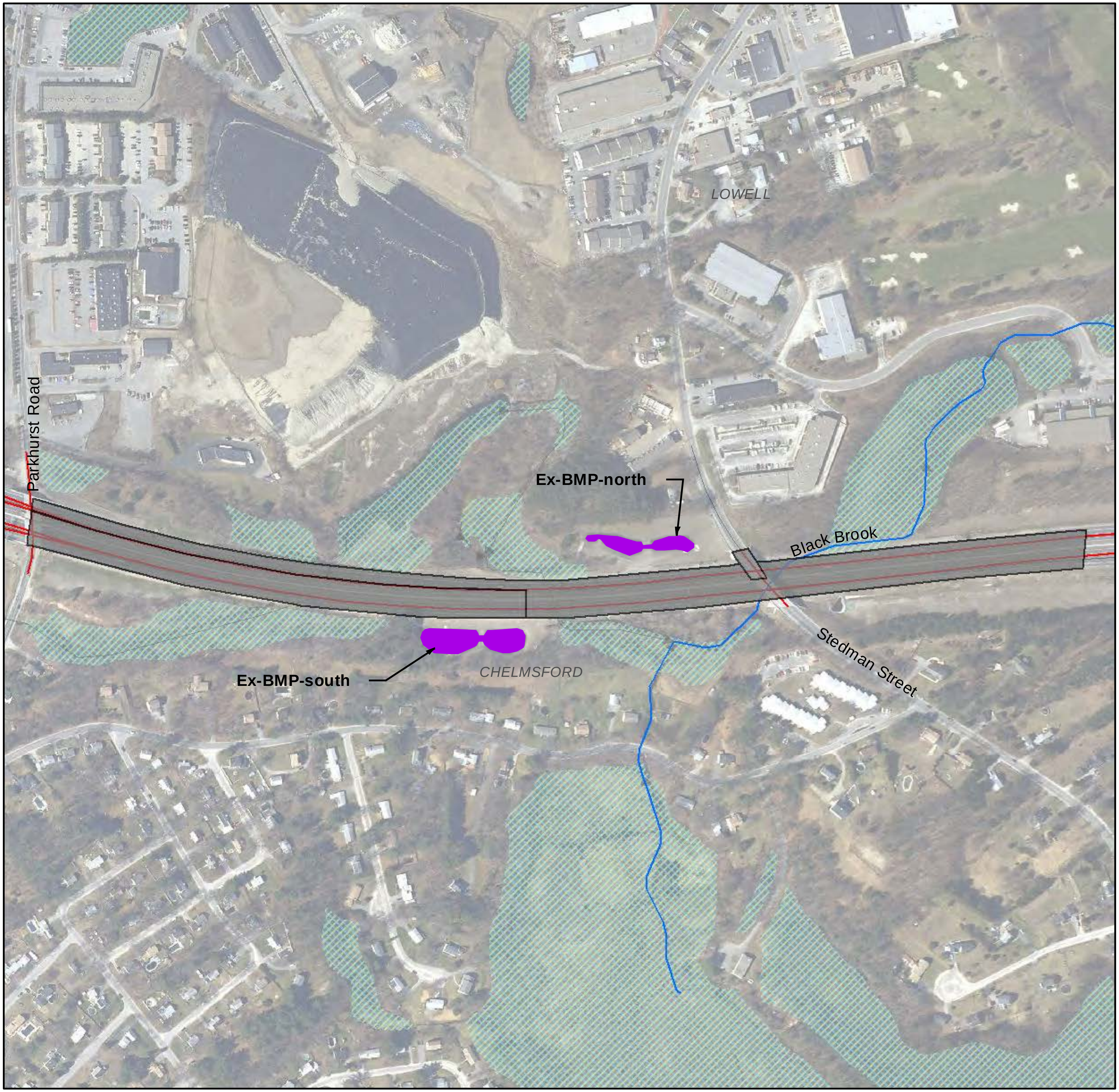


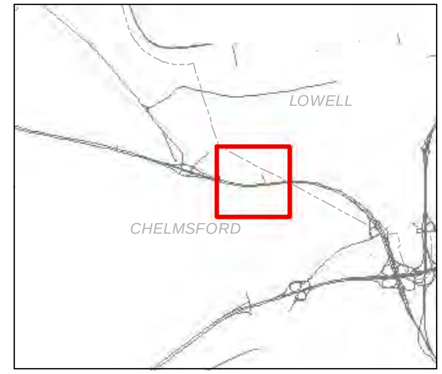
Figure 2B

Black Brook (MA84A-17)
MassDOT Directly Contributing Watershed
Rte. 3A and Pawtucket Street

June 2013

massDOT
Massachusetts Department of Transportation
Highway Division





BMPS - Basin
BMP Watershed
Impaired Stream Segment
Impaired Water Bodies
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT_Roads
MassDOT Roads
Town Boundaries

N

0 200 400 800 Feet

1 in = 450 feet

Figure 3

Black Brook (MA84A-17) Existing BMPs and BMP Watersheds

June 2013

massDOT Massachusetts Department of Transportation Highway Division

Impaired Waters Assessment for Bare Meadow Brook (MA84A-18) – Progress Report

Impaired Waterbody

Name: Bare Meadow Brook

Location: Methuen, MA

Water Body ID: MA84A-18

Impairments

Bare Meadow Brook (MA84A-18) is listed under Category 5, “Waters requiring a TMDL”, on MassDEP’s final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). According to this list, Bare Meadow Brook is impaired for the following:

- Escherichia coli
- turbidity
- sedimentation/siltation

MassDEP’s Merrimack River Watershed 2004-2009 *Water Quality Assessment Report* (MassDEP, 2010) states that Bare Meadow Brook is impaired for primary contact recreational use due to high E Coli test results. Black Meadow Brook is also covered by a draft Total Maximum Daily Load (TMDL) for pathogens according to MassDEP’s Draft Pathogen TMDL for the Merrimack River Watershed (MassDEP, no date).

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *314 CMR 4.05 (3)(b) 5 Solids*. These waters shall be free from floating, suspended and settleable solids in concentrations or combinations that would impair any use assigned to this class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.
- *314 CMR 4.05 (3)(b) 6 Turbidity.* These waters shall be free from color and turbidity in concentrations or combinations that are aesthetically objectionable or would impair any use assigned to this class.
- *314 CMR 4.05 (5) (b) Bottom Pollutants or Alterations*. All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.
- *314 CMR 4.05 (3)(b) 4 Bacteria*.
    - a. At bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: where E. coli is the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall

not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml; alternatively, where enterococci are the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no single sample taken during the bathing season shall exceed 61 colonies per 100 ml;

- b. For other waters and, during the non bathing season, for waters at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: the geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml; alternatively, the geometric mean of all enterococci samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 61 colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department;

Site Description

Bare Meadow Brook begins at Bare Meadow Street in Methuen, MA and continues for 1.6 miles northeast until it passes under the Route 213 Loop Connector, merges with Hawkes Brook, and then continues for another 1.25 miles northeast until it discharges to the Merrimack River. The entire Bare Meadow Brook segment is classified as impaired according to the Merrimack River Watershed 2004 Water Quality Assessment Report and *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). The watershed and subwatershed for Bare Meadow Brook are shown in Figure 1.

Stomwater runoff from MassDOT property is conveyed to Bare Meadow Brook through a system of catchbasins, drainage pipes, ditches, and unnamed streams. The MassDOT property directly contributing stormwater runoff to Bare Meadow Brook is illustrated on Figure 2 and is described below.

At the Rte 113 exit of the Rte 213 Loop Connector, stormwater runoff from the off-ramps south of Rte 213 is collected by catchbasins and directed to the Rte 113 municipal drainage system which ultimately discharges to Bare Meadow Brook. There is also a concrete lined drainage channel on the east side of the off-ramps that discharges to the Rte 113 drainage system.

Bare Meadow Brook passes directly underneath Rte 213 near the Rte 495 intersection. Rte 213 runoff discharges directly to Bare Meadow Brook from approximately 600 feet northwest of Pleasant Valley St to the intersection with Rte 495. Portions of the Rte 213 and Rte 495 interchange also discharge directly to Bare Meadow Brook. Runoff is conveyed by a system of catchbasins, drain pipes, and channels.

Bare Meadow Brook runs parallel to Rte 495 between Rte 213 and Rte 110, offset approximately 500 feet from Rte 495. The majority of Rte 495 stormwater runoff in this area is considered to be direct discharge due to the close proximity of Bare Meadow Brook and the lack of BMPs or other infiltration mechanisms.

A short section of Rte 110 from Webster Ave to Tobey Ave discharges directly to Bare Meadow Brook just before the confluence with the Merrimack River.

Assessment under BMP 7U

None of the impairments for Bare Meadow Brook have been addressed by a TMDL. Therefore, MassDOT assessed the impairments using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of storm water on many impairments. For this water body, MassDOT used the IC method to assess the following impairments:

- turbidity
- sedimentation/siltation

The impairment for escherichia coli is assessed separately in the section titled Assessment of Pathogen Impairment.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction necessary to attain the percent imperviousness in the watershed at which stormwater is not likely the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. IC data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer.

In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for Bare Meadow Brook (MA84A-18):

Table 1. Site Parameters for Bare Meadow Brook (MA84A-18)

Total Watershed		
Watershed Area	4,970	acres
Impervious Cover (IC) Area	770	acres
Percent Impervious	15.5	%
Subwatershed		
Subwatershed Area	2,170	acres
Impervious Cover (IC) Area	497	acres
Percent Impervious	22.9	%
IC Area at 9% Goal	195	acres
Target Reduction % in IC	60.8	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	18.7	acres
MassDOT's Target Reduction in Effective IC (60.8% of DOT Directly Contributing IC)	11.4	acres

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 60.8%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 11.4 acres.

Existing BMPs

Based on the site visit, there are no existing BMPs within MassDOT's directly contributing watershed to Bare Meadow Brook that are mitigating potential storm water quality impacts. Therefore, no effective IC reduction is provided by existing MassDOT BMPs.

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 11.4 acres, MassDOT will consider the implementation of new BMPs.

Assessment of Pathogen Impairment

MassDOT assessed the pathogen impairment using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by an order of magnitude within a given storm event at a single location (MassDEP, 2009b). Therefore, it is difficult to predict pathogen concentrations in stormwater with accuracy. Due to this difficulty, MassDOT generally will not conduct site specific assessments of loading at each location impaired for pathogens. Instead these sites will be assessed collectively based on available information on pathogen loading from highways, MassDOT actions, and information available from EPA and DEP. Based on this information MassDOT developed an approach to be consistent with relevant TMDL and permit condition requirements and an iterative adaptive management approach to stormwater management.

In addition, while there is a positive relationship between IC and pathogen loading, the relationship is not as direct as other impairments. According to the Center for Watershed Protection "…Other studies show that concentrations of bacteria are typically higher in urban areas than rural areas (USGS, 1999), but they are not always directly related to IC (CWP, 2003)." Therefore, DOT did not rely solely on the IC method to assess pathogen impairments. Instead, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

Pathogens in MassDOT Discharge

A study conducted on MassDOT's South East Expressway measured bacterial concentrations in stormwater runoff (Smith, 2002). This study found a geometric mean of 186 fecal coliforms/100 ml. Concentrations of pathogens in stormwater runoff from roadways can vary widely and pathogen concentrations in runoff across the state likely deviate significantly from this stretch of roadway's specific estimate. Event mean concentrations of fecal coliform bacteria in urban stormwater from other sources ranging between 14,000 and 17,000 fecal coliform organisms/100 mL have been reported (MassDEP, 2009b). These data suggest that pathogen loading from highways may be lower than other urban areas.

Consideration of the potential sources of pathogens supports the idea that pathogens are present in lower concentrations in highway runoff since potential pathogen sources are likely to be less prevalent in the highway environment than along other urban roadways:

- Illicit discharges: Due to the typical setback of highways from residential and commercial developments and the stand alone nature of the drainage system, the potential for illicit discharges (e.g. sewer connections, laundry tie-ins) is much lower than in other stormwater systems. This has been confirmed by MassDOT's illicit discharge detection on many miles of urban roadways within a broad range of areas across Massachusetts. After assessment of almost 140 miles, and investigation of more than 2,500 stormwater features, MassDOT's consultant performing the broad scope reviews has found no confirmed illicit discharges.
- Limited Sewer Utilities in Road Right of Ways: Since DOT does not provide sewer services, many MassDOT roads do not have sewer utilities within the road's right of way; thereby eliminating the chance of cross-connections or leaking pipes as a source of pathogens into the stormwater system.
- Pet waste: Pets are only present on highways in rare instances. In urban residential areas pets and their associated waste are much more common. MassDOT is aware that pet

waste at road side rest stops may represent a potential source of pathogens to stormwater in certain situations.

- Wildlife: Highways are not generally an attractive place for wildlife. Wildlife generally avoids highways and only occasionally crosses them.

The dearth of pathogen sources on highways and the relatively low concentrations of pathogens measured in the South East Expressway study together suggest that pathogen loading from stormwater runoff from highways is lower than other urban sources.

Furthermore, in almost all cases the contribution of pathogens from MassDOT to a specific water body is likely to be very small relative to other sources of pathogens in the watershed. Since MassDOT urban roadways are linear and usually cross watersheds, they represent a small fraction of the receiving water body's watershed. The water quality within these water bodies is dependent on discharge from various sources, including discharges from other stormwater systems and a large number of other factors.

Assessment

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

TMDLs for pathogen impairments in Massachusetts recognize that pathogens are highly variable and difficult to address and emphasize the need for an iterative adaptive management approach to address pathogens. Examples of relevant language from these TMDLs are included below:

- "given the vast potential number of bacteria sources and the difficulty of identifying and removing them from some sources such as stormwater require an iterative process and will take some time to accomplish. While the stated goal in the TMDL is to meet the water quality standard at the point of discharge it also attempts to be clear that MassDEP's expectation is that for stormwater an iterative approach is needed…" (MassDEP, 2009a)
- "The NPDES permit does not, however, establish numeric effluent limitations for stormwater discharges. Maximum extent practicable (MEP) is the statutory standard that establishes the level of pollutant reductions that regulated municipalities must achieve. The MEP standard is a narrative effluent limitation that is satisfied through implementation of SWMPs and achievement of measurable goals."(MassDEP, 2009b)
- "Although the TMDL presents quantified WLAs for stormwater that are set equivalent to the criteria in the Massachusetts Water Quality Standards, the Phase II NPDES permits will not include numeric effluent limitations. Phase II permits are intended to be BMP based permits that will require communities to develop and implement comprehensive stormwater management programs involving the use of BMPs. Massachusetts and EPA believe that BMP based Phase II permits involving comprehensive stormwater management together with specific emphasis on pollutants contributing to existing water quality problems can be consistent with the intent of the quantitative WLAs for stormwater discharges in TMDLs." (MassDEP, 2002).

This language clearly indicates that an iterative adaptive management approach is the appropriate way to address discharges to pathogen impaired waters. The recommendations in pathogen TMDLs for waters in Massachusetts generally require development and implementation of stormwater management programs, illicit discharge detection and elimination efforts, and in some cases installing BMPs to the maximum extent practicable

The draft North Coastal Watershed General MS4 permit and the draft Interstate, Merrimack, and South Coastal (IMS) watershed permits contain specific requirements for compliance with pathogen

TMDLs (in Appendix G). While these permits are still in draft form, MassDOT believes they represent the best available guidance on what EPA believes is appropriate for addressing stormwater discharges to pathogen-impaired waters. Section 2.2.1(c) of the permit states “For any discharge from its MS4 to impaired waters with an approved TMDL, the permittee shall comply with the specific terms of Part 2.1 of this permit. In addition, where an approved TMDL establishes a WLA that applies to its MS4 discharges, the permittee shall implement the specific BMPs and other permit requirements identified in Appendix G to achieve consistency with the WLA.” Appendix G references a number of programmatic BMPs that are necessary to address pathogen loading. These cover the following general topics:

- Residential educational program
- Illicit connection identification, tracking and removal
- Pet waste management.

Mitigation Plan

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Stormwater Management Plan (SWMP) including educational programs, illicit connection review and source control. The specific BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In
- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

In addition, the structural BMPs that will be considered to reduce the IC will also have the effect of reducing pathogen loads.

MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit’s requirements and TMDL recommendations. MassDOT’s existing stormwater management plan outlines BMPs that include education and illicit discharge detection and elimination. MassDOT will be implementing a pet waste management program at its rest stops that have discharges to pathogen impaired waters.

Conclusions

MassDOT used the IC Method to assess Bare Meadow Brook for the impairments identified in MassDEP’s final *Massachusetts Year 2012 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed by 11.4 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Bare Meadow Brook and found that there are no existing BMPs and therefore no existing reduction in effective IC. This information is summarized in Table 3 below.

Table 3. Effective IC Reductions under Existing & Proposed Conditions

MassDOT Direct Contributing IC	18.7	acres
MassDOT Target Reduction in Effective IC	11.4	acres
Effective IC Reduction under Existing Conditions	0	acres
Remaining Target Reduction with Proposed BMPs	**11.4**	**acres**

MassDOT should reduce its effective IC within the directly contributing watershed by 11.4 acres to achieve the targeted reduction in IC. MassDOT will now work with its design consultants to identify locations suitable for construction of additional BMPs to treat directly contributing IC as part of MassDOT's Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide the target IC reduction or treatment to the maximum extent practicable.

MassDOT has concluded based on review of the draft North Coastal Watershed General MS4 permit, the draft Interstate, Merrimack, and South Coastal watershed permits, and pathogen TMDLs for Massachusetts waters, that the BMPs outlined in the stormwater management plan and those under consideration for reducing effective IC from MassDOT areas are consistent with its existing permit requirements. MassDOT believes that these measures achieve pathogen reductions (including fecal coliform) to the maximum extent practicable and are consistent with the intent of its existing stormwater permit and the applicable Pathogen TMDLs.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of additional BMPs, and finalized assessments including reductions achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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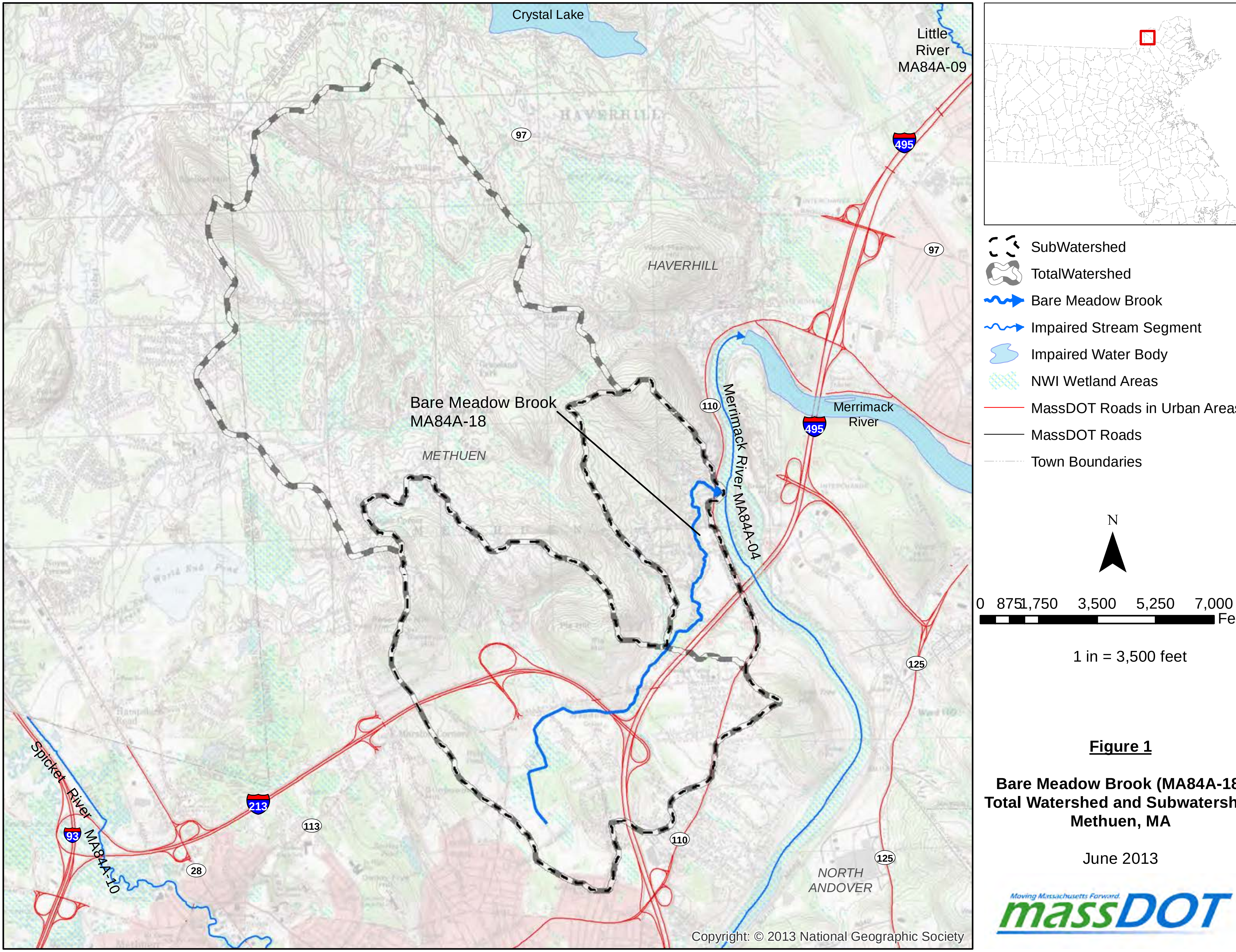
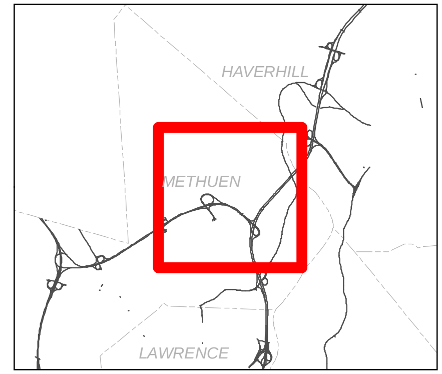


Figure 1

Bare Meadow Brook (MA84A-18)
Total Watershed and Subwatershed
Methuen, MA

June 2013

Moving Massachusetts Forward. massDOT



- SubWatershed
- MassDOT Contributing Watershed
- Bare Meadow Brook
- Impaired Stream Segment
- Impaired Water Body
- NWI Wetland Areas
- MassDOT Roads in Urban Areas
- MassDOT Roads
- Town Boundaries

N

0 375 750 1,500 2,250 3,000 Feet

1 in = 1,500 feet

Figure 2

Bare Meadow Brook (MA84A-18)
Directly Contributing IC
MassDOT Watershed
Methuen, MA

June 2013

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Impaired Waters Assessment for Bass River (MA93-07)

Impaired Waterbody

Name: Bass River

Location: Beverly, Massachusetts

Water Body ID: MA93-07

Impairments

According to the MassDEP Final Year 2012 Integrated List of Waters, this segment is listed under Category 5 as impaired for turbidity and fish passage barrier. According to the Integrated List of Waters, fish passage barrier is not a pollutant and therefore not included in this assessment.

The *North Shore Coastal Watersheds 2002 Water Quality Assessment Report* reports Bass River as a Category 3 water (according to the 2004 Integrated List of Waters) as impaired for fish barriers due to hydrostructure impacts on fish passage. The Water Quality Assessment Report also notes that Shoe Pond (formerly Segment MA93068) is included in this segment. Shoe Pond was listed as a Category 5 water as impaired for turbidity in the 2004 Integrated List of Waters.

Relevant Water Quality Standards

- Water Body Classification: B
- 314 CMR § 4.05 (3)(b) - *Class B. These waters are designated as a habitat for fish, other aquatic life, and wildlife, including for their reproduction, migration, growth and other critical functions, and for primaryand secondarycontact recreation. Where designated in 314 CMR 4.06, they shall be suitable as a source of public water supply with appropriate treatment ("Treated Water Supply"). Class B waters shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process use. These waters shall have consistently good aesthetic value.*
- 314 CMR § 4.05 (3)(b) 6 – *Class B. Color and Turbidity. These waters shall be free from color and turbidity in concentrations of combinations that are aesthetically objectionable or would impair any use assigned to this class.*

Summary

MassDOT has assessed stormwater impacts from MassDOT properties discharging to the Bass River using BMP 7U to address impairments not covered by a TMDL. The following sections describe the methodology for this assessment. Based on this assessment, MassDOT determined that a 5-acre reduction in effective impervious cover (IC) would be needed to meet the targets for this watershed.

MassDOT has concluded that no existing stormwater best management practices (BMPs) are in place to provide effective IC reduction. To reduce MassDOT's contribution to impairments within the Bass River watershed, MassDOT proposes 5 BMPs. The BMPs consist of 5 water quality swales and will provide an estimated 6.0 acres of effective IC reduction. During the design phase, MassDOT will collect additional information on the soils, property ownership, wetlands and other site conditions which may limit the potential for stormwater BMPs. Therefore, MassDOT has proposed additional BMPs in this assessment phase which show the effective IC reduction target being exceeded.

See the **Proposed Mitigation Plan** section of this assessment for more information.

Reductions Applied to MassDOT Direct Watershed

	Effective IC (Acres)
MassDOT's Area Directly Contributing to Impaired Segment	6.7
Target Reduction	5.0
Reduction Provided in Proposed Conditions	6.0

Site Description

The Bass River (Segment MA93-07) is located in the town of Beverly, Massachusetts an urban residential costal town as shown in Figure 1. This segment of the Bass River flows from its headwaters, east of Beverly Airport in Beverly, to the outlet of Lower Shoe Pond, north of Route 62 in Beverly. This section of Bass River starts by flowing openly through a wooded area north of Route 128. The river then enters a residential area, before being culverted under Route 128. After flowing under Route 128, Bass River continues to flow openly 550 feet before being culverted under a residential area until it reaches the edge of Beverly Golf and Tennis Club where Bass River flows through an open channel and then outlets to Lower Shoe Pond.

As shown on Figure 1, MassDOT properties within the watershed of MA93-07 include Route 128 and Route 1A in Beverly, Massachusetts. Stormwater from Route 1A, a residential two-lane road, enters into the municipal storm drain system and does not discharge to Bass River. Stormwater from Route 128 does directly discharge to Beaver Brook, roughly a total of 3,000 feet of Route 128 surrounding the crossing of Bass River under Route 128 drains directly to Bass River, as shown in Figure 2. This section of Route 128 consists of a divided highway with two, 12-foot lanes, a 10-foot shoulder in the right lane, and a 6-foot shoulder in the left lane, in each direction. Currently, stormwater from Route 128 east of Bass River enters catch basins which line the shoulders and enters a mainline under the median of Route 128 and discharges into the culverted portion of Bass River. Stormwater from Route 128 west of Bass River is collected in catch basins that line the shoulders which outlet to a drainage ditches in the pervious areas adjacent to Route 128 and discharges to Bass River.

Assessment for Turbidity under BMP 7U

MassDOT assessed the stormwater-related impairments not addressed by a TMDL (turbidity) using the approach described in BMP 7U of MassDOT's Stormwater Management Plan (Water Quality Impaired Waters Assessment and Mitigation Plan), which applies to impairments that have not been addressed by a TMDL. According to the Integrated List of Waters, fish passage barrier is not a pollutant. MassDOT has not assessed the fish passage barrier impairment in this assessment as it is not a pollutant and not related to stormwater.

For the stormwater-related impairments for this water body not covered by a TMDL, MassDOT used an application of EPA Region I's Impervious Cover (IC) Method described in EPA's Stormwater TMDL Implementation Support Manual (ENSR, 2006). MassDOT used this method to assess potential stormwater impacts on the impaired water and develop the target IC to ensure that stormwater is not the cause of the impairments. The IC Method relates an aquatic system's health (i.e., state of impairment) to the percentage of IC in its contributing watershed. This method is largely based on the work of the Center for Watershed Protection, which has compiled and evaluated extensive data relating watershed IC to the hydrologic, physical, water quality, and biological conditions of aquatic systems (Schueler, 2003). Water quality in tributary streams, rivers, lakes and ponds is a direct reflection of loading from the watershed (Wetzel, 2001); therefore, the IC method can be used as a surrogate for pollutant loading when evaluating water quality impairments and their causes. Consistent with the findings of EPA and others, MassDOT concluded that when a watershed had less than 9% IC, stormwater was not the likely cause of the impairment.

MassDOT developed the target IC reduction using the approach outlined in *Description of MassDOT's Application of Impervious Cover Method in BMP 7U* (MassDOT, 2011). Since the development of the MassDOT Application of IC Method, MassDOT has further refined its approach to evaluate MassDOT's effective IC and BMP performance. For the Bass River, MassDOT used the long-term continuous simulation model (the assessment model) to estimate effective IC.

MassDOT estimated the effective IC of its contributing drainage area with existing and proposed stormwater BMPs by comparing the runoff and pollutant response of its drainage area to the response of simulated watersheds with equivalent area, but varying IC from 0 to 100% (simulated IC watersheds). The IC percentage of the watershed that produces a similar response to MassDOT's watershed was determined to be the effective IC of MassDOT's watershed. For a more detailed description of this approach, see the Long-Term Continuous Simulation for Pollutant Loading and Treatment for MassDOT Impaired Waters Program.

The MassDOT IC method for the impaired waters of the Bass River includes the following steps:

1. Calculate the percent IC of the water body's entire contributing watershed (total watershed to downstream end of impaired segment) and that of the local watershed contributing directly to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body.
2. For subwatersheds with greater than 9% IC, calculate the amount of IC reduction needed to achieve 9%. For subwatersheds with less and 9% IC, perform no further analysis under BMP 7U.
3. Calculate percentage of IC in the MassDOT directly contributing drainage area.
4. Apply reduction of IC necessary for the subwatershed to achieve 9% to MassDOT contributing drainage area as a target to address the stormwater impairments. Calculate resulting target IC for MassDOT drainage area.
5. In the case where BMPs are in place or where BMPs are proposed, derive IC reduction rates for the BMPs using MassDOT's assessment model based on size, function, and contributing watersheds of the BMPs.

BMP 7U Assessment

Using the approach described above, MassDOT calculated the following values for the total contributing watershed and the watershed of the impaired water (Bass River) to determine the IC target (see Figure 1). MassDOT has determined that the total watershed (total watershed upstream of the downstream end of the impaired segment) and the subwatershed (local watershed contributing directly to the impaired segment) for Bass River were the same.

Watershed Impervious Cover

	Total Watershed
Watershed Area	1,991 acres
Impervious Cover (IC) Area	662 acres
Percent Impervious	33%
IC Area at 9% Goal	179 acres
Target Reduction % in IC	73 %

The total watershed is greater than 9% impervious indicating that stormwater is a likely contributor to the impairment. To meet the 9% effective IC target, the effective IC within the watershed will need to be reduced by 73%. Therefore, the effective IC of MassDOT's directly contributing area should also be reduced by the same percentage to meet the target. The following table shows the resulting targets for MassDOT's contributing property.

Reductions Applied to MassDOT Direct Watershed

MassDOT's Area Directly Contributing to Impaired Segment	12.0 acres
MassDOT's IC Area Directly Contributing to Impaired Segment	6.7 acres
MassDOT's Percent Impervious	56 %
MassDOT's Target Reduction in Effective IC (73% of DOT Directly Contributing IC)	5.0 acres
Target Effective IC	15 %

MassDOT's directly contributing area includes 6.7 acres of IC (56 % of total contributing area). To meet the target reduction of effective IC, MassDOT should mitigate 5.0 acres of effective IC. Equivalently, MassDOT's contributing drainage area should act as a watershed of 15% IC. There are no existing BMPs to mitigate the effects of IC.

BMP 7U Mitigation Plan

Under existing conditions, MassDOT's estimated effective IC exceeds the target as described above. To mitigate the effects of IC, MassDOT reviewed potential locations to implement stormwater BMPs to the maximum extent practical given site constraints.

This assessment has identified locations for potential stormwater BMPs and estimated the effective IC accounting for their treatment. The Proposed Mitigation Plan section describes the BMPs and their IC reduction performance.

Proposed Mitigation Plan to Address Impervious Cover

In this assessment, MassDOT has identified 5 stormwater BMPs that may be implemented on MassDOT property to mitigate the effective IC to address the Bass River turbidity impairment. These BMPs include water quality swales, shown with their estimated contributing drainage areas in Figures 3 and 4. These locations were chosen based on a cursory review of the drainage systems, topography, property lines, and other site constraints. Detailed survey, complete utility location information, official property ownership, and soils evaluation information will influence the final selection and design of BMPs. Below is a description of these potential proposed BMPs. The 5 proposed BMPs consist of water quality swales located in the pervious areas adjacent to either Route 128 westbound or Route 128 eastbound. The hydrological soils group in this area consist of predominately A soils. The overflow from four of the five swales discharge directly into Bass River and the one swale that does not overflow directly into Bass River is directed to another BMP.

PR BMP 1-3
Proposed BMP 1, 2 and 3 are water quality swales located in the pervious areas adjacent to Route 128, west of Bass River. Stormwater runoff from Route 128 is collected in catch basins located in the shoulders of the roadway and discharge to existing drainage ditches l in the pervious area adjacent to Route 128 eastbound. Stormwater that is collected in the catch basins located in the outer shoulder of Route 128 westbound can be redirected to PR BMP 1 and PR BMP 3. Stormwater that is currently collected by the catch basins in the inner shoulder of Route 128 westbound and the shoulders of Route 128 eastbound can continue to be directed into the existing drainage ditch adjacent to Route 128 eastbound, the area proposed for PR BMP 2. There is an existing headwall located between PR BMP 1 and PR BMP 3. Overflow from PR BMP 1 will be collected by the headwall that culverts under Route 128 to PR BMP 2. Overflow from PR BMP 3 and PR BMP 2 will flow into Bass River. Check dams could be added to all three of the swales to allow for more storage of stormwater and promote infiltration.

PR BMP 4-5
Proposed BMP 4 and 5 are water quality swales located in the pervious area adjacent to Route 128, east of Bass River. Currently, stormwater runoff drains into catch basins that line the shoulders of Route 128 and outlet into a mainline that runs under the median and drains into the culverted portion of Bass River under Route 128. Stormwater that is collected by catch basins in the outer shoulders could be directed to the areas proposed as PR BMP 4 or PR BMP 5. The stormwater that is collected in the catch basins located in the inner shoulders would outlet into the mainline. Check dams could be added to the swales to allow for more storage of stormwater and promote infiltration before the stormwater overflows into Bass River

A proposed conditions simulation was developed including proposed BMPs, estimated potential contributing drainage areas and rough sizing of the proposed BMPs. The table below shows the proposed BMPs, their MassDOT drainage areas, and estimated effective IC reductions. The outputs from the assessment model showing effective IC analysis for each BMP are attached. The assessment model identifies each BMP by unique ID, which is included in the table below.

MassDOT used the assessment model to simulate the MassDOT directly contributing watershed and proposed BMPs for Bass River. The assessment model also simulated watersheds with the same area as the MassDOT watershed but with varying percentages of IC from 0 to 100% (simulated IC watersheds). The results of the simulated IC watersheds are used as “benchmarks” to determine effective IC of the MassDOT directly contributing watershed. The annual median runoff volume, phosphorus and total suspended solids (TSS) loads, and flow duration for the MassDOT watershed were compared to those results for the simulated IC watersheds to determine (based on similar runoff and load responses) the equivalent or effective impervious cover of the MassDOT watershed with BMPs treating a portion of the runoff. The graph and table below summarize assessment model results for the MassDOT directly contributing drainage area including the impacts of the proposed BMPs, along with the simulated IC watersheds.

Proposed Mitigation

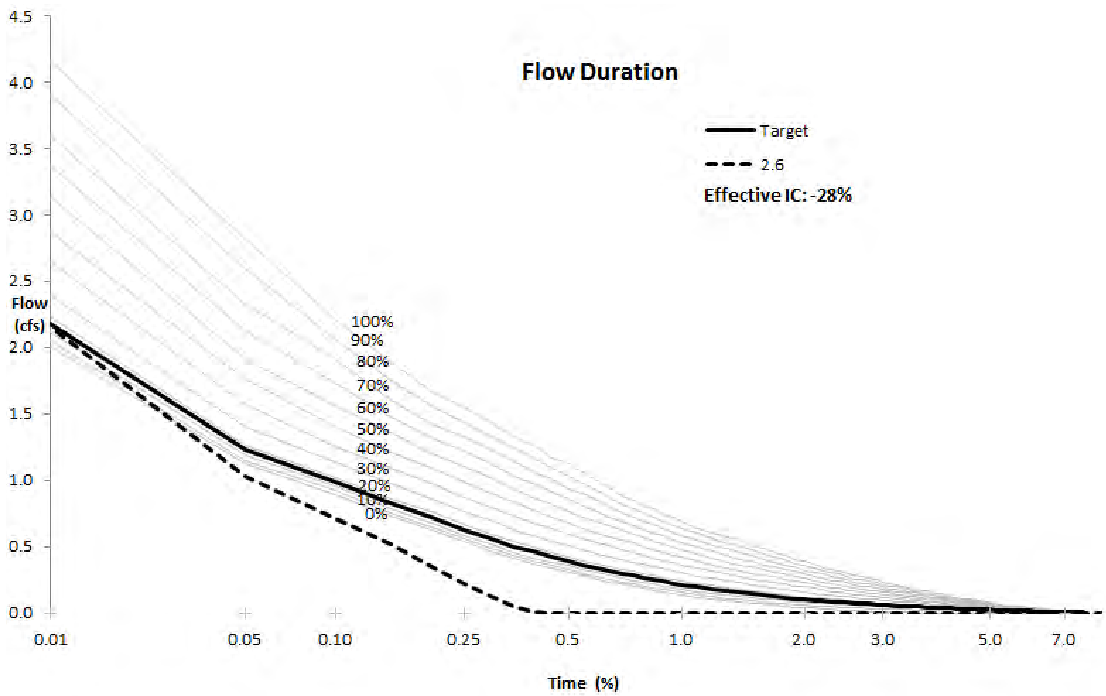
BMP ID	BMP Type	Contributing Effective IC (acres)	Estimated Percent Reduction in Effective IC	Estimated Reduction of Effective IC (acres)
PR BMP 1 (1.6)	Water Quality Swale	0.4	190%	0.7
PR BMP 2 (2.6)	Water Quality Swale	3.0	126%	4.2
PR BMP 3 (3.6)	Water Quality Swale	0.4	206%	0.8
PR BMP 4 (4.6)	Water Quality Swale	0.6	148%	0.9
PR BMP 5 (5.6)	Water Quality Swale	0.5	217%	1.0
Total*		**4.8**	**89%**	**6.0**

* Total Effective IC reduction based on the assessment model results for the total MassDOT directly discharging drainage area to the receiving water (not sum of individual BMP reductions).

Note: The predicted effective IC is determined by comparing the BMP's calculated median annual discharge volume, runoff flow/duration relationship, median annual phosphorus load and median annual total suspended solids load to predicted discharge values for benchmark watersheds with the same size and varying percent IC. In cases where analysis predicts that BMPs would discharges less runoff volume and pollutant mass than those predicted for a 0% IC (pervious, woods in good condition) benchmark watershed, then the predicted effective IC removal would be greater than 100% and reduction of effective IC area will be greater than the BMP contributing IC area.

Proposed Median Annual Load Comparisons

Simulated IC Watersheds	Runoff (ac-ft)	P (lb.)	TSS (lb.)
0% IC	8.7	0.6	42
5% IC	10.3	1.0	209
10% IC	11.8	1.5	443
Target 15% IC	**13.3**	**2.3**	**840**
20% IC	14.8	3.0	1,224
30% IC	17.8	5.4	2,497
40% IC	20.8	8.5	4,215
50% IC	23.7	12.2	6,315
60% IC	26.6	16.2	8,611
70% IC	29.5	20.3	10,929
80% IC	32.4	24.4	13,241
90% IC	35.4	28.3	15,495
100% IC	38.3	32.4	17,787
Existing Conditions	23.3	17.1	9,275
Proposed Conditions	8.1	5.3	2,872
Reduction %	**65%**	**69%**	**69%**
Effective IC	**-2%**	**30%**	**32%**



Effective IC Results

Existing Effective IC	6.7 ac
Proposed Estimated Effective IC	0.7 ac
IC Reduction % with Proposed BMPs	89%
Estimated Effective IC*	6%

*Average of estimated effective IC for annual median runoff volume, phosphorus and TSS loads, and flow duration

MassDOT estimated the effective IC under proposed conditions as 9% by comparing the annual median runoff volume, phosphorus and TSS loads, and flow distribution statistics (flow duration) from MassDOT drainage area to the receiving water to those results for simulated IC watersheds. The proposed BMPs mitigate an estimated 6.7 acres of IC, resulting in 0.7 acres of effective IC for the MassDOT direct watershed.

MassDOT will continue to ensure proper non-structural BMPs are being implemented within the watershed of the Bass River, including regular roadway and drainage system maintenance, erosion and sedimentation control, and outreach and education.

In addition, BMP implementation through MassDOT's programmed projects are carefully evaluated and implemented where practicable, and documented through the MassDOT Water Quality Data Form. The potential for BMPs outside of MassDOT property will be reviewed during the design phase of these projects and through ongoing partnerships with other state and local entities.

Conclusions

MassDOT has assessed stormwater impacts from MassDOT properties directly discharging to the Bass River using BMP 7U to address impairments not covered by a TMDL. This assessment found that no existing BMPs treat stormwater discharges from MassDOT properties. MassDOT proposes to install 5 BMPs to reduce MassDOT's contribution to impairments within the Bass River watershed.

The following table summarizes the total effective IC reductions proposed in the Bass River's watershed.

Reductions Applied to MassDOT Direct Watershed

	Effective IC (Acres)
MassDOT's Area Directly Contributing to Impaired Segment	6.7
Target Reduction	5.0
Reduction Provided in Proposed Conditions	6.0

The proposed BMPs will also reduce the effective IC of the watershed by 6.0 acres, which is more than the target reduction of 5.0 acres. The proposed effective IC reduction is greater than the target but constraints due to soil conditions, right-of-way ownership, and other unforeseen conditions may limit the practicality of these BMPs in the design phase.

MassDOT will proceed to the design phase to develop construction plans for the proposed BMPs as part of the MassDOT Impaired Waters Program. The project designer will gather additional information in this phase, such as soil data and site survey, to further refine the proposed BMPs. Once the design of the proposed BMPs is finalized, MassDOT will provide an update with additional information and summarize the effective IC reduction based on the as-built condition.

As an overall program, MassDOT will re-evaluate the potential need for structural BMPs to address pollutant loading when roadwork is conducted as programmed projects for the area. Further work by MassDOT on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to address impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of proposed BMPs and finalized assessments including reduction achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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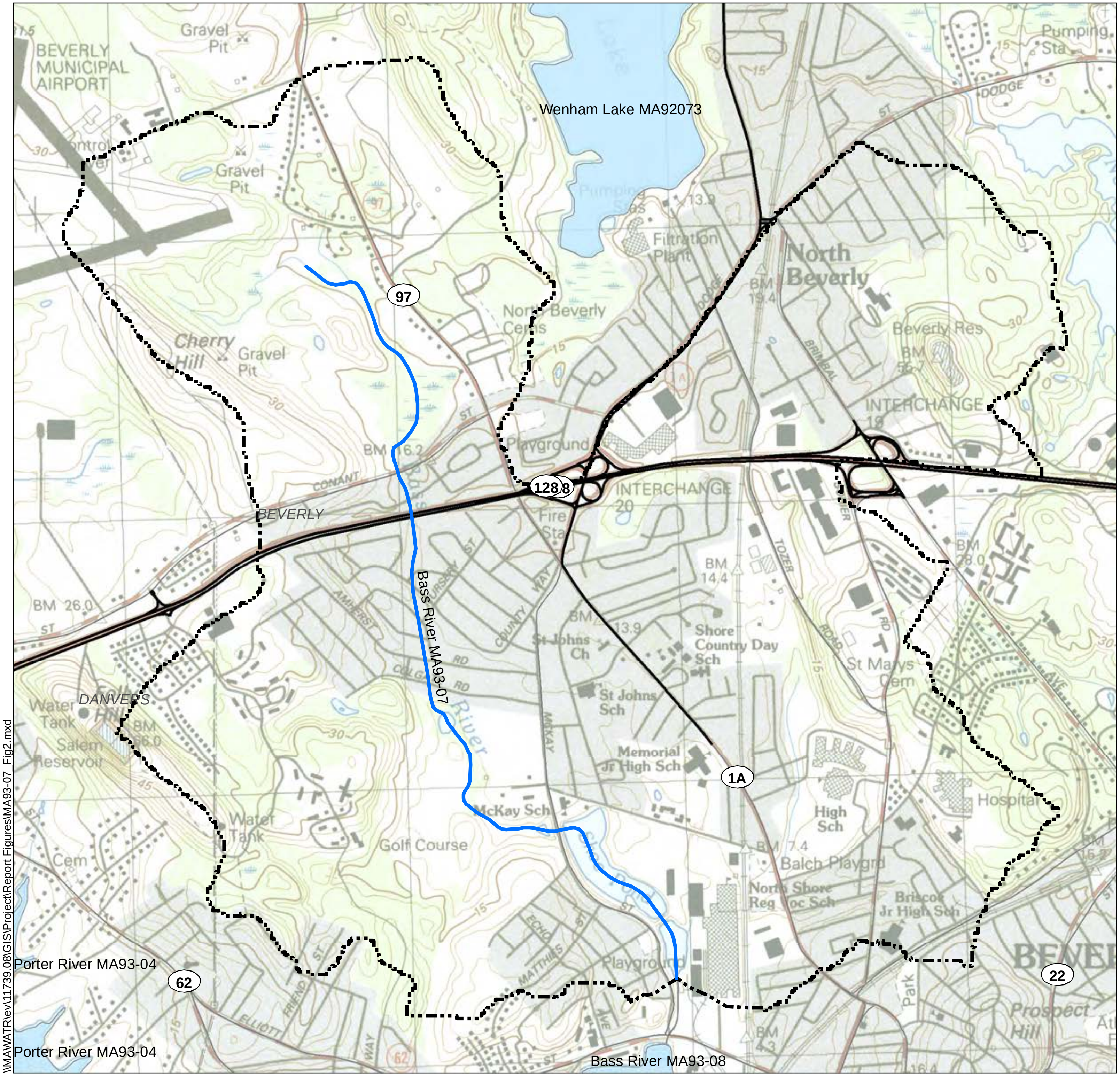

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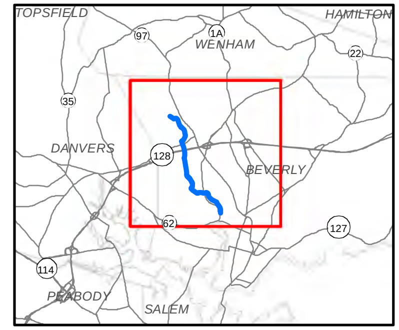


Assessed Segment

Watershed

MassDOT Roadways

Impaired Streams

Impaired Lakes

N

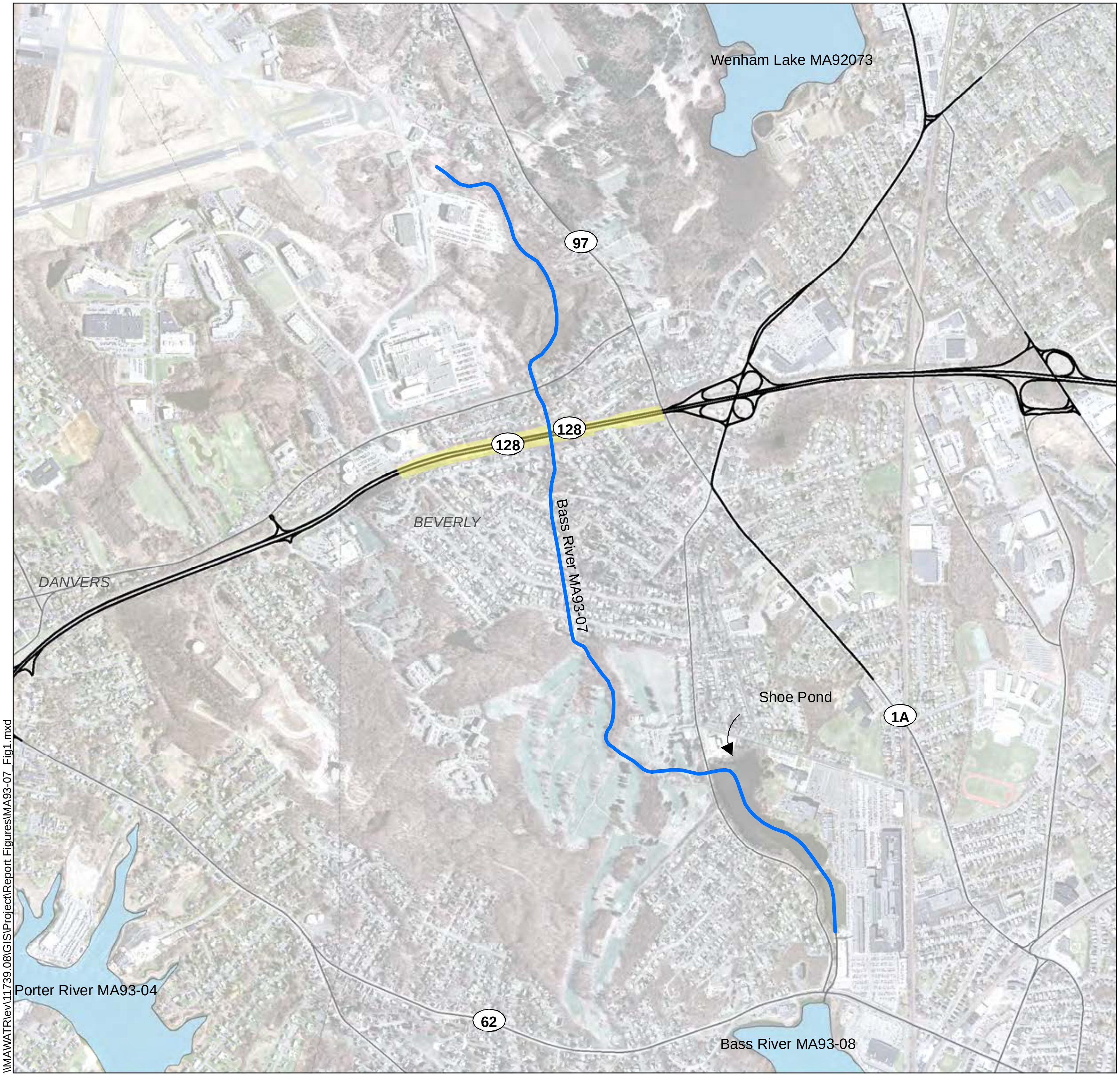
0 0.25 0.5 Miles

Figure 1

Bass River (MA93-07) Watershed

June 2013

massDOT Massachusetts Department of Transportation Highway Division



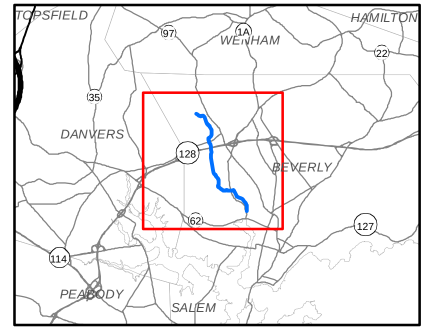


Figure 2

Bass River (MA93-07) Directly Contributing MassDOT Watershed

June 2013

massDOT Massachusetts Department of Transportation Highway Division

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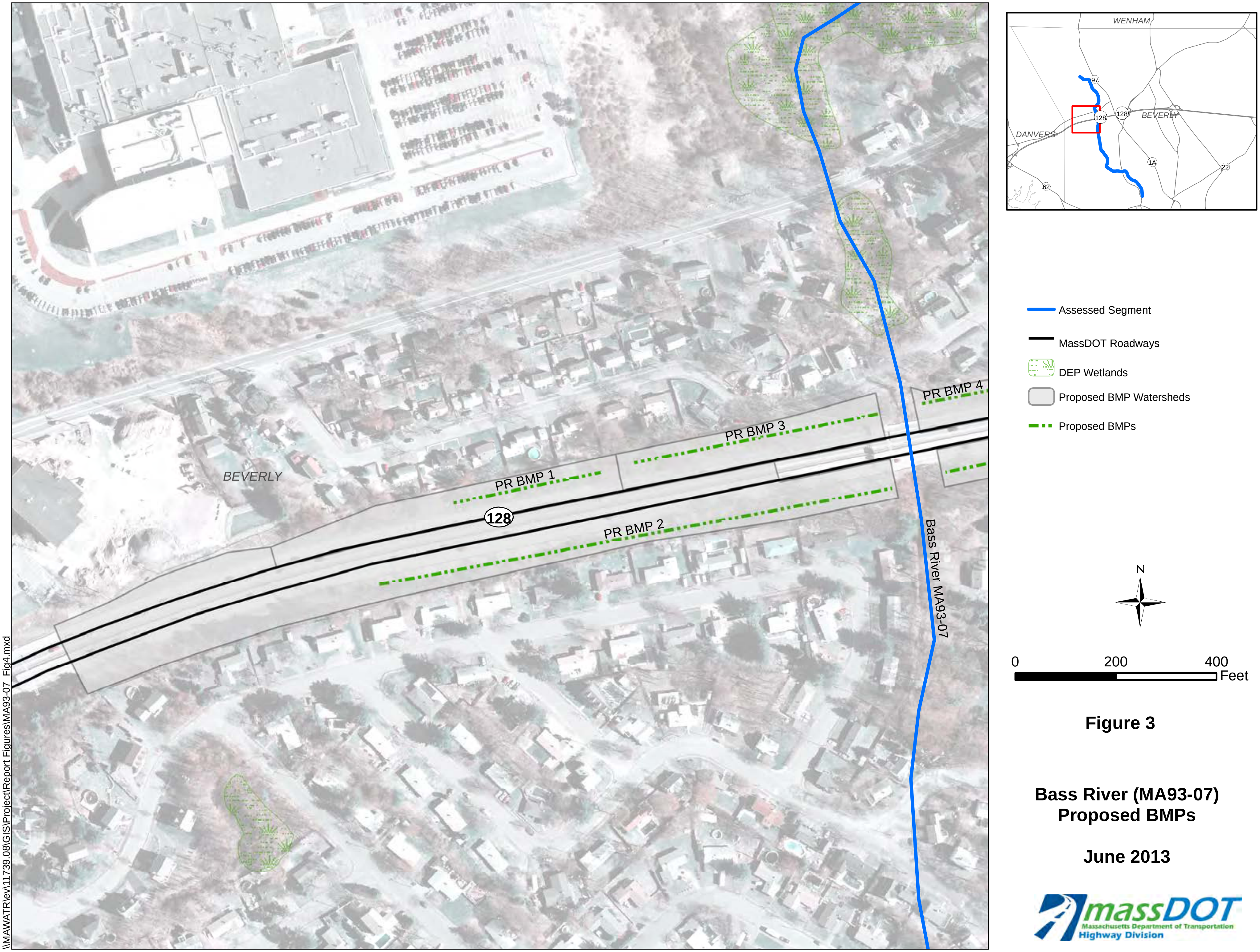

Assessed Segment

MassDOT Roadways

DEP Wetlands

Proposed BMP Watersheds

Proposed BMPs

N

0 200 400 Feet

Figure 3

Bass River (MA93-07) Proposed BMPs

June 2013

massDOT Massachusetts Department of Transportation Highway Division

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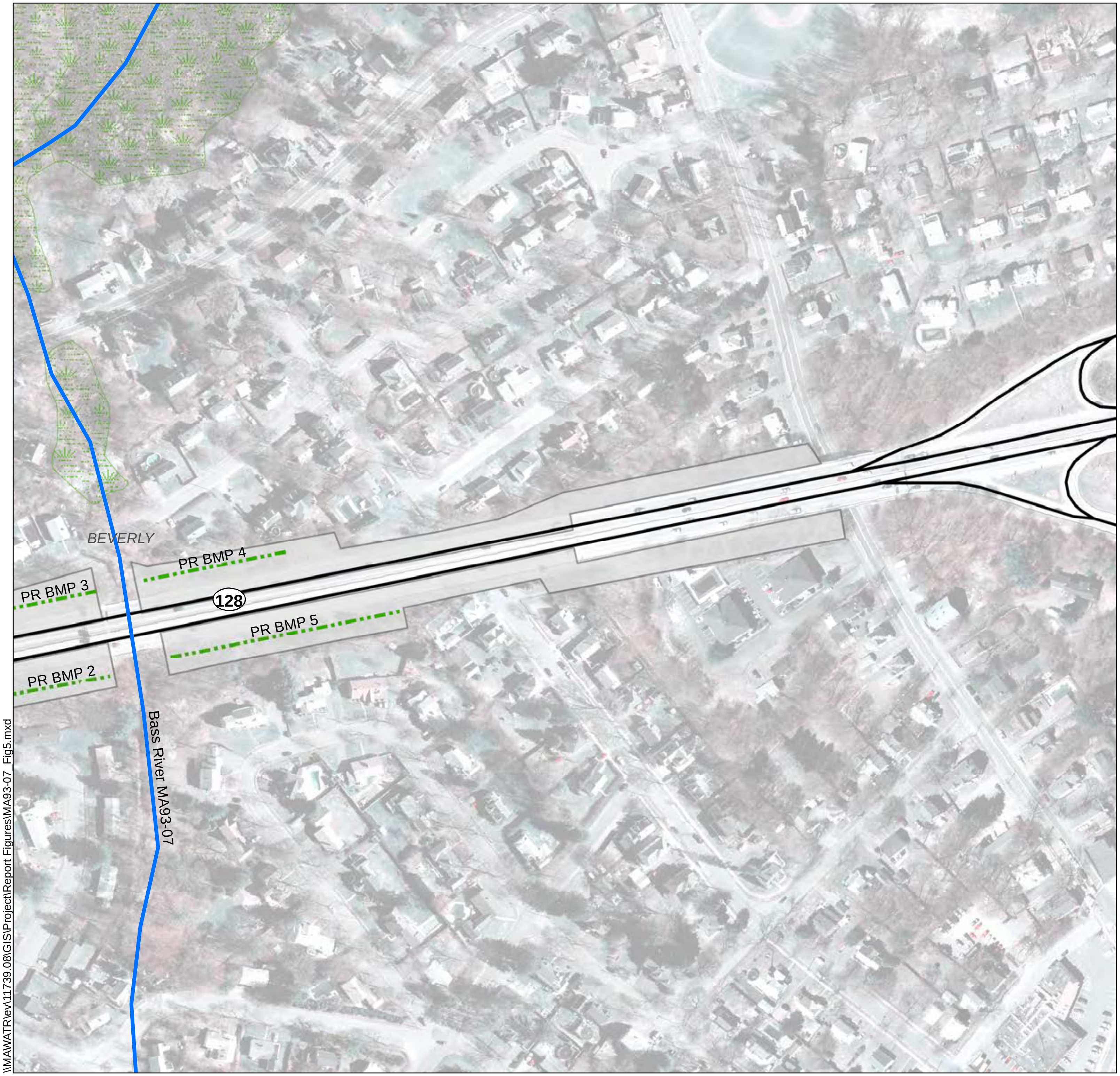

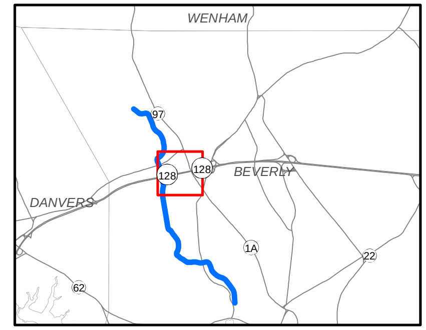

Assessed Segment
MassDOT Roadways
DEP Wetlands
Proposed BMP Watersheds
Proposed BMPs

N

0 200 400 Feet

Figure 4

Bass River (MA93-07)
Proposed BMPs

June 2013

massDOT
Massachusetts Department of Transportation
Highway Division

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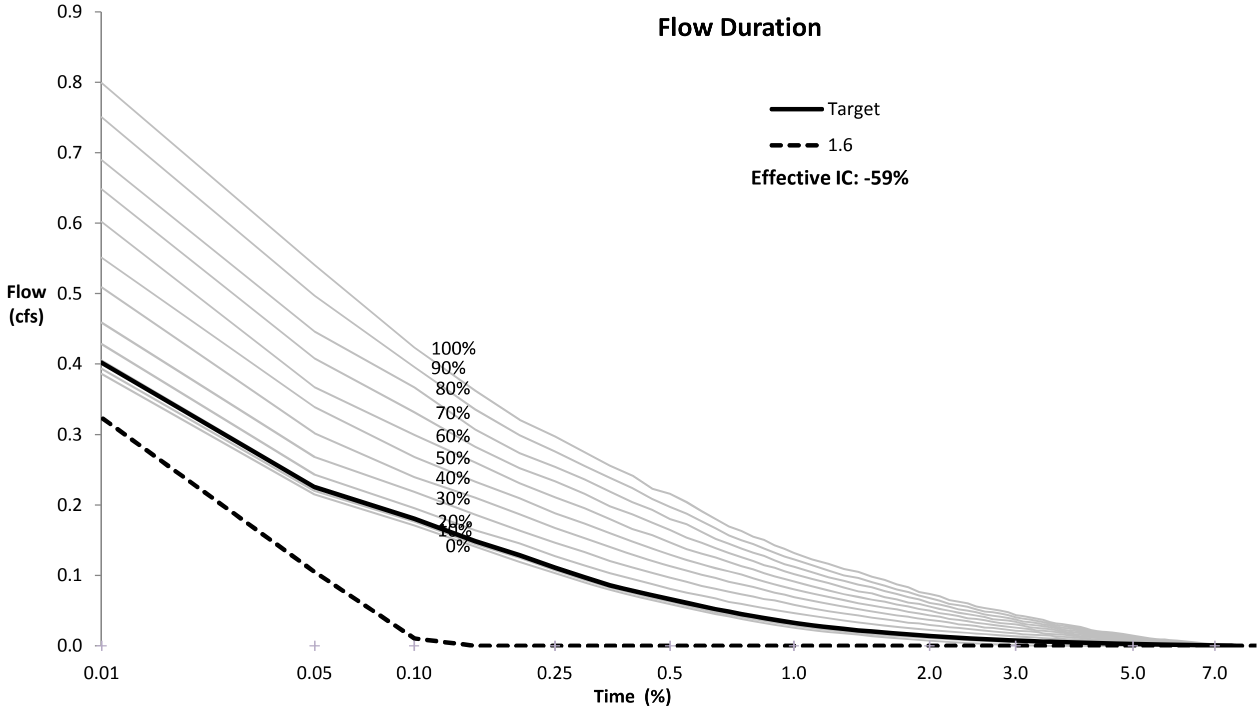
MA93-07 Assessment Model Result Summary for Impervious Cover
1.6 PR BMP 1



Median Annual Load Comparison Table

Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	0.8	0.1	4
5%IC	0.9	0.1	19
10% IC	1.1	0.1	41
20% IC	1.4	0.3	113
30% IC	1.6	0.5	231
40% IC	1.9	0.8	390
50% IC	2.2	1.1	584
60% IC	2.5	1.5	796
70% IC	2.7	1.9	1,010
80% IC	3.0	2.3	1,224
90% IC	3.3	2.6	1,432
100% IC	3.5	3.0	1,644
Watershed Load	1.46	0.70	358
BMP Output	0.07	0.01	1
Target	1.05	0.12	35
Reduction %	**95%**	**99%**	**100%**
Effective IC	**-25%**	**-8%**	**-1%**

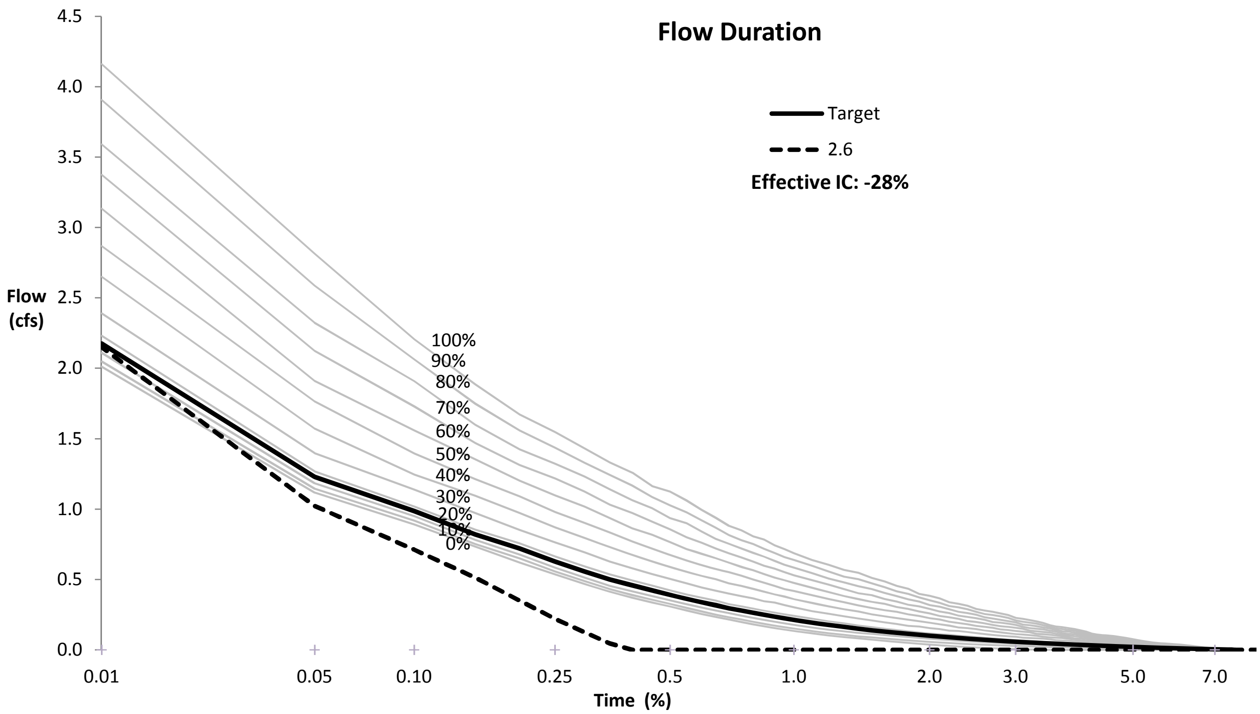
Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		1.1
Watershed IC (no BMP)	32%	0.4
Target IC reduction	73%	0.3
Effective IC w/BMP	-29%	(0.3)
IC Reduction	190%	0.7

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-07 Assessment Model Result Summary for Impervious Cover

2.6 PR BMP 2



Median Annual Load Comparison Table

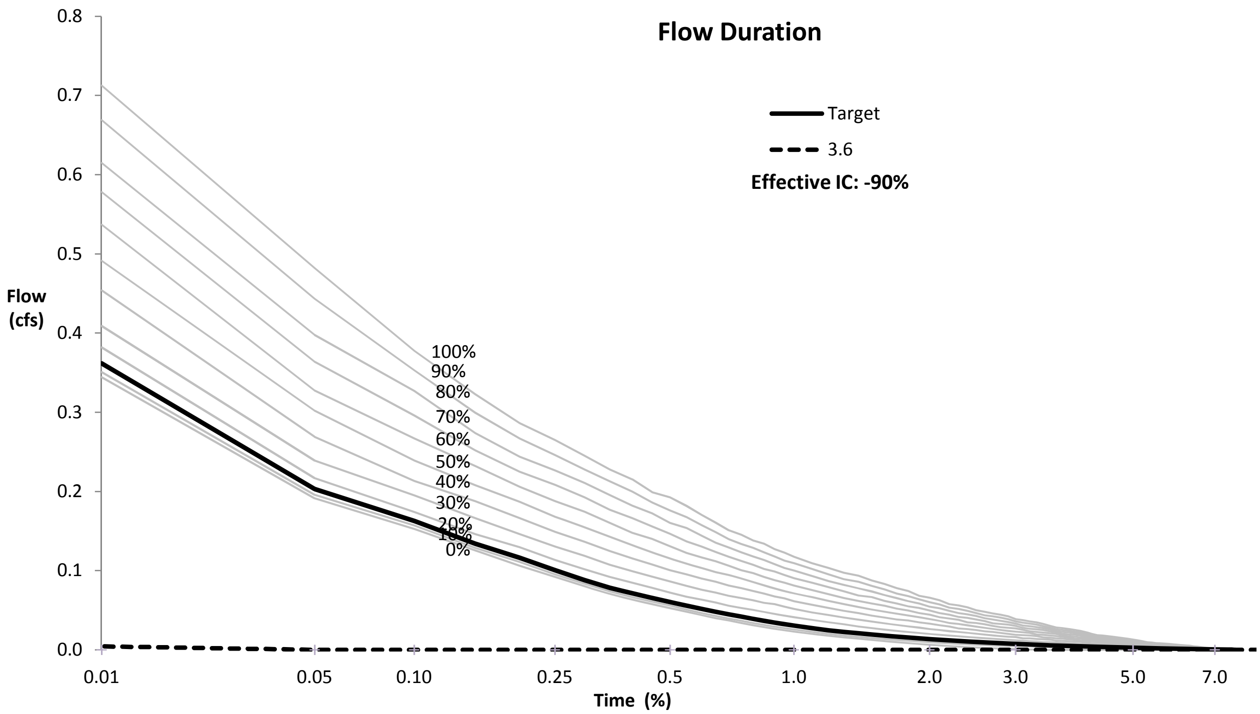
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	4.2	0.3	20
5%IC	4.9	0.5	101
10% IC	5.7	0.7	213
20% IC	7.1	1.5	589
30% IC	8.6	2.6	1,202
40% IC	10.0	4.1	2,029
50% IC	11.4	5.9	3,039
60% IC	12.8	7.8	4,144
70% IC	14.2	9.8	5,260
80% IC	15.6	11.7	6,372
90% IC	17.0	13.6	7,457
100% IC	18.4	15.6	8,560
Watershed Load	11.70	8.31	4,497
BMP Output	1.46	0.17	38
Target	6.48	1.12	420
Reduction %	**88%**	**98%**	**99%**
Effective IC	**-18%**	**-4%**	**1%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		5.8
Watershed IC (no BMP)	57%	3.3
Target IC reduction	73%	2.4
Effective IC w/BMP	-15%	(0.9)
IC Reduction	126%	4.2

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-07 Assessment Model Result Summary for Impervious Cover
3.6 PR BMP 3



Median Annual Load Comparison Table

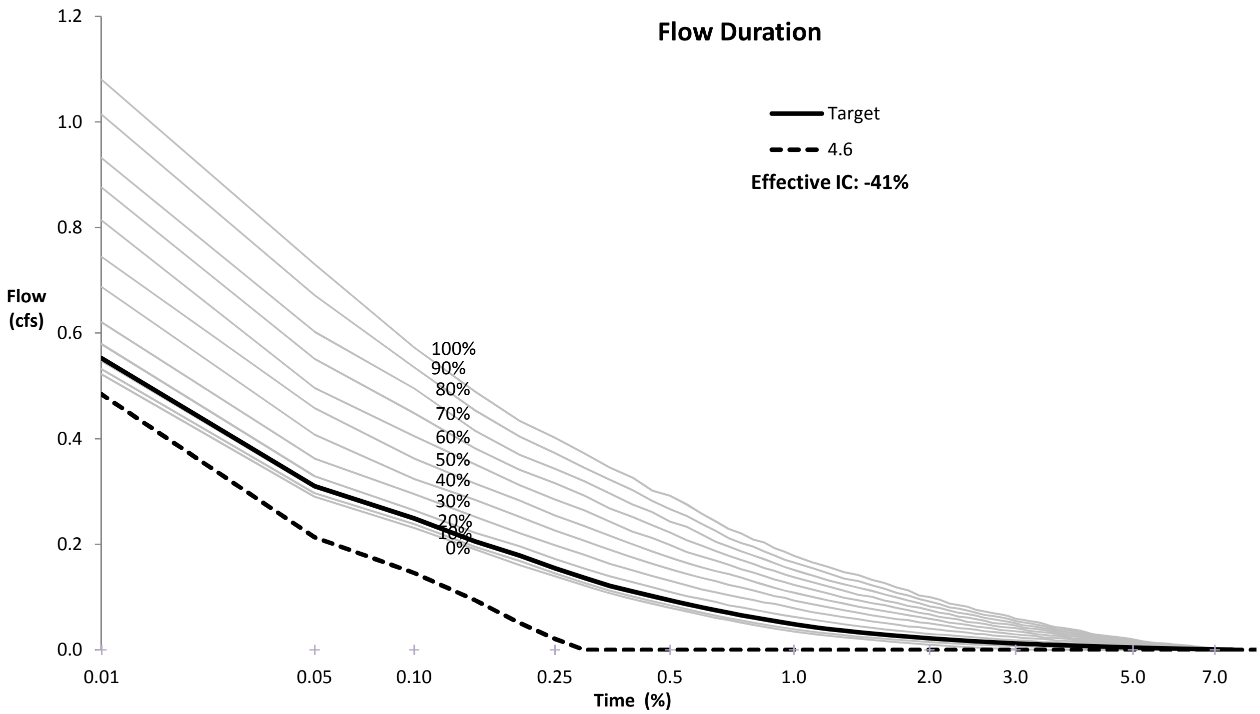
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	0.7	0.1	3
5%IC	0.8	0.1	17
10% IC	1.0	0.1	37
20% IC	1.2	0.2	101
30% IC	1.5	0.4	206
40% IC	1.7	0.7	347
50% IC	2.0	1.0	521
60% IC	2.2	1.3	710
70% IC	2.4	1.7	901
80% IC	2.7	2.0	1,091
90% IC	2.9	2.3	1,277
100% IC	3.2	2.7	1,466
Watershed Load	1.33	0.90	484
BMP Output	-	-	-
Target	0.98	0.12	38
Reduction %	**100%**	**100%**	**100%**
Effective IC	**-28%**	**-8%**	**-1%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		1.0
Watershed IC (no BMP)	38%	0.4
Target IC reduction	73%	0.3
Effective IC w/BMP	-40%	(0.4)
IC Reduction	206%	0.8

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-07 Assessment Model Result Summary for Impervious Cover
4.6 PR BMP 4



Median Annual Load Comparison Table

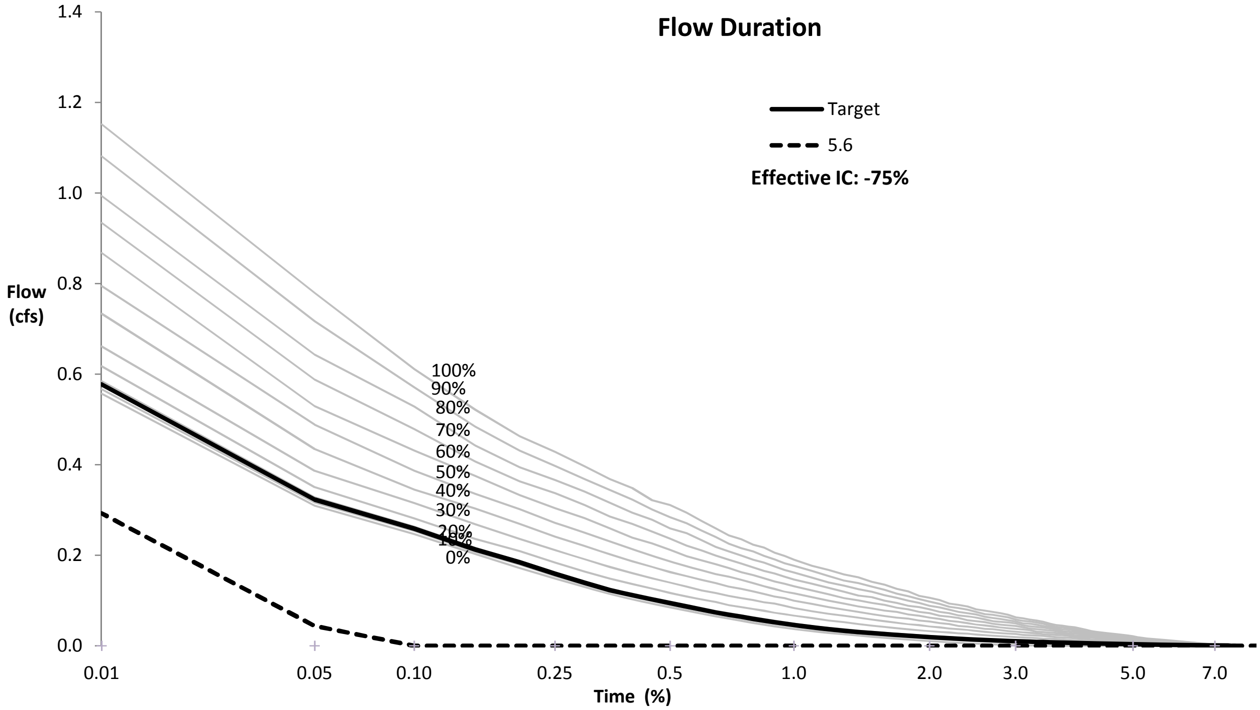
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	1.1	0.1	5
5%IC	1.3	0.1	26
10% IC	1.5	0.2	55
20% IC	1.9	0.4	153
30% IC	2.2	0.7	312
40% IC	2.6	1.1	526
50% IC	3.0	1.5	789
60% IC	3.3	2.0	1,075
70% IC	3.7	2.5	1,365
80% IC	4.0	3.0	1,654
90% IC	4.4	3.5	1,935
100% IC	4.8	4.0	2,222
Watershed Load	2.22	1.48	797
BMP Output	0.27	0.03	8
Target	1.53	0.21	69
Reduction %	**88%**	**98%**	**99%**
Effective IC	**-21%**	**-5%**	**1%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		1.5
Watershed IC (no BMP)	42%	0.6
Target IC reduction	73%	0.5
Effective IC w/BMP	-20%	(0.3)
IC Reduction	148%	0.9

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-07 Assessment Model Result Summary for Impervious Cover
5.6 PR BMP 5



Median Annual Load Comparison Table

Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	1.2	0.1	6
5%IC	1.4	0.1	28
10% IC	1.6	0.2	59
20% IC	2.0	0.4	163
30% IC	2.4	0.7	333
40% IC	2.8	1.1	562
50% IC	3.2	1.6	841
60% IC	3.5	2.2	1,147
70% IC	3.9	2.7	1,456
80% IC	4.3	3.2	1,764
90% IC	4.7	3.8	2,064
100% IC	5.1	4.3	2,370
Watershed Load	1.75	1.20	646
BMP Output	0.03	0.00	0
Target	1.49	0.17	46
Reduction %	**98%**	**100%**	**100%**
Effective IC	**-27%**	**-8%**	**-1%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		1.6
Watershed IC (no BMP)	29%	0.5
Target IC reduction	73%	0.3
Effective IC w/BMP	-34%	(0.6)
IC Reduction	217%	1.0

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
    a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
    b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

Impaired Waters Assessment for Forest River (MA93-10)

Impaired Water Body

Name: Forest River

Location: Salem, MA

Water Body ID: MA93-10

Impairments

Forest River (MA93-10) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2010 Integrated List of Waters* (MassDEP, 2011). Forest River is impaired for the following:

- dissolved oxygen saturation

According to MassDEP's *North Shore Coastal Watersheds 2002 Water Quality Assessment Report* (MassDEP, 2007), Forest River is impaired due to organic enrichment/low dissolved oxygen and pathogens as well as flow alteration and other habitat alteration. The report recommends operating the existing tidal gates at the mouth of Forest River (at the Route 114 crossing of the River) in a manner that maximizes tidal flushing in order to benefit the overall ecology of the Forest River. The report also recommends conducting biological, habitat, and water quality monitoring, and conducting bacteria sampling.

Relevant Water Quality Standards

Water Body Classification: Class SA

314 CMR 4.05 (4) (a) 1 Dissolved Oxygen. Shall not be less than 6.0 mg/l. Where natural background conditions are lower, DO shall not be less than natural background. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.

Site Description

Forest River is a 16.6 acre water body located in Salem, MA. Forest River (MA93-10) and Salem Harbor (MA93-21) are separated by tide gates at the MassDOT Route 114 Bridge. During a site visit on April 25, 2013, it was determined that drainage outfalls on the Route 114 bridge are directly discharging to Salem Harbor. Therefore, this bridge was not considered in this analysis. Land use surrounding Forest River is undeveloped upland and wetland area surrounded by primarily residential development. The Salem State University (South Campus) is located on Harrison Road, immediately west of the Route 1A crossing of the Forest River.

The watershed of MassDOT's property directly contributing stormwater is comprised of approximately 0.7 miles of Loring Avenue (Route 1A) (Figure 3). Stormwater is collected through a series of catch basins and is conveyed through a closed drainage system to outfalls that directly discharge to Forest River. An existing outfall is shown in Photo 1. Route 1A north of the MassDOT directly contributing watershed was determined to be an indirect discharge to Forest River. Stormwater from this section first flows through wetlands, allowing infiltration and resulting treatment.

Photo 1: Stormwater Outfall Discharging to Forest River

Assessment under BMP 7U

The impairments for Forest River have not been addressed by a TMDL. Therefore, MassDOT assessed the impairments using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of stormwater on many impairments. For this water body, MassDOT used the IC method to assess the following impairments:

- dissolved oxygen saturation

.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction required to ensure that stormwater is not the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. IC data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer. In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for Forest River (MA93-10):

Table 1. Site Parameters for Forest River (MA93-10)

Total Watershed		
Watershed Area	1,380	acres
Impervious Cover (IC) Area	397	acres
Percent Impervious	28.8	%
IC Area at 9% Goal	124	acres
Target Reduction % in IC	68.7	%
Subwatershed		
Watershed Area	308	acres
Impervious Cover (IC) Area	94	acres
Percent Impervious	30.5	%
IC Area at 9% Goal	28	acres
Target Reduction % in IC	70.5	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area Directly Contributing to Impaired Segment	4.9	acres
MassDOT's Target Reduction in Effective IC (70.5% of DOT Directly Contributing IC)	3.5	acres

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 70.5%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 3.5 acres.

Existing BMPs

There are no existing BMPs in the Forest River directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to Forest River.

Mitigation Plan

No mitigation of impervious surface is achieved by existing BMPs. Therefore, MassDOT considered the implementation of additional BMPs to reach the target reduction of 3.5 acres.

During a site visit on April 25, 2013, two proposed BMP locations were identified. The BMPs proposed below were determined to be feasible based on several constraints considered. National Heritage and Endangered Species (NHESP) Priority Habitats and Estimated Habitats of Rare Species are not present in the Forest River subwatershed. In addition, there are no Department of Environmental Protection (DEP) Zone II Wellhead Protection Areas or Interim Wellhead Protection Areas (IWPA) at the proposed locations (Figure 2).

The location for the potential BMPs were identified along MassDOT's Route 1A right-of-way and are proposed to be in series, as shown in Figure 4. Review of the Natural Resources Conservations Service Web Soil Survey identified these areas to have a Hydraulic Soil Group of B, ideal for infiltration. Based on the proposed conditions, the recommended BMPs achieve a total effective IC reduction of 0.8 acres.

Pr-BMP-1

At this location, the roadway cross slope conveys stormwater from both lanes to an asphalt berm and catch basins on the southbound side of Route 1A. To the west of the asphalt berm, there is an existing grassy area that does not currently receive runoff from the MassDOT roadway. MassDOT will consider constructing a vegetated filter strip at this location by removing the existing asphalt berm and abandoning one catch basin to allow sheet flow from the roadway into the proposed BMP, a vegetated filter strip. Existing drainage, sewer, and gas utilities identified from a 2012 survey plan were considered when determining the type of BMP feasible and location. The vegetated filter strip will have a minimum width of 25 feet and run parallel to Route 1A for approximately 250 feet. Vegetated checkdams will be placed at intervals within the filter strip. Pr-BMP-1 will achieve 56% effective IC reduction.

Location for Pr-BMP-1, Vegetated Filter Strip

Pr-BMP-2

Like Pr-BMP-1, this area is located adjacent to 1A on the westerly side. Stormwater currently flows along the existing bituminous berm and into an existing catch basin. This catch basin then flows directly into Forest River. MassDOT will consider constructing an infiltration swale at this location by removing the existing asphalt berm and abandoning one catch basin to allow sheet flow from the roadway to flow into the proposed BMP. Vegetated checkdams will be placed at intervals within the swale. In an effort to collect, and treat, more impervious area, the closed drainage system that runs under the existing grassy area will be broken before connecting to one of the proposed abandoned catch basins. At this location, a new drainage manhole and outlet pipe will discharge into the infiltration swale. The stormwater will then flow southerly toward a proposed outlet structure. This structure will then be connected to an existing nearby catch basin that ultimately discharges to Forest River. Pr-BMP-1 will be graded to allow stormwater to flow into this BMP. As with Pr-BMP-1, existing utilities identified in a 2012 survey were considered while selecting a BMP for this location. A trapezoidal swale with a bottom width ranging of 10-20 feet, top width 22- 32 feet, and a rise of 2 feet will achieve a 92% effective IC removal.

Location for Pr-BMP-2, Infiltration Swale

Conclusions

MassDOT used the IC Method to assess Forest River for the impairments identified in MassDEP's final *Massachusetts Year 2010 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed by 3.5 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Forest River to identify existing BMPs and found that no BMPs exist. In addition, proposed BMP locations were evaluated to determine the feasibility at this location. Two BMPs were proposed at this location and are summarized in Table 2 below.

Table 2. Summary of Proposed Conditions

BMP Name	BMP Type	Effective IC Percent Reduction	Effective IC Reduction (acres)	Notes for Consideration during design**
Pr-BMP-1*	Vegetated Filter Strip	56%	0.22	Convert existing grassy area
Pr-BMP-2*	Infiltration Swale	92%	0.59	Convert existing grassy area
Total			**0.81**	

*Denotes a BMP in series.

**See section titled Mitigation Plan for more details and notes.

MassDOT should reduce its effective IC within the directly contributing watershed by an additional 2.6 acres to achieve the targeted reduction in IC. This information is summarized in Table 3 below.

Table 3. Effective IC Reductions under Existing and Proposed Conditions

IC in Directly Contributing Watershed	4.9	acres
Target Reduction in Effective IC	3.5	acres
Effective IC Reduced by Existing BMPs	0.0	acres
Effective IC Reduced by Proposed BMPs	0.8	acres
IC Target Remaining	**2.6**	**acres**

As described above, the BMPs proposed in this assessment were determined to be feasible within the current right-of-way and road drainage constraints. Additional reductions in effective impervious cover were determined to not be practicable due to site constraints including limited available land and wetland constraints at existing outfalls. During design, the consultants will review with MassDOT the proposed conditions presented in this assessment and also any additional drainage modifications that could be made to the existing stormwater infrastructure.

MassDOT will now work with its design consultants to develop design plans for the proposed BMPs as part of MassDOT’s Impaired Waters Retrofit Initiative. The design consultants will develop construction plans for BMPs that will aim to provide treatment to the maximum extent practicable.

As an overall program, MassDOT will identify opportunities for structural BMPs to address pollutant loading when road work is conducted as programmed projects for this area. Work on programmed projects which often include broader scale road layout changes may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding the design progress made towards meeting the IC reduction, plans for construction of the BMPs and finalized assessments. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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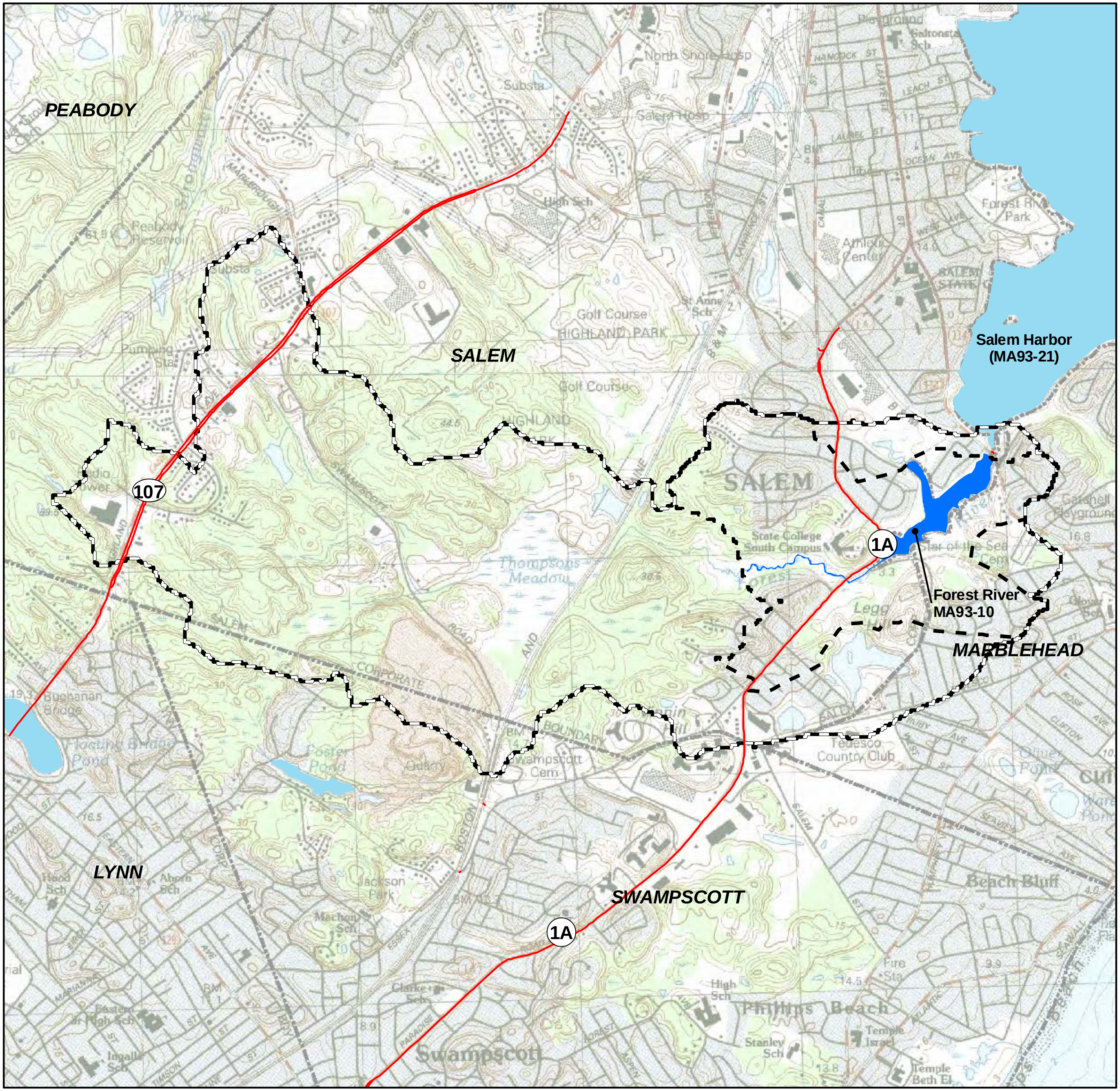
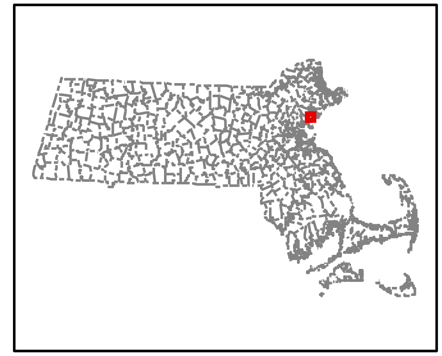




MassDOT Urban Area Roads
Forest River Subwatershed
Forest River Total Watershed
Impaired Water Bodies
Forest River
Town Boundaries

0 1,000 2,000 4,000
Feet

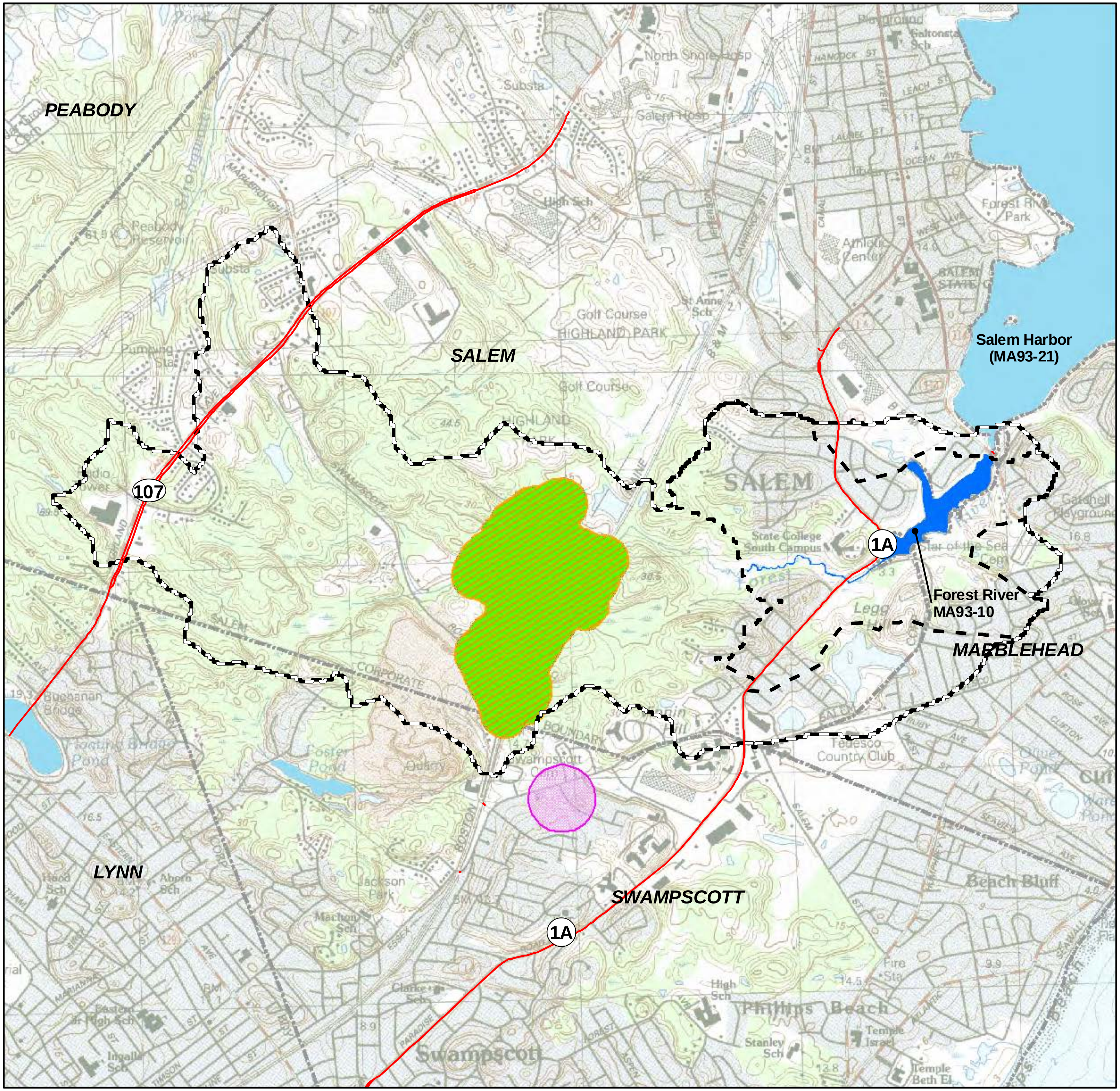
Figure 1

Forest River (MA93-10) Total and Sub Watershed

May 2013

Source: MassGIS, USGS 2009

massDOT Massachusetts Department of Transportation Highway Division



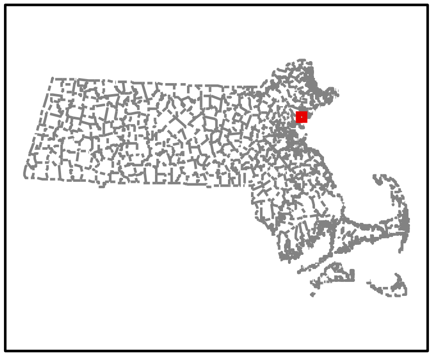


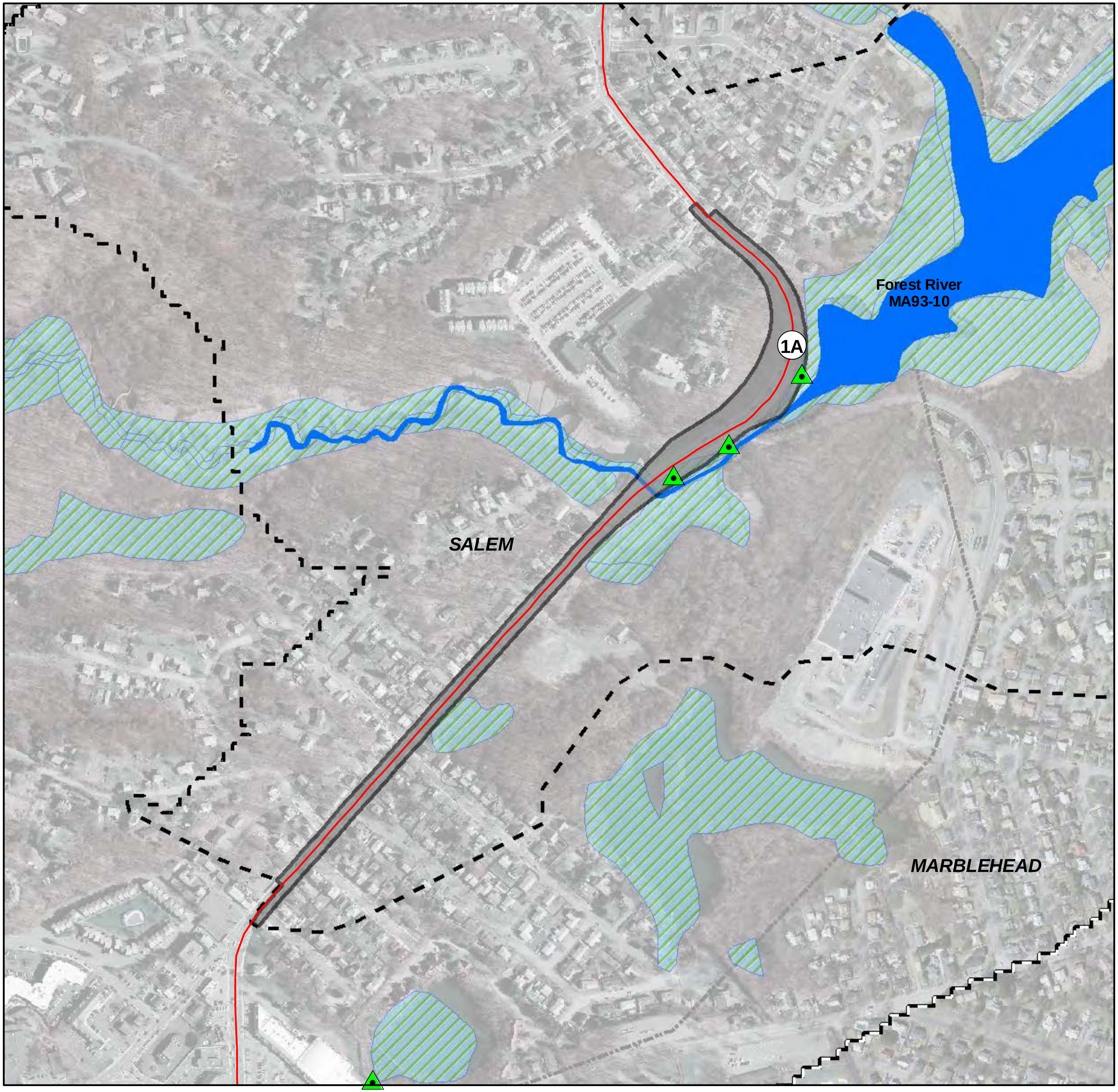
Figure 2

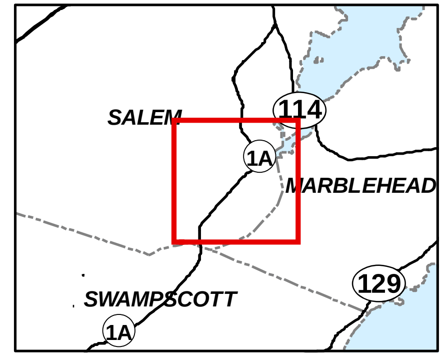
Forest River (MA93-10)
NHESP Rare Species
DEP Regulated Critical
Areas

May 2013

Source: MassGIS, USGS 2009

massDOT
Massachusetts Department of Transportation
Highway Division





MassDOT Stormwater Outfalls
MassDOT Urban Area Roads
MassDOT Directly Contributing Watersheds
Forest River Subwatershed
Forest River Total Watershed
Impaired Water Bodies
Forest River
NWI Wetland Areas
Town Boundaries

N

0 250 500 1,000
Feet

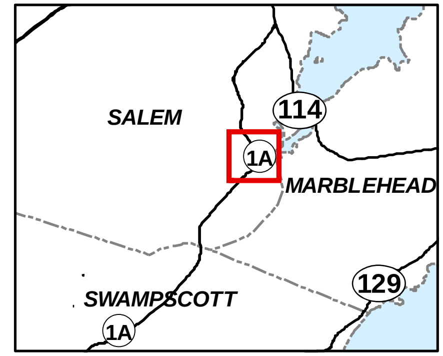
Figure 3

Forest River (MA93-10) Directly Contributing MassDOT Watershed

May 2013

Source: MassGIS, USGS 2009

massDOT Massachusetts Department of Transportation Highway Division



- Direction of Drainage
- Proposed BMP - Filter Strip
- Proposed BMP - Infiltration Swale
- MassDOT Stormwater Outfalls
- MassDOT Urban Area Roads
- Impaired Water Bodies
- Forest River
- NWI Wetland Areas
- Town Boundaries

N

0 100 200 400

Feet

Figure 4

Forest River (MA93-10)
Proposed BMPs

May 2013

Source: MassGIS, USGS 2009

massDOT Massachusetts Department of Transportation Highway Division

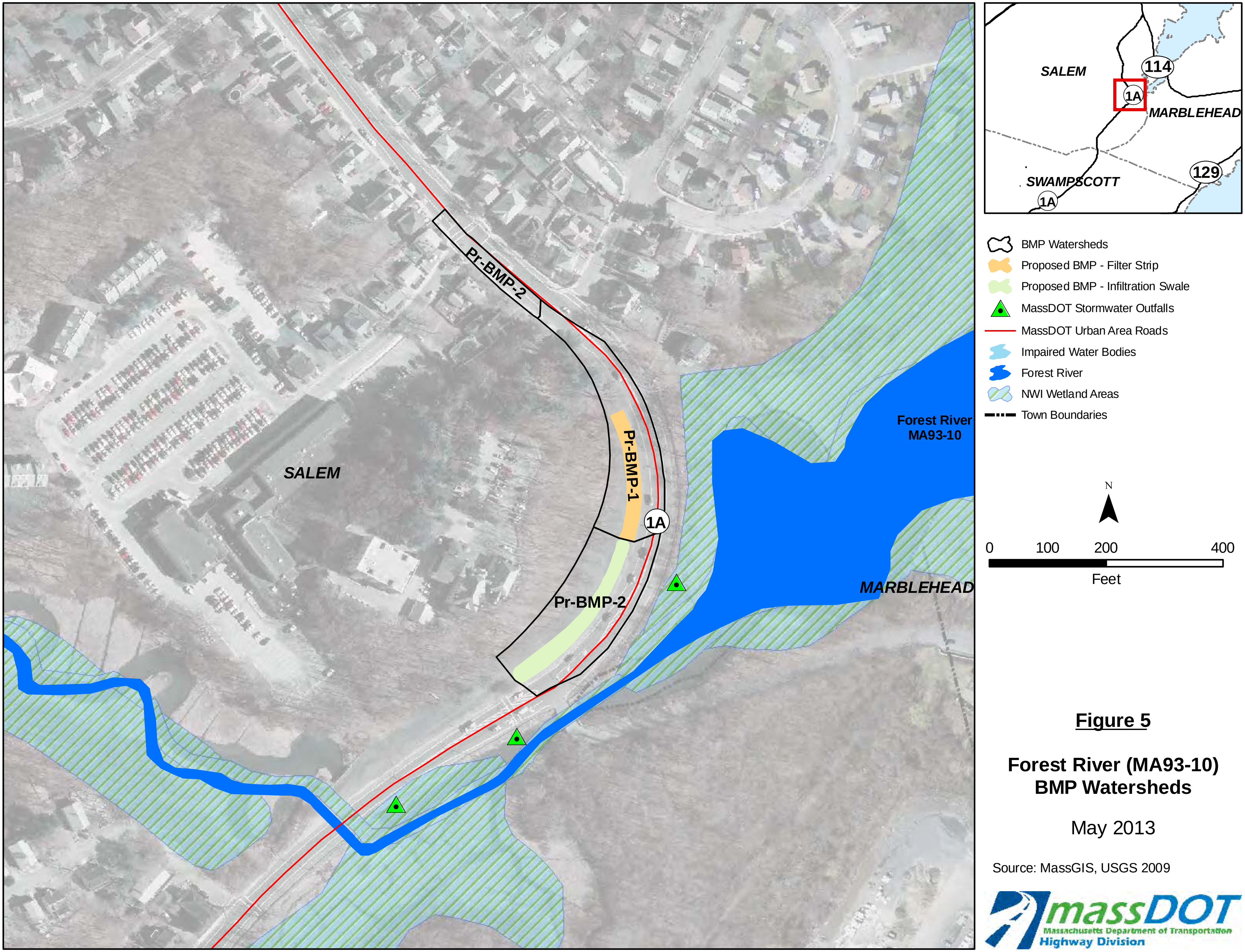


Figure 5

Forest River (MA93-10)
BMP Watersheds

May 2013

Source: MassGIS, USGS 2009

massDOT Massachusetts Department of Transportation Highway Division

Impaired Waters Assessment for Beaver Brook (MA93-37)

Impaired Waterbody

Name: Beaver Brook

Location: Danvers, Massachusetts

Water Body ID: MA93-37

Impairments

According to the MassDEP Final Year 2012 Integrated List of Waters, this segment is listed under Category 5 as impaired for dissolved oxygen.

The *North Shore Coastal Watersheds 2002 Water Quality Assessment Report* lists organic enrichment/low DO and pathogens as impairments to this segment, but does not list any causes for the impairments. The report states that Beaver Brook has a small drainage area and experienced extremely low flow conditions during the water quality testing event. The river's flow through a large impounded area known as "the Meadow" is suggested as a potential natural cause for the low dissolved oxygen saturation.

Relevant Water Quality Standards

- Water Body Classification: B
- 301 CMR § 4.05 (3)(b) – *Class B. These waters are designed as habitat for fish, other aquatic life, and wildlife, including for their reproduction, migration, growth, and other critical functions, and for primary and secondary contact recreation. Where designated in 314 CMR 4.06, they shall be suitable as a source of public water supply with appropriate treatment ("Treated Water Supply"). Class B waters shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value.*
- 314 CMR § 4.05 (3)(b)(1) – *Dissolved Oxygen. a. Shall not be less than 6.0 mg/l in cold water fisheries and not less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.*

Summary

MassDOT has assessed stormwater impacts from MassDOT properties discharging to the Beaver Brook using BMP 7U to address impairments not covered by a TMDL. The following sections describe the methodology for this assessment. Based on this assessment, MassDOT determined that a 37-acre reduction in effective impervious cover (IC) would be needed to meet the targets for this watershed.

MassDOT has concluded that no existing stormwater best management practices (BMPs) are in place to provide effective IC reduction. To reduce MassDOT's contribution to impairments within the Beaver Brook watershed, MassDOT proposes 27 BMPs. The proposed BMPs consist of 3 infiltration basins, 12 leaching basins and 12 water quality swales. These BMPs will provide approximately 22.1 acres of effective IC reduction.

See the **Proposed Mitigation Plan** section of this assessment for more information.

Reductions Applied to MassDOT Direct Watershed

	Effective IC (Acres)
MassDOT's Area Directly Contributing to Impaired Segment	57.1
Target Reduction	40.0
Reduction Provided in Proposed Conditions	22.1

Site Description

The Beaver Brook segment MA93-37 is located in Danvers, Massachusetts an urban, residential town. Beaver Brook is within the Crane River subwatershed. Beaver Brook's head waters are located west of Route 95 in Danvers, and the river runs 2.7 miles southeast to its inlet at Mill Pond in Danvers (Figure 1). Beaver Brook is impaired due to dissolved oxygen. Land use in the watershed to Beaver Brook includes, residential, forest, open land, and commercial.

MassDOT-owned properties that directly discharge to Segment MA93-37 include portions of Interstate 95 (I-95), Route 1, Route 62 and Center Street in Danvers as shown in Figure 2. Stormwater from I-95 northbound is discharged to the pervious area adjacent to I-95 northbound. Stormwater that is collected from I-95 southbound is routed to a closed drainage system that outlets directly to Beaver Brook.

Stormwater from Route 1 is collected in catch basins in the left and right shoulders in both directions. Stormwater from a portion of Route 1 is collected in catch basins in the left and right shoulder which carry the stormwater into a mainline in the median of Route 1 and stormwater from the remaining portion of Route 1 is collected in catch basins in the shoulders which outlet along Beaver Brook.

Stormwater on parts of Center Street enters the drainage system of the I-95 and Route 1 interchange through catch basins, this stormwater is discharged to the pervious area between Route 1 north and I-95 south. Stormwater from Route 62 and the interchange between Route 1 and Route 62 enters a main drainage line in the median of Route 62 which is discharged into a wetland adjacent to I-95 south. Water from the wetland flows through a culverted stream under I-95 and then flows openly into Beaver Brook at its crossing with Route 62.

Soils in the area of Route 1 consist of mostly hydrologic soil group (HSG) C soils, and soils in the area of I-95 consist of mostly HSG B soils. There were a few rock outcrops found in the area and there are several wetland areas adjacent to I-95. No existing BMPs were identified to treat stormwater from MassDOT properties before reaching Beaver Brook.

Assessment for Dissolved Oxygen under BMP 7U

MassDOT assessed the stormwater-related impairments not addressed by a TMDL using the approach described in BMP 7U of MassDOT's Stormwater Management Plan (Water Quality Impaired Waters Assessment and Mitigation Plan), which applies to impairments that have not been addressed by a TMDL.

For the stormwater-related impairments for this water body not covered by a TMDL, MassDOT used an application of EPA Region I's Impervious Cover (IC) Method described in EPA's Stormwater TMDL Implementation Support Manual (ENSR, 2006). MassDOT used this method to assess potential stormwater impacts on the impaired water and develop the target IC to ensure that stormwater is not the cause of the impairments. The IC Method relates an aquatic system's health (i.e., state of impairment) to the percentage of IC in its contributing watershed. This method is largely based on the work of the Center for Watershed Protection, which has compiled and evaluated extensive data relating watershed IC to the hydrologic, physical, water quality, and biological conditions of aquatic systems (Schueler, 2003). Water quality in tributary streams, rivers, lakes and ponds is a direct reflection of loading from the watershed (Wetzel, 2001); therefore, the IC method can be used as a surrogate for pollutant loading when evaluating water quality impairments and their causes. Consistent with the findings of EPA and others, MassDOT concluded that when a watershed had less than 9% IC, stormwater was not the likely cause of the impairment.

MassDOT developed the target IC reduction using the approach outlined in *Description of MassDOT's Application of Impervious Cover Method in BMP 7U* (MassDOT, 2011). Since the development of the MassDOT Application of IC Method, MassDOT has further refined its approach to evaluate MassDOT's effective IC and BMP performance. For the Beaver Brook, MassDOT used the long-term continuous simulation model (the assessment model) to estimate phosphorus loading and to estimate effective IC.

MassDOT estimated the effective IC of its contributing drainage area with existing and proposed stormwater BMPs by comparing the runoff and pollutant response of its drainage area to the response of simulated watersheds with equivalent area, but varying IC from 0 to 100% (simulated IC watersheds). The IC percentage of the watershed that produces a similar response to MassDOT's watershed was determined to be the effective IC of MassDOT's watershed. For a more detailed description of this approach, see the Long-Term Continuous Simulation for Pollutant Loading and Treatment for MassDOT Impaired Waters Program.

The MassDOT IC method for the impaired waters of the Beaver Brook includes the following steps:

1. Calculate the percent IC of the water body's entire contributing watershed (total watershed to downstream end of impaired segment) and that of the local watershed contributing directly to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body.
2. For subwatersheds with greater than 9% IC, calculate the amount of IC reduction needed to achieve 9%. For subwatersheds with less and 9% IC, perform no further analysis under BMP 7U.
3. Calculate percentage of IC in the MassDOT directly contributing drainage area.

4. Apply reduction of IC necessary for the subwatershed to achieve 9% to MassDOT contributing drainage area as a target to address the stormwater impairments. Calculate resulting target IC for MassDOT drainage area.
5. In the case where BMPs are in place or where BMPs are proposed, derive IC reduction rates for the BMPs using MassDOT's assessment model based on size, function, and contributing watersheds of the BMPs.

BMP 7U Assessment

Using the approach described above, MassDOT calculated the following values for the total contributing watershed and the subwatershed of the impaired water (Beaver Brook) to determine the IC target (see Figure 1). MassDOT has determined that the total watershed (total watershed upstream of the downstream end of the impaired segment) and the subwatershed (local watershed contributing directly to the impaired segment) for Beaver Brook were the same.

Watershed Impervious Cover

	Total Watershed
Watershed Area	1,473 acres
Impervious Cover (IC) Area	451 acres
Percent Impervious	31%
IC Area at 9% Goal	133 acres
Target Reduction % in IC	71 %

The watershed is greater than 9% impervious indicating that stormwater is a likely contributor to the impairment. To meet the 9% effective IC target, the effective IC within the watershed will need to be reduced by 71%. Therefore, the effective IC of MassDOT's directly contributing area should also be reduced by the same percentage to meet the target. The following table shows the resulting targets for MassDOT's contributing property.

Reductions Applied to MassDOT Direct Watershed

MassDOT's Area Directly Contributing to Impaired Segment	108 acres
MassDOT's IC Area Directly Contributing to Impaired Segment	57 acres
MassDOT's Percent Impervious	53 %
MassDOT's Target Reduction in Effective IC (71% of DOT Directly Contributing IC)	40 acres
Target Effective IC	16 %

MassDOT's directly contributing area includes 57 acres of IC (53 % of total contributing area). To meet the target reduction of effective IC, MassDOT should mitigate 40 acres of effective IC. Equivalently, MassDOT's contributing drainage area should act as a watershed of 16 % IC.

There are no existing BMPs to mitigate the effects of IC.

BMP 7U Mitigation Plan

Under existing conditions, MassDOT's estimated effective IC exceeds the target as described in the previous section. To mitigate the effects of IC, MassDOT reviewed potential stormwater BMPs to the maximum extent practical given site constraints.

This assessment has identified locations for 27 potential stormwater BMPs and estimated the effective IC accounting for their treatment. The Proposed Mitigation Plan section describes the BMPs and their IC reduction performance.

Proposed Mitigation Plan to Address Impervious Cover

In this assessment, MassDOT has identified 27 potential stormwater BMPs that may be implemented on MassDOT property to mitigate the effective IC to address the Beaver Brook impairments. These BMPs include water quality swales, leaching basins, and infiltration basins, shown with their estimated contributing drainage areas in Figures 3 and 4. These locations were chosen based on a cursory review of the drainage systems, topography, property lines, and other site constraints. Detailed survey, complete utility location information, official property ownership, and soils evaluation information will influence the final selection and design of BMPs. Below is a description of these potential proposed BMPs.

MassDOT has proposed a wide variety of BMPs to help mitigate impervious cover in the Beaver Brook watershed. Proposed infiltration basins could be constructed in pervious vegetated islands located within the intersections of the MassDOT roadways. The proposed water quality swales could be constructed from existing drainage ditches which consist of both paved waterways and pervious ditches. The proposed leaching basins could be used instead of the existing catch basins located in the roadway shoulders. Outlet structures for the proposed BMPs could use existing manholes, drop inlets and headwalls located in the assessed area.

PR BMP 1
Proposed BMP 1 is a water quality swale that could be constructed from an existing paved swale. Runoff from 2 lanes and the shoulder from I-95 south currently drain into the existing paved swale. The stormwater flows to a headwall at the end of the swale which discharges into a wetland adjacent to the on-ramp from Route 62 to I-95 south. The concrete from the paved swale could be removed and check dams could be added which could help promote infiltration. The length of the swale might be constricted due to a ledge outcrop north of the swale.

PR BMP 2
Proposed BMP 2 is a water quality swale that could be constructed from an existing drainage ditch adjacent to I-95 northbound. Currently, stormwater enters catch basins that line the left and right shoulders of I-95 north and outlet in the existing drainage ditch. Stormwater that enters the existing drainage ditch flows to a stream that runs parallel to Route 62 and leads to Beaver Brook at its crossing under Route 62. Check dams could be added to the existing drainage ditch to help promote infiltration before the stormwater reaches the stream.

PR BMP 3
Proposed BMP 3 is a water quality swale that could be constructed from the pervious area in the median between I-95 north and I-95 south, north of the Beaver Brook culvert under I-95. Currently, stormwater is collected in catch basins that line the left and right shoulders of I-95 northbound and southbound. The stormwater collected in these catch basins drain into a mainline which outlets the water to the pervious area adjacent to I-95 north and then enters a wetland system north of Beaver Brook. The mainline could be cut and daylighted in areas where the median is wide enough to support a water quality swale and the catch basins could be diverted into the swale. Check dams could be installed to promote infiltration before the stormwater is discharged to the wetlands surrounding Beaver Brook.

PR BMP 4
Proposed BMP 4 is a water quality swale that could be constructed in the pervious median between I-95 north and I-95 south, south of the Beaver Brook culvert under I-95. Currently, stormwater collected the in catch basins in the left shoulder is carried through a closed drainage system and discharged to the pervious area adjacent to I-95 north. Stormwater could be treated by installing curb cuts to direct runoff to the swale and by diverting the outlets of catch basins to the proposed swale in the median. Storage area to promote infiltration for stormwater could be created by installing check dams in the water quality swale.

PR BMP 5
Proposed BMP 5 is a water quality swale that could be constructed in the pervious area in the median between I-95 northbound and I-95 southbound near the I-95 southbound off-ramp at Center Street. Currently, stormwater that is collected in the catch basins along the shoulders of I-95 southbound is discharged to the pervious area adjacent to I-95 south. The stormwater that is collected in the catch basins in I-95 north is carried into a mainline that runs under the median which outlets into the pervious area adjacent to I-95 north. Treating stormwater in PR BMP 5 would require diverting the stormwater from the catch basins that line the inner lane shoulders into the median. PR BMP 5 could treat a total of two lanes and two shoulders from I-95. The stormwater from the remaining lanes could be treated in PR BMP 6 or PR BMP 7.

PR BMP 6
Proposed BMP 6 is a water quality swale that could be constructed from an existing drainage ditch in the pervious area adjacent to I-95 northbound. Currently, this area only receives overflow runoff from I-95 northbound that fails to enter catch basins. The catch basins that line the outer shoulder of I-95 northbound could be diverted into the swale and check dams could be installed to increase storage of stormwater to allow for infiltration. The length of the swale is constricted at its downstream end by wetland flow that enters the existing drainage ditch and runs adjacent to I-95 north.

PR BMP 7
Proposed BMP 7 is an infiltration basin that could be constructed in the vegetated island between I-95 southbound and the off-ramp from I-95 southbound to Center Street. Currently, no runoff from impervious areas flows to this area. However, catch basins line the shoulders adjacent to the vegetated island that could be diverted to the infiltration basin. To increase the storage of stormwater, the vegetated island would need to be graded to create a basin. The area of the basin is constricted due to the variable topography of the area. An outlet control structure could be constructed in the place of an existing manhole to collect the overflow from the basin. The overflow would discharge into the pervious area between the on-ramp from I-95 southbound to Center Street and Route 1 northbound. Overflow from PR BMP 8 and PR BMP 9 could also be treated in this infiltration basin.

PR BMP 8
Proposed BMP 8 is a water quality swale that could be constructed in the median between I-95 northbound and I-95 southbound, north of Center Street. Currently, stormwater is collected in catch basins in the shoulders of I-95 and is carried into a drainage mainline in the median, which is then outlets to the pervious area between Route 1 northbound and the off-ramp from I-95 southbound to Center Street. Stormwater from the catch basins in the inner shoulder from I-95 northbound and I-95 southbound could be diverted into the water quality swale. The water that drains into the catch basins in the outer lanes of this portion of I-95 could be treated in either PR BMP 7 or PR BMP 9.

PR BMP 9
PR BMP 9 is a water quality swale that could be constructed from the paved swale adjacent to I-95 northbound, north of Center Street. Currently, runoff that fails to enter the catch basins that are located within the outer shoulder for I-95 northbound drains into the paved swale. The catch

basins currently drain into a drainage mainline in the median of I-95. The pavement in the swale could be removed and check dams could be installed to increase storage of stormwater to promote infiltration. Also, the stormwater from the catch basins could be diverted to the swale to increase the stormwater draining to the swale. PR BMP 9 could treat two lanes and one shoulder from I-95 northbound before the stormwater overflows into an existing headwall that could outlet the water into PR BMP 7.

PR BMP 10
PR BMP 10 is an infiltration basin that could be constructed from the vegetated island between Route 62 westbound and the on-ramp from Route 62 westbound to Route 1 southbound. Currently, catch basins in this area collect stormwater and carry it into the main drainage line that runs in the median of Route 62. The main drainage line drains into the pervious area adjacent to I-95 northbound and Route 62 westbound. Stormwater that enters this area flows into an existing stream that drains to Beaver Brook at its crossing with Route 62. By diverting the catch basins adjacent to the vegetated island, PR BMP 10 could treat stormwater runoff from the ramp from Route 1 southbound to Route 62 westbound. The overflow from this basin could drain back into the Route 62 mainline.

PR BMP 11
PR BMP 11 is a water quality swale that could be constructed along the edge of the interchange infield at the on-ramp from Route 62 westbound to Route 1 southbound. Currently, catch basins line the roads of the Route 1 and Route 62 interchange and carry stormwater into the mainline in the median of Route 62. The catch basins in the ramp could be diverted into the swale. To increase storage, the existing drop inlet located at the end of the swale could be raised and check dams could be installed. Overflow from the swale could flow into the Route 62 main drainage line.

PR BMP 12
Proposed BMP 12 is a water quality swale that could be constructed along the edge of the interchange infield at the off ramp from Route 1 northbound and Route 62 eastbound. Currently, stormwater from Route 1 drains into catch basins in the shoulders, which enter a mainline in the median of Route 1. This mainline runs through the interchange infield and outlets into the wetland located north of Route 62 westbound in the vegetated area inside the on-ramp from Route 62 to I-95 southbound. The mainline could be cut to surface the stormwater for treatment inside PR BMP 12. There are currently catch basins on the edge of the ramp that could be diverted to PR BMP 12 as well. Overflow from PR BMP 12 could enter back into the existing Route 1 mainline via an existing drop inlet.

PR BMP 13
Proposed BMP 13 is a water quality swale that could be constructed in the pervious area adjacent to Route 62 eastbound. Currently, stormwater from Route 1 enters a mainline in the median via catch basins in the shoulders. Stormwater from the on-ramp from Route 62 eastbound to Route 1 northbound, and the off ramp from Route 1 southbound to Route 62 eastbound discharge into the Route 1 mainline via catch basins. The mainline runs under the pervious area being proposed as PR BMP 13. Daylighting the mainline could allow for treatment of the stormwater in PR BMP 13. Catch basins also line the right shoulder of Route 62 eastbound adjacent to the location proposed for PR BMP 13. These catch basins could be diverted into PR BMP 13. Overflow from the swale could drain into the existing drop inlet located at the low point in the pervious area. Check dams could be added to the area to increase storage and promote infiltration.

PR BMP 14
Proposed BMP 14 is an infiltration basin that could be constructed in the infield between Route 62 westbound and the on-ramp from Route 62 westbound to Route 1 northbound. Currently, stormwater is caught in catch basins in the shoulders of the ramps and enters the Route 62 drainage mainline in the median of Route 62. Diverting the catch basins to the pervious area

could allow for treatment of stormwater. An existing manhole could be converted into a drop inlet to allow for overflow to re-enter the existing drainage network.

PR BMP 15-26

Proposed BMP 15-26 consist of leaching basins located in the median of Route 1 at each of the existing catch basin locations adjacent to the median. Currently, catch basins located in the shoulders of Route 1 drain into a main line, or outlet into the pervious area adjacent to Route 1 north. The catch basins could be diverted into leaching basins in the median to potentially allow for infiltration. The median is currently 20 feet wide, which would allow enough room to install leaching basins. This preliminary assessment indicates that the leaching basins will not achieve a high runoff and pollutant removal if soils are as mapped (HSG C soils). Site investigation may reveal soils with higher infiltration ability and therefore these leaching basins have been included in this assessment for further consideration.

PR BMP 27

Proposed BMP 27 is a water quality swale that could be constructed from the existing drainage ditch within the infield of the Center Street interchange. Currently, stormwater drains to catch basins along the shoulder of the ramp which drain to the pervious area between Route 1 northbound and the off-ramp from I-95 southbound to Center Street. By diverting the flow from the catch basins, stormwater could be treated in the water quality swale. Overflow from the swale could discharge through the existing headwall at the low point in the existing drainage ditch. Check dams could be added to the existing drainage ditch to increase storage and promote infiltration.

A proposed conditions simulation was developed including proposed BMPs, estimated potential contributing drainage areas and rough sizing of the proposed BMPs. The table below shows the proposed BMPs, their MassDOT drainage areas, and estimated effective IC reductions. The outputs from the assessment model showing effective IC analysis for each BMP are attached. The assessment model identifies each BMP by unique ID, which is included in the table.

The proposed BMPs would result in an estimated 22.1 acres of effective IC reduction, compared to the target of 40 acres.

MassDOT used the assessment model to simulate the MassDOT directly contributing watershed and proposed BMPs for Beaver Brook. The assessment model also simulated watersheds with the same area as the MassDOT watershed but with varying percentages of IC from 0 to 100% (simulated IC watersheds). The results of the simulated IC watersheds are used as “benchmarks” to determine effective IC of the MassDOT directly contributing watershed. The annual median runoff volume, phosphorus and total suspended solids (TSS) loads, and flow duration for the MassDOT watershed were compared to those results for the simulated IC watersheds to determine (based on similar runoff and load responses) the equivalent or effective impervious cover of the MassDOT watershed with BMPs treating a portion of the runoff. The graph and tables on pages 9 and 10 summarize assessment model results for the MassDOT directly contributing drainage area including the impacts of the proposed BMPs, along with the simulated IC watersheds.

Proposed Mitigation

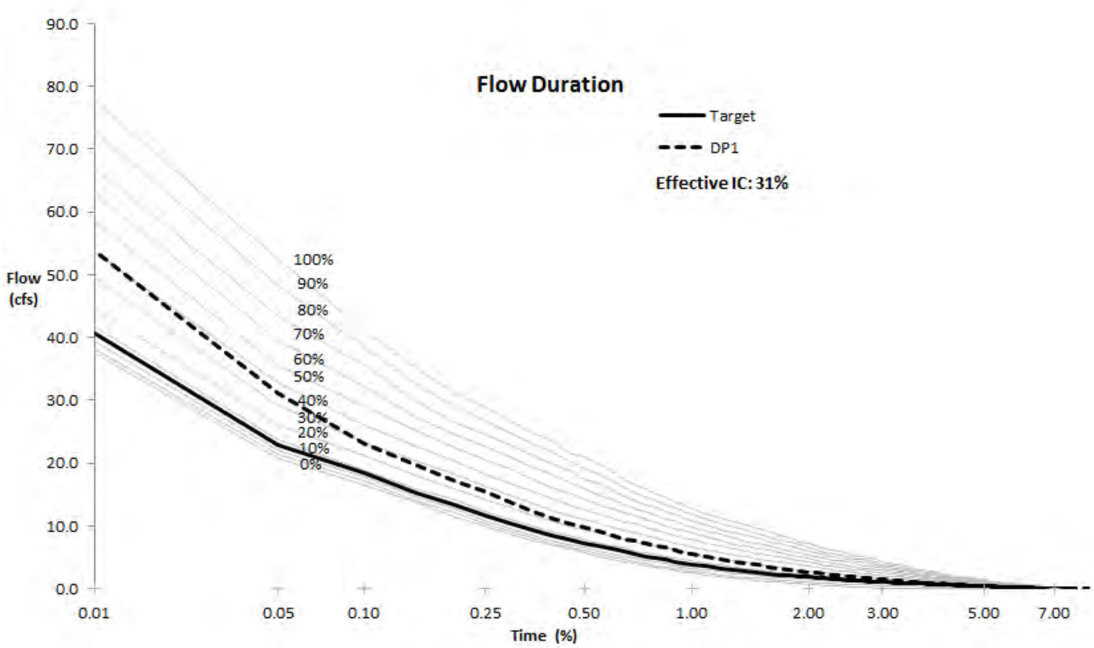
Watershed / BMP ID	BMP Type	Contributing Effective IC (acres)	Estimated Percent Reduction of Effective IC	Estimated Reduction Effective IC (acres)
PR BMP 01 (1.6)	Water Quality Swale	1.0	106%	1.1
PR BMP 02 (2.6)	Water Quality Swale	1.8	25%	0.5
PR BMP 03 (8.6)	Water Quality Swale	5.8	53%	3.1
PR BMP 04 (9.6)	Water Quality Swale	0.8	156%	1.2
PR BMP 05 (10.6)	Water Quality Swale	1.2	119%	1.4
PR BMP 06 (11.6)	Water Quality Swale	0.9	98%	0.9
PR BMP 07 (13.7)	Infiltration Basin	3.5	130%	4.6
PR BMP 08 (14.6)	Water Quality Swale	0.8	149%	1.1
PR BMP 09 (15.6)	Water Quality Swale	1.0	99%	1.0
PR BMP 10 (3.7)	Infiltration Basin	0.5	145%	0.7
PR BMP 11 (4.6)	Water Quality Swale	0.2	147%	0.3
PR BMP 12 (5.6)	Water Quality Swale	2.7	49%	1.3
PR BMP 13 (6.6)	Water Quality Swale	5.3	21%	1.1
PR BMP 14 (7.7)	Infiltration Basin	3.4	65%	2.2
PR BMP 15 (29.5)	Leaching Basin	0.2	8%	0.0
PR BMP 16 (26.5)	Leaching Basin	1.1	1%	0.0
PR BMP 17 (25.5)	Leaching Basin	0.6	2%	0.0
PR BMP 18 (24.5)	Leaching Basin	0.6	10%	0.1
PR BMP 19 (23.5)	Leaching Basin	0.6	14%	0.1
PR BMP 20 (22.5)	Leaching Basin	0.7	3%	0.0
PR BMP 21 (21.5)	Leaching Basin	0.5	3%	0.0
PR BMP 22 (20.5)	Leaching Basin	0.4	3%	0.0
PR BMP 23 (19.5)	Leaching Basin	0.6	2%	0.0
PR BMP 24 (18.5)	Leaching Basin	0.5	2%	0.0
PR BMP 25 (30.5)	Leaching Basin	0.4	3%	0.0
PR BMP 26 (17.5)	Leaching Basin	0.4	3%	0.0
PR BMP 27 (12.6)	Water Quality Swale	6.7	85%	5.7
Total*		**57.1**	**39%**	**22.1**

* Total Effective IC reduction based on the assessment model results for the total MassDOT directly discharging drainage area to the receiving water (not sum of individual BMP reductions).

Note: The predicted effective IC is determined by comparing the BMP's calculated median annual discharge volume, runoff flow/duration relationship, median annual phosphorus load and median annual total suspended solids load to predicted discharge values for benchmark watersheds with the same size and varying percent IC. In cases where analysis predicts that BMPs would discharges less runoff volume and pollutant mass than those predicted for a 0% IC (pervious, woods in good condition) benchmark watershed, then the predicted effective IC removal would be greater than 100% and reduction of effective IC area will be greater than the BMP contributing IC area.

Proposed Median Annual Load Comparisons

Simulated IC Watersheds	Runoff (ac-ft)	Pd (lb.)	TSS (lb.)
0% IC	78.2	5.7	381
5% IC	92.3	9.1	1,876
10% IC	105.9	13.3	3,978
Target 16% IC	**120.4**	**20.7**	**7,731**
20% IC	133.1	27.2	10,990
30% IC	160.0	48.3	22,425
40% IC	187.0	76.1	37,855
50% IC	213.1	109.4	56,710
60% IC	239.0	145.2	77,330
70% IC	265.1	182.0	98,154
80% IC	291.1	218.8	118,912
90% IC	317.8	254.5	139,154
100% IC	344.0	291.0	159,742
Existing Conditions	215.2	110.5	57,142
Proposed Conditions	156.7	69.2	33,072
Reduction %	**27%**	**37%**	**42%**
Effective IC	**29%**	**37%**	**37%**



Effective IC Results

Existing Estimated Effective IC	57.1 ac
Proposed Estimated Effective IC	35.0 ac
IC Reduction % with Proposed BMPs	39%
Estimated Effective IC*	32%

*Average of estimated Effective IC for annual median runoff volume, phosphorus and TSS loads, and flow duration

MassDOT estimated the effective IC under proposed conditions as 32% by comparing the annual median runoff volume, phosphorus and TSS loads, and flow distribution statistics (flow duration) from MassDOT drainage area to the receiving water to those results for simulated IC watersheds. The proposed BMPs mitigate an estimated 22.1 acres of IC, resulting in 35.0 acres of effective IC for the MassDOT direct watershed.

MassDOT will continue to ensure proper non-structural BMPs are being implemented within the watershed of Beaver Brook, including regular roadway and drainage system maintenance, erosion and sedimentation control, and outreach and education. In addition, BMP implementation through MassDOT's programmed projects are carefully evaluated and implemented where practicable, and documented through the MassDOT Water Quality Data Form.

Conclusions

MassDOT has assessed stormwater impacts from MassDOT properties directly discharging to the Beaver Brook using BMP 7U to address impairments not covered by a TMDL. This assessment found that no existing BMPs treat stormwater discharges from MassDOT properties. MassDOT proposes to install 27 BMPs to reduce MassDOT's contribution to impairments within the Beaver Brook watershed.

The following table summarizes the effective IC reductions proposed in the Beaver Brook's watershed.

Reductions Applied to MassDOT Direct Watershed

	Effective IC (Acres)
MassDOT's Area Directly Contributing to Impaired Segment	57.1
Target Reduction	40.0
Reduction Provided in Proposed Conditions	22.1

The proposed BMPs will result in a reduction in effective IC of the watershed by 22.1 acres, which is less than the target reduction of 40.0 acres.

MassDOT will proceed to the design phase to develop construction plans for the proposed BMPs as part of the MassDOT Impaired Waters Program. The project designer will gather additional information in this phase, such as soil data and site survey, to further refine the proposed BMPs. Once the design of the proposed BMPs is finalized, MassDOT will provide an update with additional information and summarize the final phosphorus and effective IC reduction based on the as-built condition.

As an overall program, MassDOT will re-evaluate the potential need for structural BMPs to address pollutant loading when roadwork is conducted as programmed projects for the area. Further work by MassDOT on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to address impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of proposed BMPs and finalized assessments including reduction achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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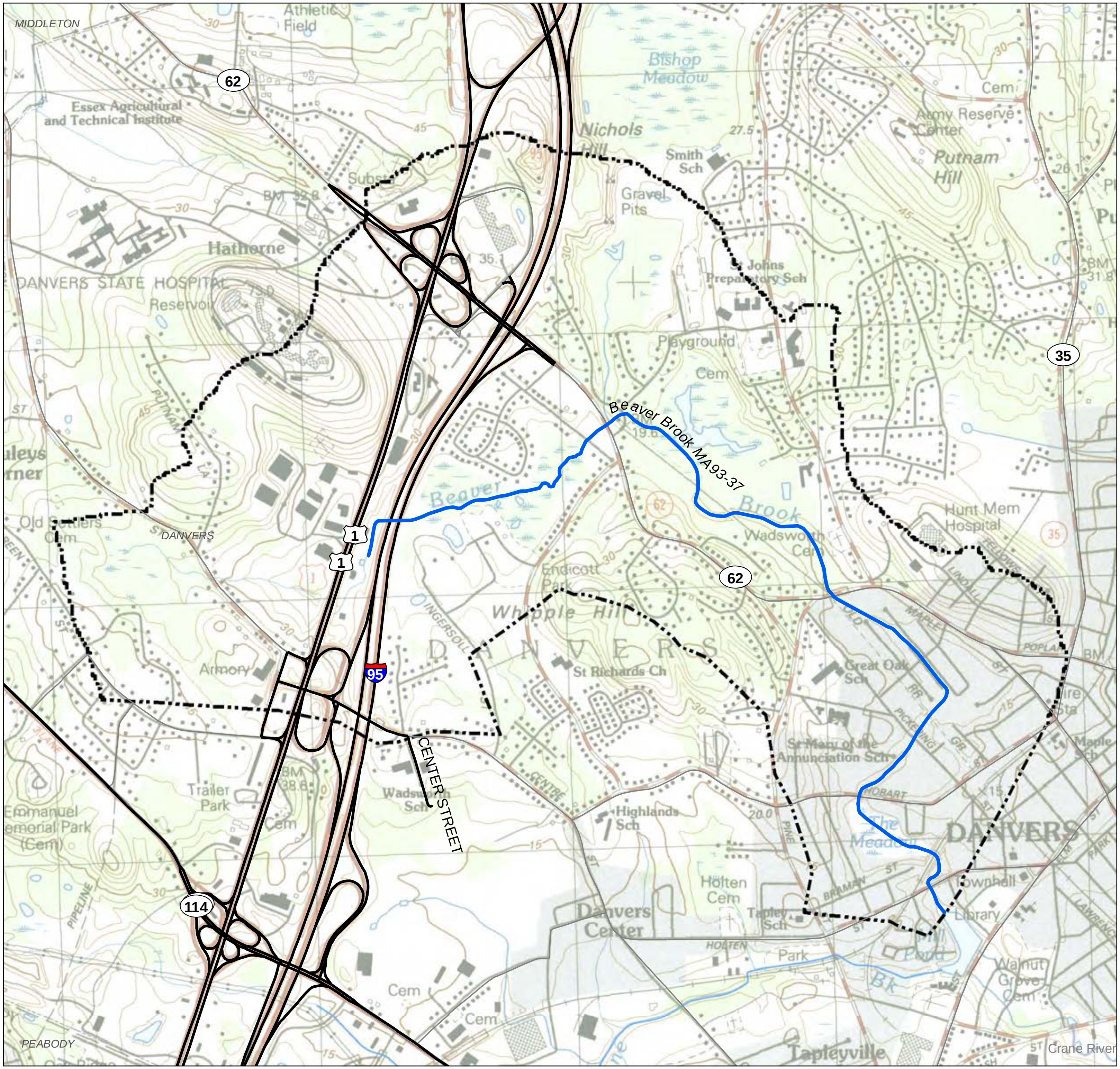

Assessed Segment

Impaired Lakes

Impaired Streams

MassDOT Roadways

Watershed

N

0 0.25 0.5 Miles

Figure 1

Beaver Brook (MA93-37) Watershed

June 2013

massDOT Massachusetts Department of Transportation Highway Division

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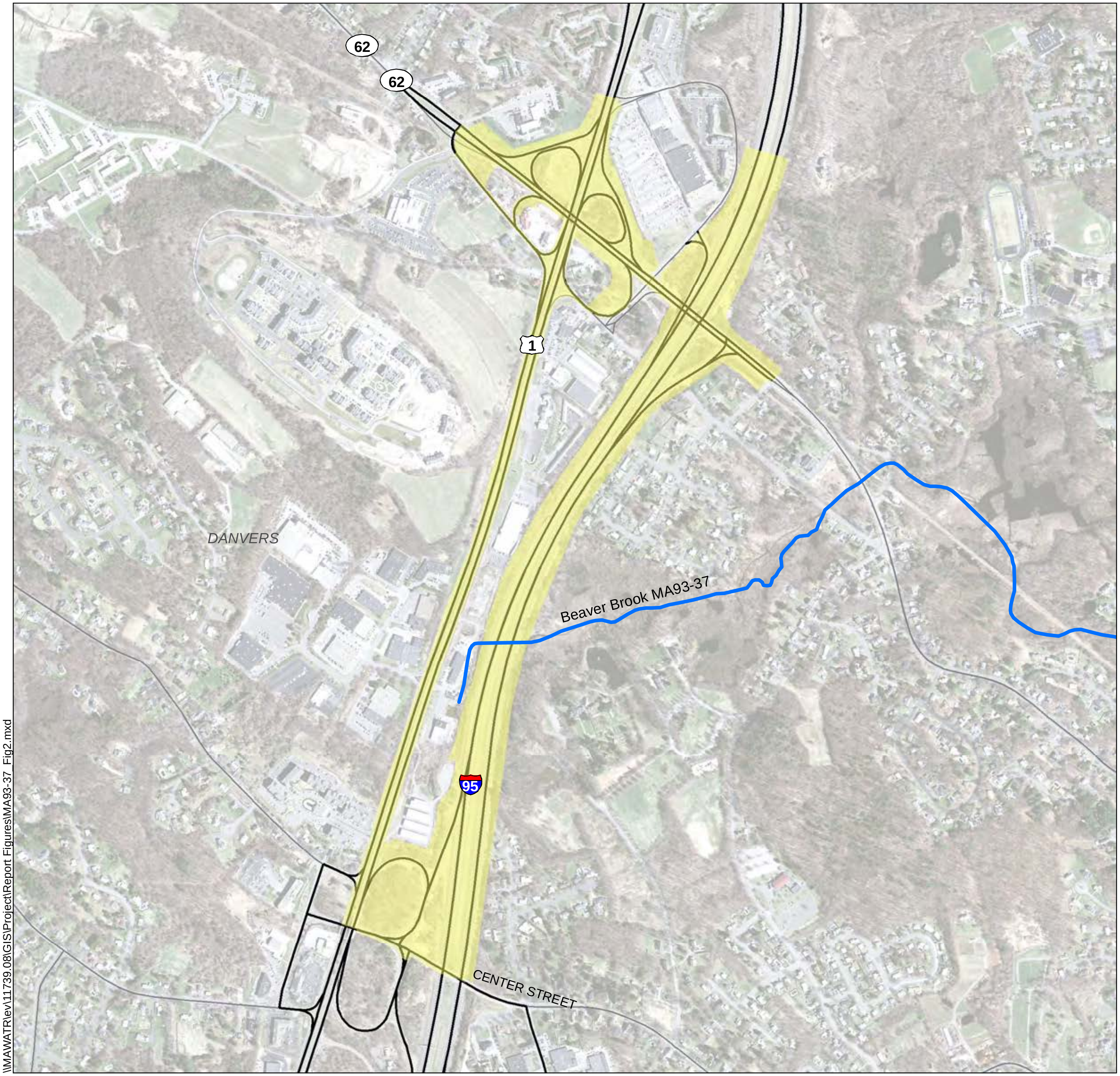

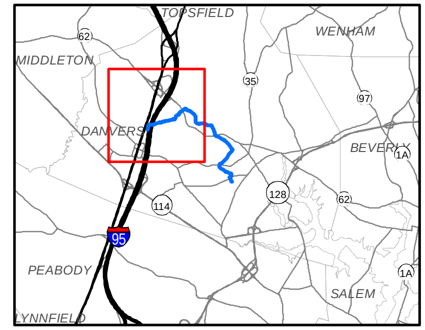

Assessed Segment

MassDOT Roadways

MassDOT Directly Discharing Area

N

0 750 1,500 Feet

Figure 2

Beaver Brook (MA93-37) Directly Contributing MassDOT Watershed

June 2013

massDOT Massachusetts Department of Transportation Highway Division

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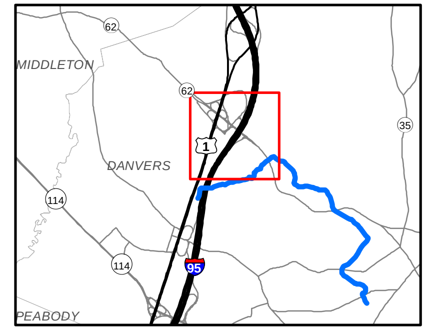

Proposed Leaching Basins

Proposed Swales

Proposed Basins

Proposed BMP Watersheds

Assessed Segment

MassDOT Roadways

DEP Wetlands

N

0 400 800 Feet

Figure 3

Beaver Brook (MA93-37)
Proposed BMPs

June 2013

massDOT Massachusetts Department of Transportation Highway Division

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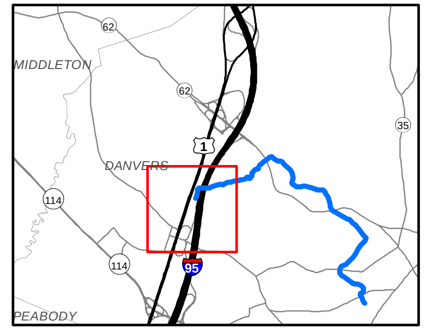

- Proposed Leaching Basins
- Proposed Swales
- Proposed Basins
- Proposed BMP Watersheds
- Assessed Segment
- MassDOT Roadways
- DEP Wetlands

N

0 400 800 Feet

Figure 4

Beaver Brook (MA93-37) Proposed BMPs

June 2013

massDOT Massachusetts Department of Transportation Highway Division

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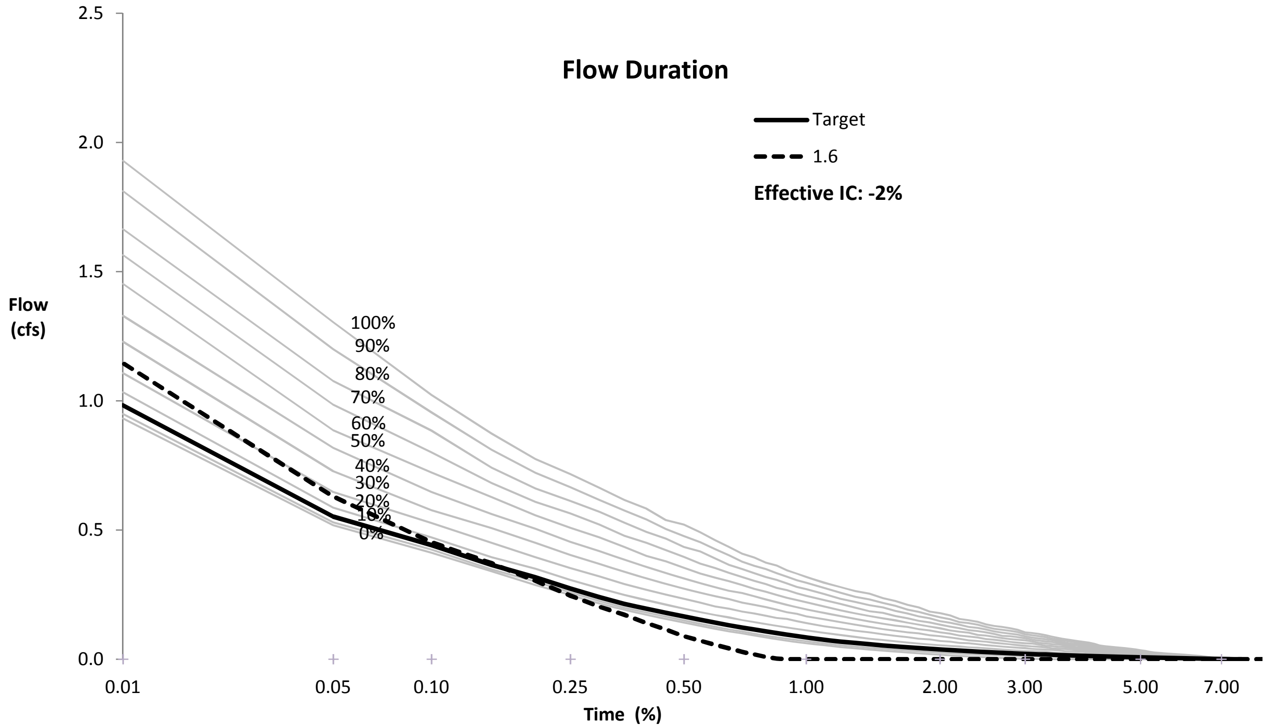
MA93-37 Assessment Model Result Summary for Impervious Cover
1.6 PR BMP 01



Median Annual Load Comparison Table

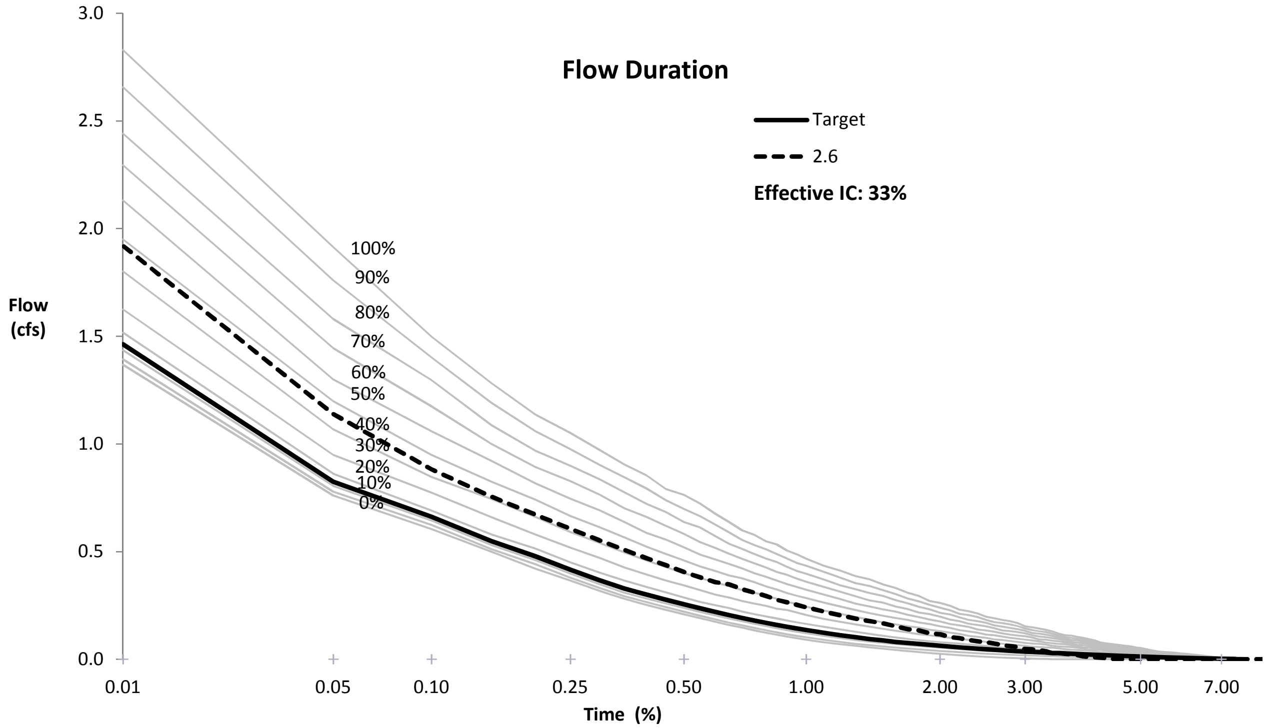
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	1.9	0.1	9
5%IC	2.3	0.2	47
10% IC	2.6	0.3	99
20% IC	3.3	0.7	273
30% IC	4.0	1.2	557
40% IC	4.6	1.9	941
50% IC	5.3	2.7	1,409
60% IC	5.9	3.6	1,921
70% IC	6.6	4.5	2,439
80% IC	7.2	5.4	2,955
90% IC	7.9	6.3	3,458
100% IC	8.5	7.2	3,969
Watershed Load	4.11	2.09	1,072
BMP Output	1.37	0.16	34
Target	2.69	0.36	113
Reduction %	**67%**	**92%**	**97%**
Effective IC	**-8%**	**1%**	**3%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		2.7
Watershed IC (no BMP)	37%	1.0
Target IC reduction	71%	0.7
Effective IC w/BMP	-2%	(0.1)
IC Reduction	106%	1.1

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-37 Assessment Model Result Summary for Impervious Cover
2.6 PR BMP 02



Median Annual Load Comparison Table

Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	2.9	0.2	14
5%IC	3.4	0.3	68
10% IC	3.9	0.5	145
20% IC	4.8	1.0	400
30% IC	5.8	1.8	817
40% IC	6.8	2.8	1,379
50% IC	7.8	4.0	2,066
60% IC	8.7	5.3	2,818
70% IC	9.7	6.6	3,576
80% IC	10.6	8.0	4,333
90% IC	11.6	9.3	5,070
100% IC	12.5	10.6	5,820
Watershed Load	6.97	3.73	1,920
BMP Output	5.89	2.94	1,115
Target	4.20	0.66	233
Reduction %	**15%**	**21%**	**42%**
Effective IC	**31%**	**41%**	**35%**

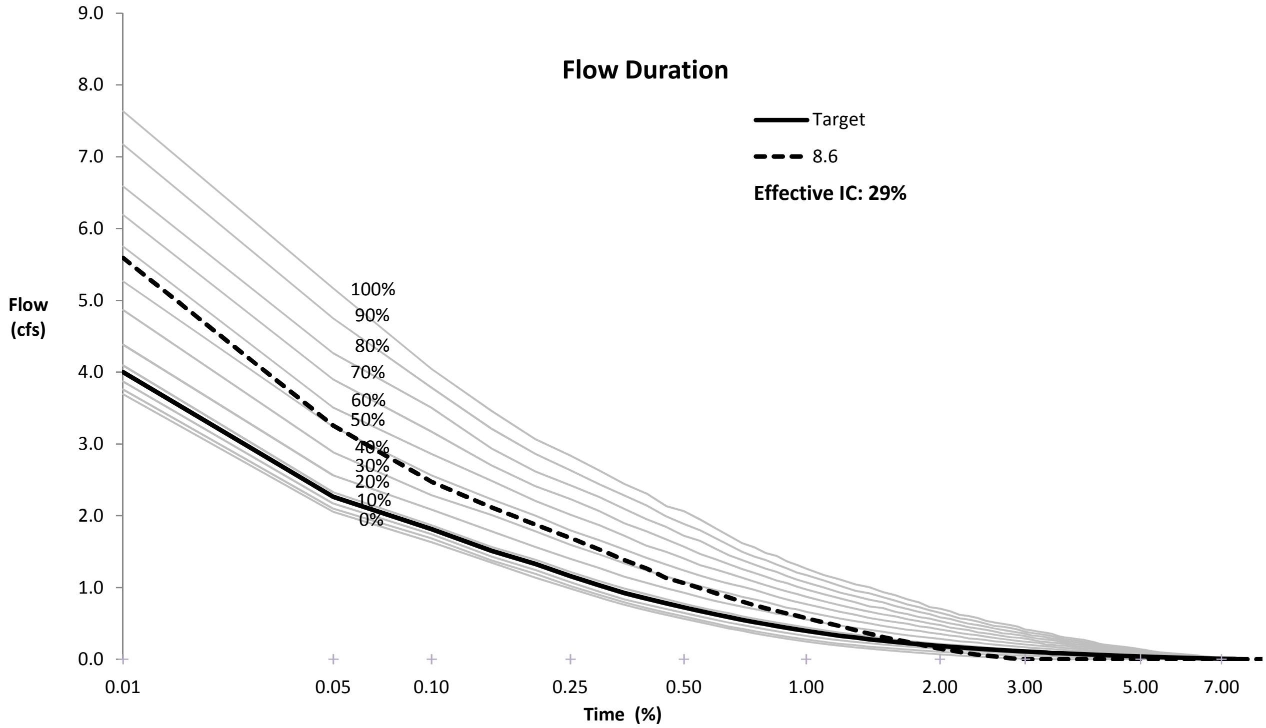
Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		3.9
Watershed IC (no BMP)	46%	1.8
Target IC reduction	71%	1.3
Effective IC w/BMP	35%	1.4
IC Reduction	25%	0.5

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
    a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
    b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-37 Assessment Model Result Summary for Impervious Cover

8.6 PR BMP 03



Median Annual Load Comparison Table

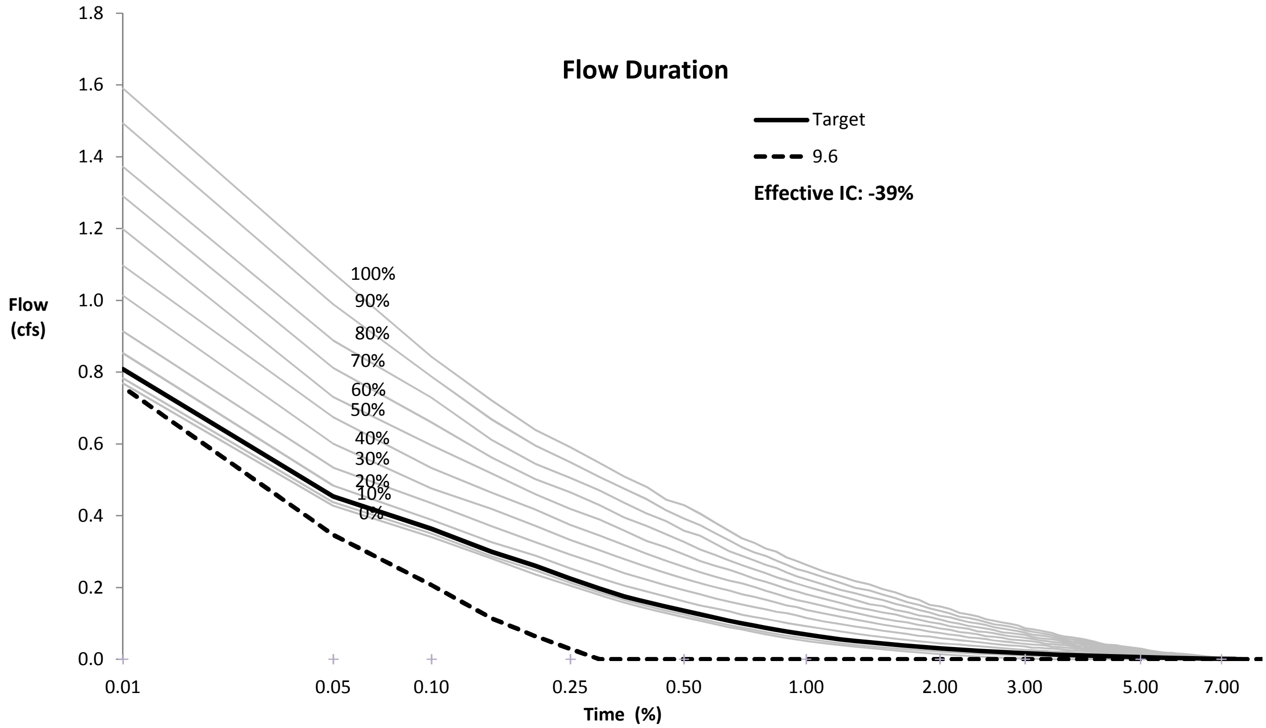
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	7.7	0.6	37
5%IC	9.1	0.9	185
10% IC	10.4	1.3	391
20% IC	13.1	2.7	1,081
30% IC	15.7	4.8	2,206
40% IC	18.4	7.5	3,724
50% IC	21.0	10.8	5,578
60% IC	23.5	14.3	7,607
70% IC	26.1	17.9	9,655
80% IC	28.6	21.5	11,697
90% IC	31.3	25.0	13,688
100% IC	33.8	28.6	15,714
Watershed Load	21.39	11.62	6,047
BMP Output	13.19	4.13	1,401
Target	12.00	2.12	799
Reduction %	**38%**	**64%**	**77%**
Effective IC	**20%**	**27%**	**23%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		10.6
Watershed IC (no BMP)	55%	5.8
Target IC reduction	71%	4.1
Effective IC w/BMP	26%	2.7
IC Reduction	53%	3.1

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-37 Assessment Model Result Summary for Impervious Cover
9.6 PR BMP 04



Median Annual Load Comparison Table

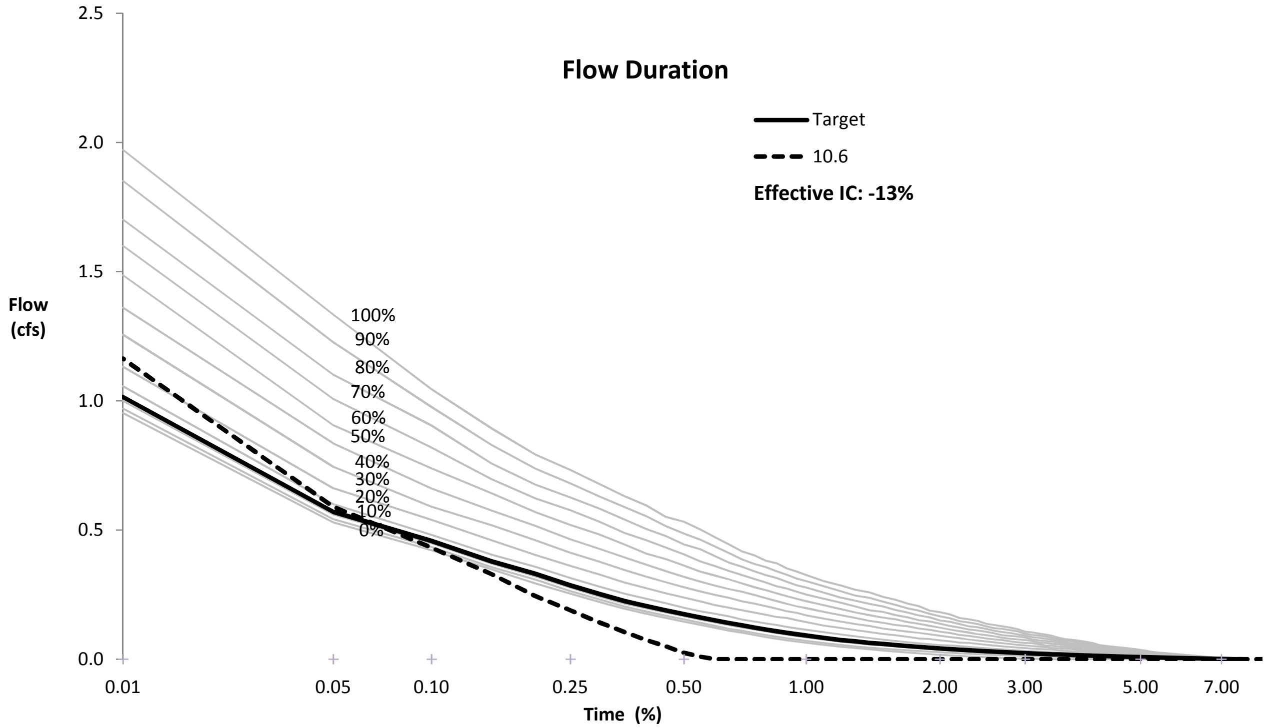
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	1.6	0.1	8
5%IC	1.9	0.2	38
10% IC	2.2	0.3	82
20% IC	2.7	0.6	225
30% IC	3.3	1.0	459
40% IC	3.8	1.6	776
50% IC	4.4	2.2	1,162
60% IC	4.9	3.0	1,584
70% IC	5.4	3.7	2,011
80% IC	6.0	4.5	2,436
90% IC	6.5	5.2	2,851
100% IC	7.0	6.0	3,273
Watershed Load	3.28	1.58	817
BMP Output	0.44	0.03	3
Target	2.19	0.28	87
Reduction %	**86%**	**98%**	**100%**
Effective IC	**-20%**	**-6%**	**-1%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		2.2
Watershed IC (no BMP)	36%	0.8
Target IC reduction	71%	0.6
Effective IC w/BMP	-20%	(0.4)
IC Reduction	156%	1.2

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-37 Assessment Model Result Summary for Impervious Cover
10.6 PR BMP 05



Median Annual Load Comparison Table

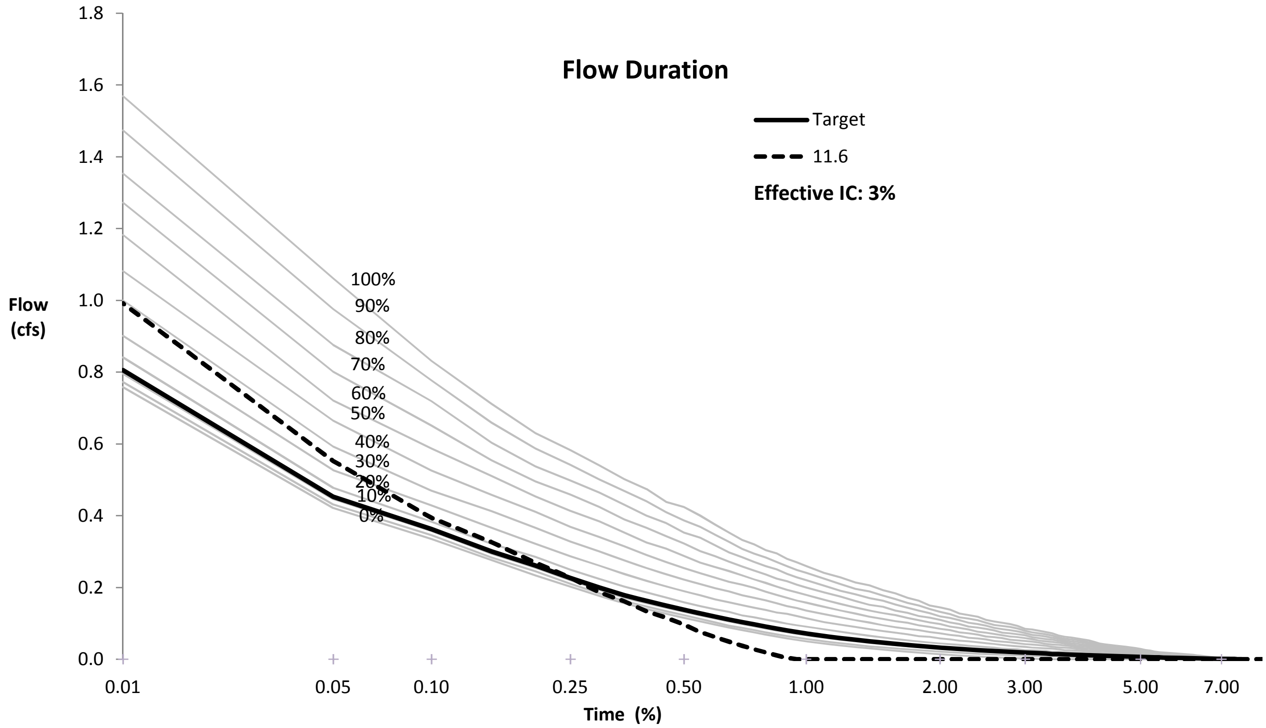
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	2.0	0.1	10
5%IC	2.3	0.2	48
10% IC	2.7	0.3	101
20% IC	3.4	0.7	279
30% IC	4.1	1.2	570
40% IC	4.8	1.9	962
50% IC	5.4	2.8	1,441
60% IC	6.1	3.7	1,964
70% IC	6.7	4.6	2,493
80% IC	7.4	5.6	3,021
90% IC	8.1	6.5	3,535
100% IC	8.7	7.4	4,058
Watershed Load	4.62	2.35	1,225
BMP Output	1.08	0.11	18
Target	2.86	0.43	145
Reduction %	**77%**	**96%**	**99%**
Effective IC	**-13%**	**-2%**	**1%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		2.7
Watershed IC (no BMP)	43%	1.2
Target IC reduction	71%	0.8
Effective IC w/BMP	-8%	(0.2)
IC Reduction	119%	1.4

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-37 Assessment Model Result Summary for Impervious Cover
11.6 PR BMP 06



Median Annual Load Comparison Table

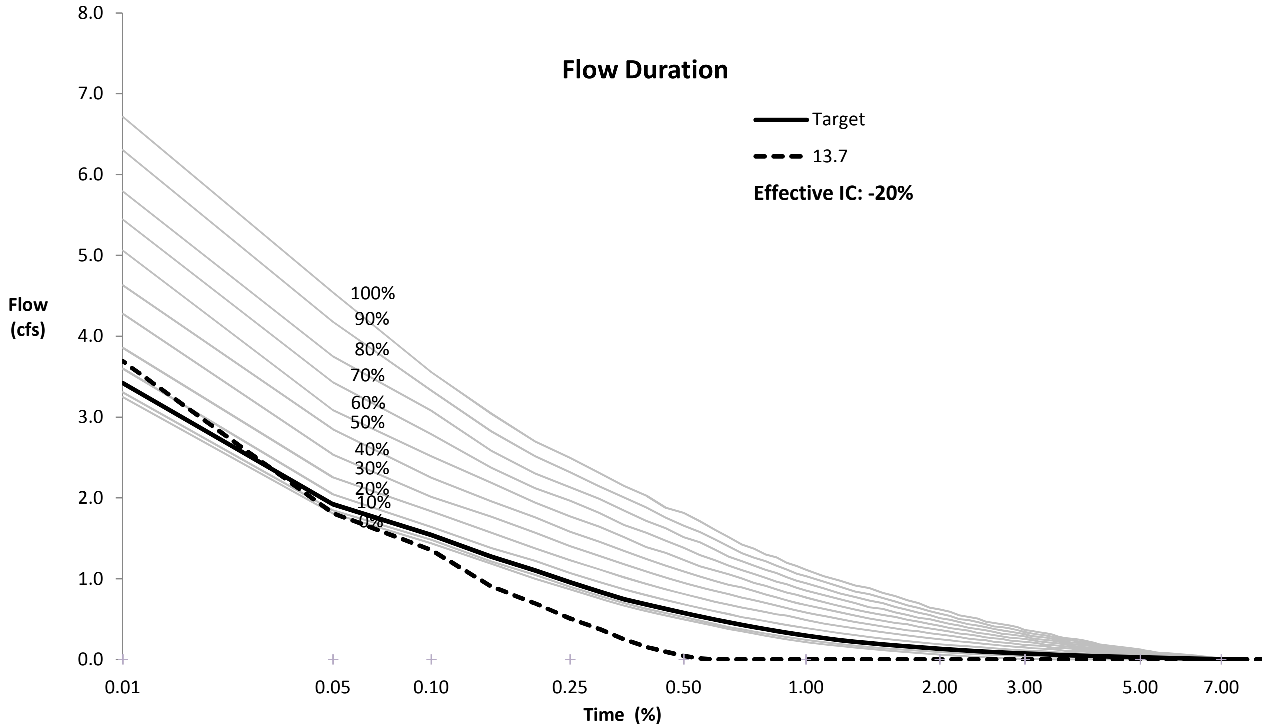
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	1.6	0.1	8
5%IC	1.9	0.2	38
10% IC	2.1	0.3	80
20% IC	2.7	0.6	222
30% IC	3.2	1.0	453
40% IC	3.8	1.5	765
50% IC	4.3	2.2	1,146
60% IC	4.8	2.9	1,563
70% IC	5.4	3.7	1,984
80% IC	5.9	4.4	2,403
90% IC	6.4	5.1	2,812
100% IC	7.0	5.9	3,229
Watershed Load	3.61	1.85	967
BMP Output	1.26	0.16	36
Target	2.26	0.33	110
Reduction %	**65%**	**92%**	**96%**
Effective IC	**-6%**	**3%**	**5%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		2.2
Watershed IC (no BMP)	42%	0.9
Target IC reduction	71%	0.6
Effective IC w/BMP	1%	0.0
IC Reduction	98%	0.9

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-37 Assessment Model Result Summary for Impervious Cover
13.7 PR BMP 07



Median Annual Load Comparison Table

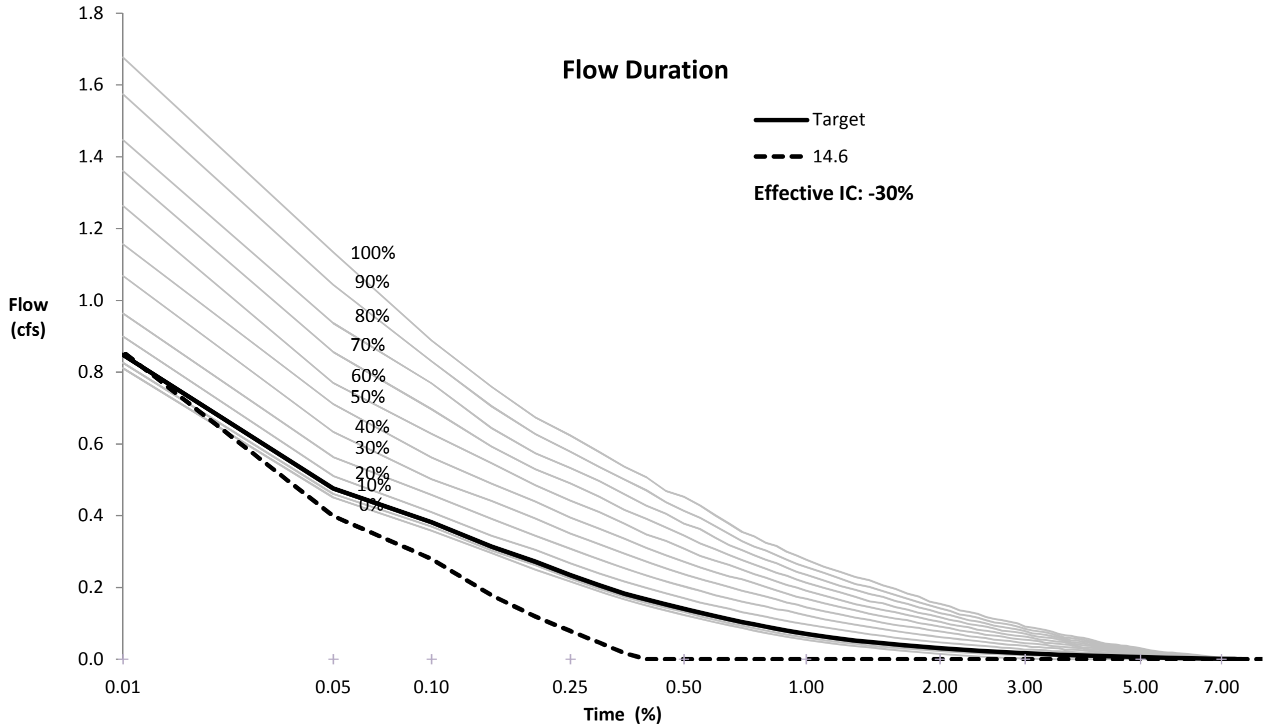
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	6.8	0.5	33
5%IC	8.0	0.8	162
10% IC	9.2	1.1	344
20% IC	11.5	2.4	951
30% IC	13.8	4.2	1,940
40% IC	16.2	6.6	3,274
50% IC	18.4	9.5	4,905
60% IC	20.7	12.6	6,689
70% IC	22.9	15.7	8,490
80% IC	25.2	18.9	10,286
90% IC	27.5	22.0	12,037
100% IC	29.8	25.2	13,818
Watershed Load	14.70	7.09	3,678
BMP Output	3.17	0.27	38
Target	9.36	1.25	396
Reduction %	**78%**	**96%**	**99%**
Effective IC	**-15%**	**-4%**	**0%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		9.3
Watershed IC (no BMP)	37%	3.5
Target IC reduction	71%	2.5
Effective IC w/BMP	-11%	(1.1)
IC Reduction	130%	4.6

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
    a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
    b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-37 Assessment Model Result Summary for Impervious Cover
14.6 PR BMP 08



Median Annual Load Comparison Table

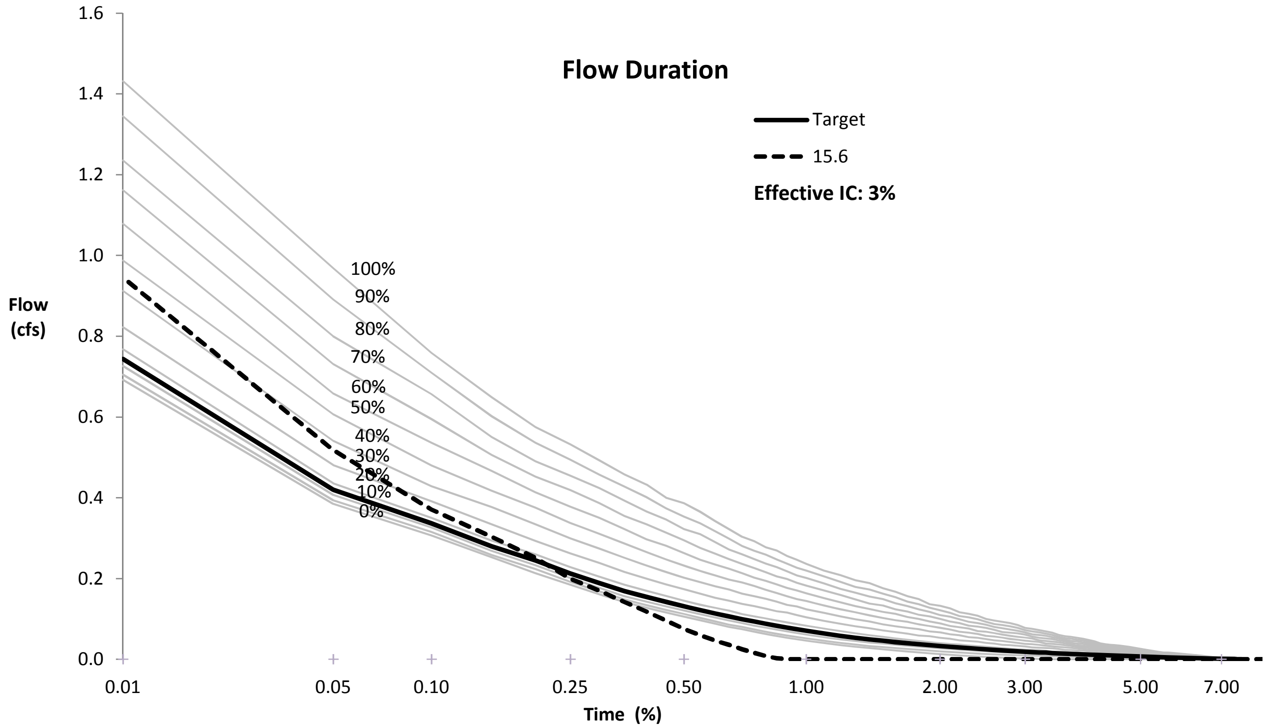
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	1.7	0.1	8
5%IC	2.0	0.2	41
10% IC	2.3	0.3	86
20% IC	2.9	0.6	237
30% IC	3.5	1.0	484
40% IC	4.0	1.6	818
50% IC	4.6	2.4	1,225
60% IC	5.2	3.1	1,670
70% IC	5.7	3.9	2,120
80% IC	6.3	4.7	2,569
90% IC	6.9	5.5	3,006
100% IC	7.4	6.3	3,451
Watershed Load	3.28	1.55	796
BMP Output	0.60	0.05	5
Target	2.26	0.28	82
Reduction %	**82%**	**97%**	**99%**
Effective IC	**-18%**	**-5%**	**0%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		2.3
Watershed IC (no BMP)	33%	0.8
Target IC reduction	71%	0.5
Effective IC w/BMP	-16%	(0.4)
IC Reduction	149%	1.1

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-37 Assessment Model Result Summary for Impervious Cover
15.6 PR BMP 09



Median Annual Load Comparison Table

Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	1.4	0.1	7
5%IC	1.7	0.2	35
10% IC	2.0	0.2	73
20% IC	2.5	0.5	203
30% IC	3.0	0.9	414
40% IC	3.4	1.4	698
50% IC	3.9	2.0	1,046
60% IC	4.4	2.7	1,427
70% IC	4.9	3.4	1,811
80% IC	5.4	4.0	2,194
90% IC	5.9	4.7	2,567
100% IC	6.3	5.4	2,947
Watershed Load	3.69	1.97	1,036
BMP Output	1.12	0.14	32
Target	2.17	0.35	129
Reduction %	**70%**	**93%**	**97%**
Effective IC	**-6%**	**3%**	**4%**

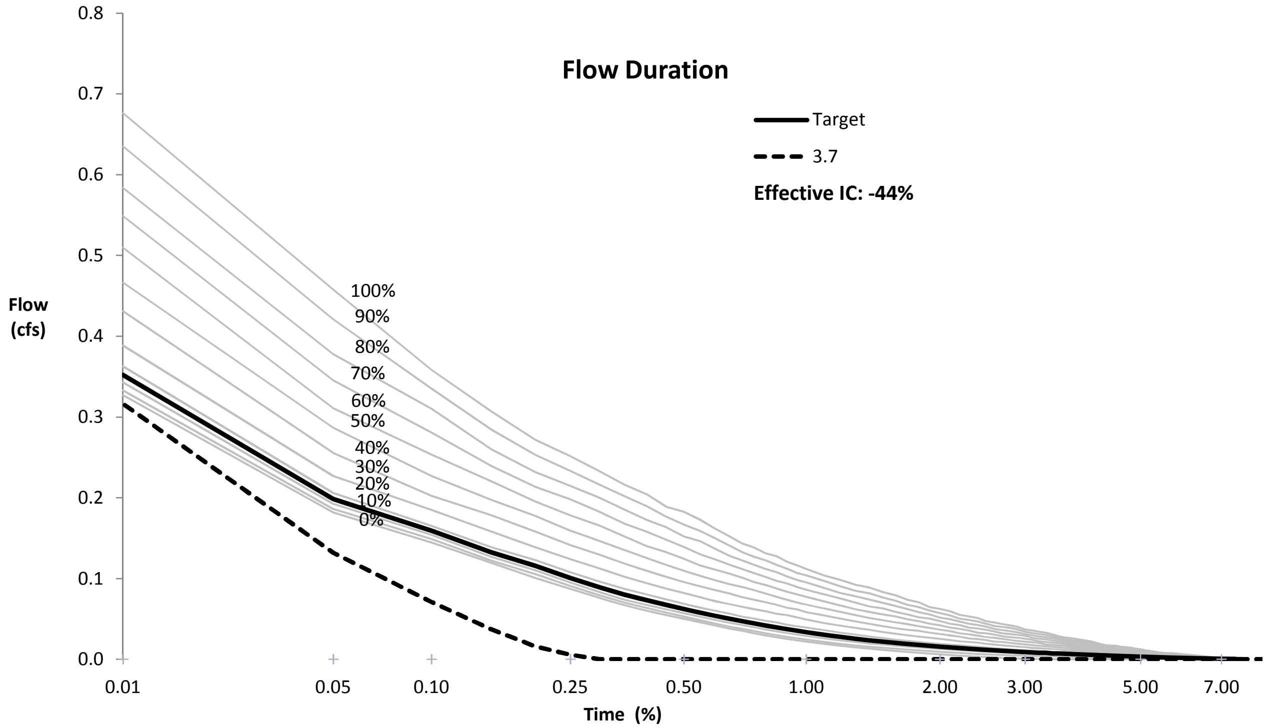
Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		2.0
Watershed IC (no BMP)	49%	1.0
Target IC reduction	71%	0.7
Effective IC w/BMP	0%	0.0
IC Reduction	99%	1.0

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
    a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
    b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-37 Assessment Model Result Summary for Impervious Cover

3.7 PR BMP 10



Median Annual Load Comparison Table

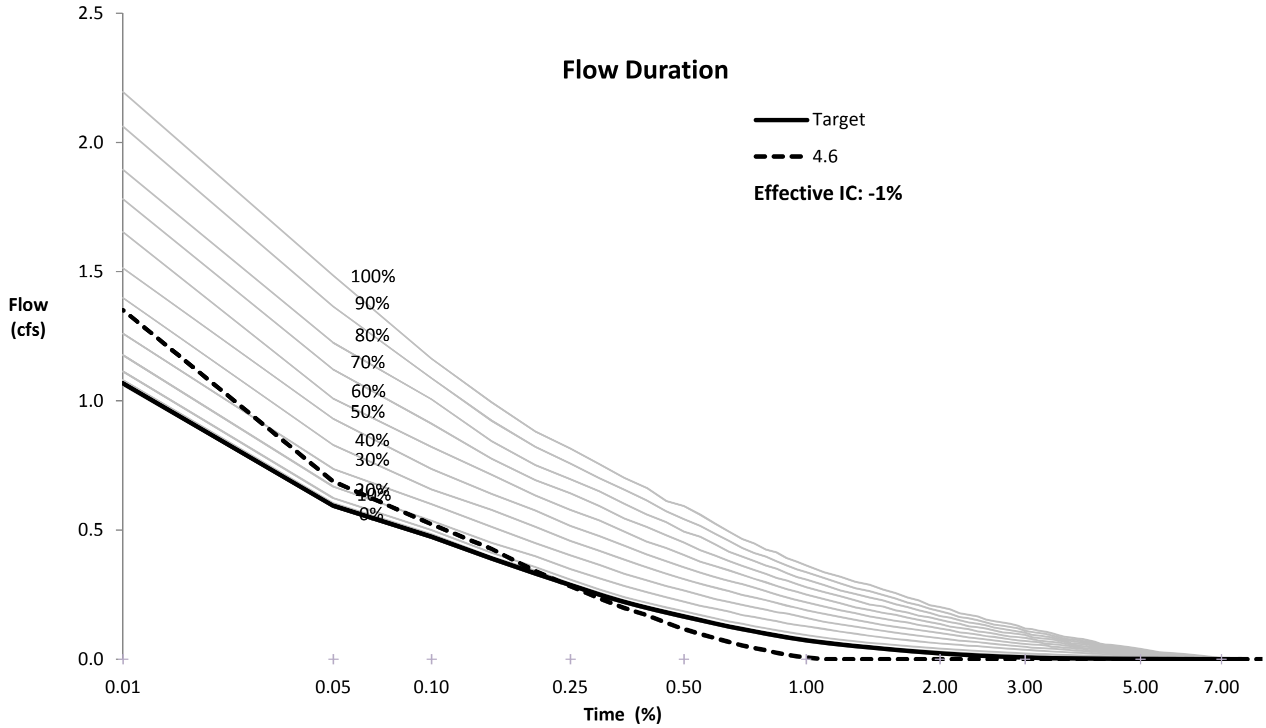
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	0.7	0.0	3
5%IC	0.8	0.1	16
10% IC	0.9	0.1	35
20% IC	1.2	0.2	96
30% IC	1.4	0.4	195
40% IC	1.6	0.7	330
50% IC	1.9	1.0	494
60% IC	2.1	1.3	674
70% IC	2.3	1.6	855
80% IC	2.5	1.9	1,036
90% IC	2.8	2.2	1,213
100% IC	3.0	2.5	1,392
Watershed Load	1.90	0.94	492
BMP Output	0.11	0.01	1
Target	1.03	0.17	62
Reduction %	**94%**	**99%**	**100%**
Effective IC	**-23%**	**-7%**	**-1%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		0.9
Watershed IC (no BMP)	50%	0.5
Target IC reduction	71%	0.3
Effective IC w/BMP	-23%	(0.2)
IC Reduction	145%	0.7

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
    a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
    b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-37 Assessment Model Result Summary for Impervious Cover
4.6 PR BMP 11



Median Annual Load Comparison Table

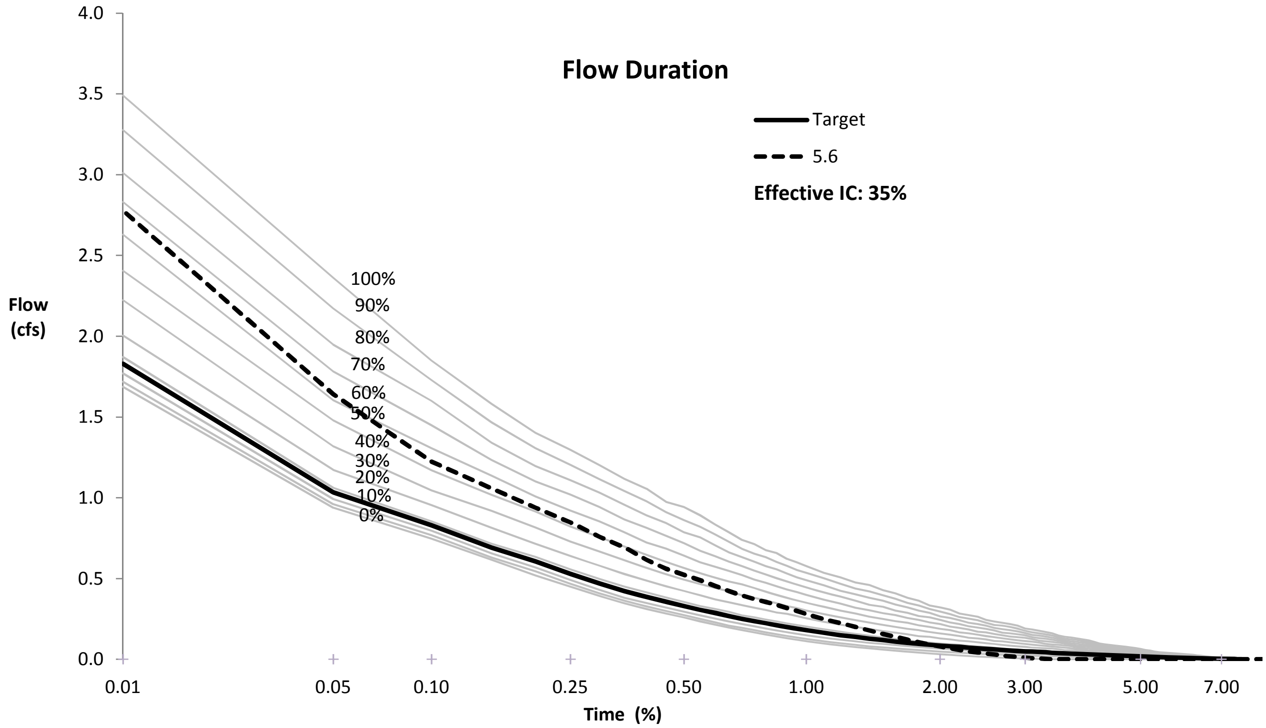
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	2.2	0.2	11
5%IC	2.6	0.3	53
10% IC	3.0	0.4	112
20% IC	3.8	0.8	311
30% IC	4.5	1.4	634
40% IC	5.3	2.2	1,070
50% IC	6.0	3.1	1,604
60% IC	6.8	4.1	2,187
70% IC	7.5	5.1	2,776
80% IC	8.2	6.2	3,363
90% IC	9.0	7.2	3,935
100% IC	9.7	8.2	4,517
Watershed Load	2.88	0.53	200
BMP Output	1.64	0.12	10
Target	2.35	0.19	25
Reduction %	**43%**	**78%**	**95%**
Effective IC	**-7%**	**-2%**	**0%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		3.1
Watershed IC (no BMP)	6%	0.2
Target IC reduction	71%	0.1
Effective IC w/BMP	-3%	(0.1)
IC Reduction	147%	0.3

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-37 Assessment Model Result Summary for Impervious Cover
5.6 PR BMP 12



Median Annual Load Comparison Table

Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	3.5	0.3	17
5%IC	4.2	0.4	84
10% IC	4.8	0.6	179
20% IC	6.0	1.2	494
30% IC	7.2	2.2	1,008
40% IC	8.4	3.4	1,702
50% IC	9.6	4.9	2,550
60% IC	10.7	6.5	3,477
70% IC	11.9	8.2	4,414
80% IC	13.1	9.8	5,347
90% IC	14.3	11.4	6,257
100% IC	15.5	13.1	7,183
Watershed Load	10.39	5.41	2,794
BMP Output	6.55	1.66	528
Target	5.48	0.97	365
Reduction %	**37%**	**69%**	**81%**
Effective IC	**25%**	**25%**	**21%**

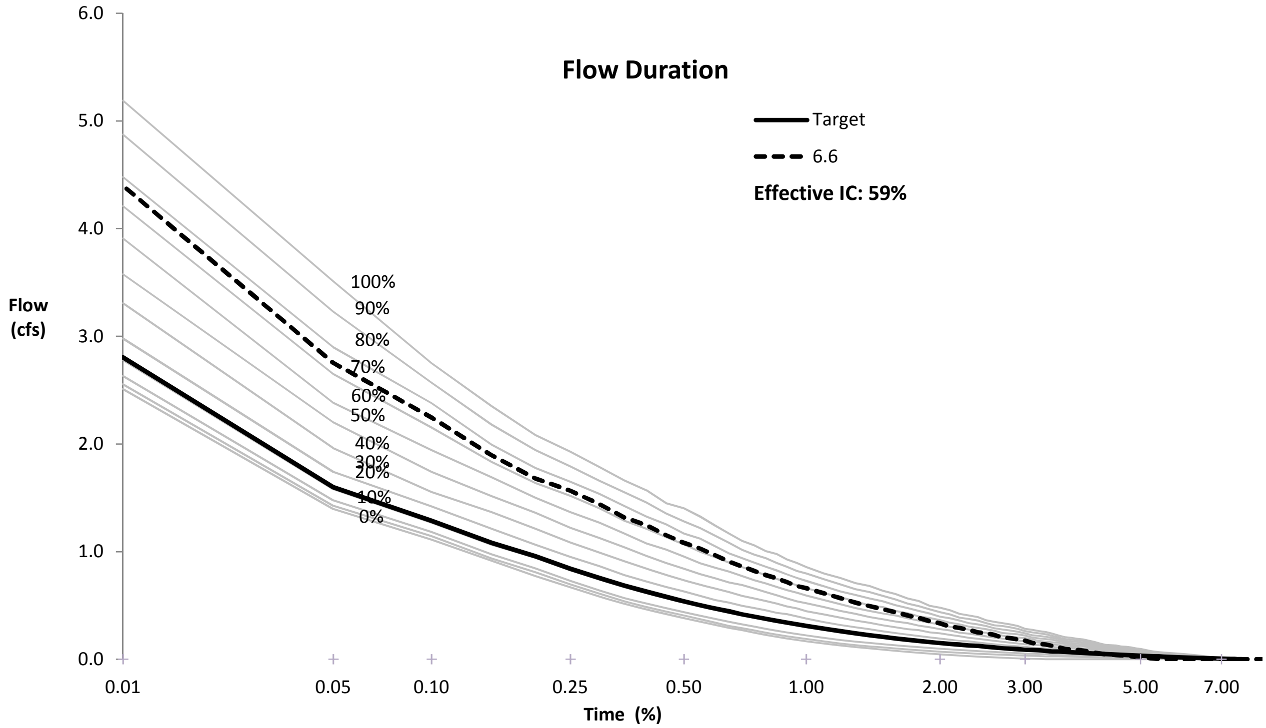
Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		4.9
Watershed IC (no BMP)	55%	2.7
Target IC reduction	71%	1.9
Effective IC w/BMP	28%	1.4
IC Reduction	49%	1.3

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-37 Assessment Model Result Summary for Impervious Cover

6.6 PR BMP 13



Median Annual Load Comparison Table

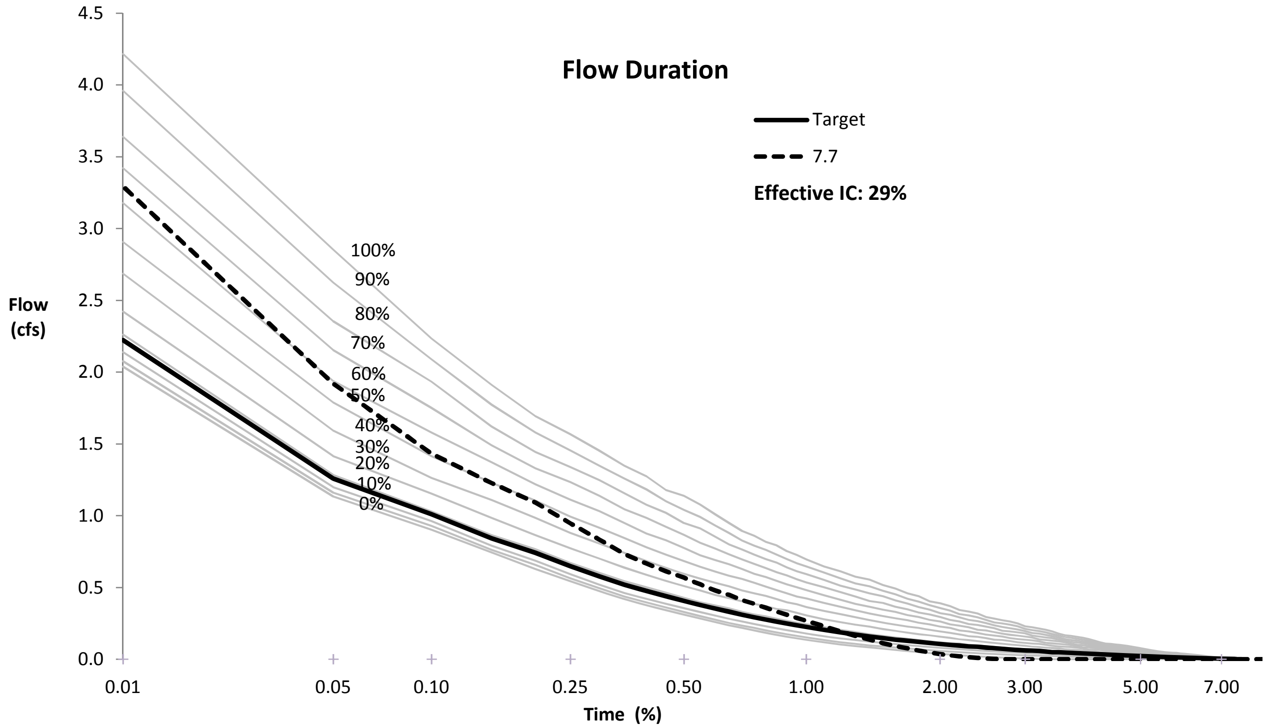
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	5.2	0.4	25
5%IC	6.2	0.6	125
10% IC	7.1	0.9	266
20% IC	8.9	1.8	735
30% IC	10.7	3.2	1,499
40% IC	12.5	5.1	2,530
50% IC	14.2	7.3	3,791
60% IC	16.0	9.7	5,169
70% IC	17.7	12.2	6,561
80% IC	19.5	14.6	7,949
90% IC	21.2	17.0	9,302
100% IC	23.0	19.5	10,678
Watershed Load	18.48	10.30	5,444
BMP Output	16.20	8.18	3,069
Target	9.10	1.98	823
Reduction %	**12%**	**21%**	**44%**
Effective IC	**61%**	**54%**	**44%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		7.2
Watershed IC (no BMP)	73%	5.3
Target IC reduction	71%	3.7
Effective IC w/BMP	58%	4.2
IC Reduction	21%	1.1

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-37 Assessment Model Result Summary for Impervious Cover
7.7 PR BMP 14



Median Annual Load Comparison Table

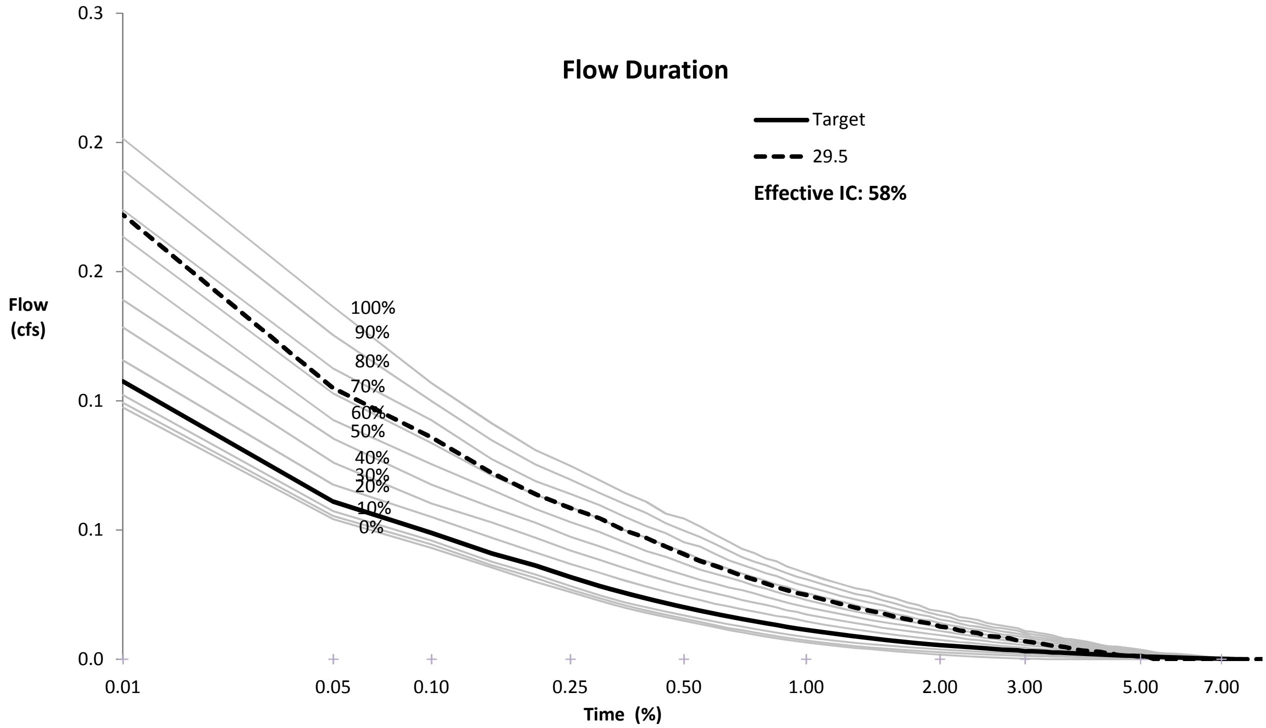
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	4.3	0.3	21
5%IC	5.0	0.5	102
10% IC	5.8	0.7	216
20% IC	7.2	1.5	597
30% IC	8.7	2.6	1,218
40% IC	10.2	4.1	2,057
50% IC	11.6	5.9	3,081
60% IC	13.0	7.9	4,201
70% IC	14.4	9.9	5,333
80% IC	15.8	11.9	6,460
90% IC	17.3	13.8	7,560
100% IC	18.7	15.8	8,679
Watershed Load	13.08	6.96	3,600
BMP Output	6.53	1.29	364
Target	6.78	1.25	482
Reduction %	**50%**	**81%**	**90%**
Effective IC	**15%**	**18%**	**14%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		5.9
Watershed IC (no BMP)	59%	3.4
Target IC reduction	71%	2.4
Effective IC w/BMP	21%	1.2
IC Reduction	65%	2.2

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
    a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
    b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-37 Assessment Model Result Summary for Impervious Cover
29.5 PR BMP 15



Median Annual Load Comparison Table

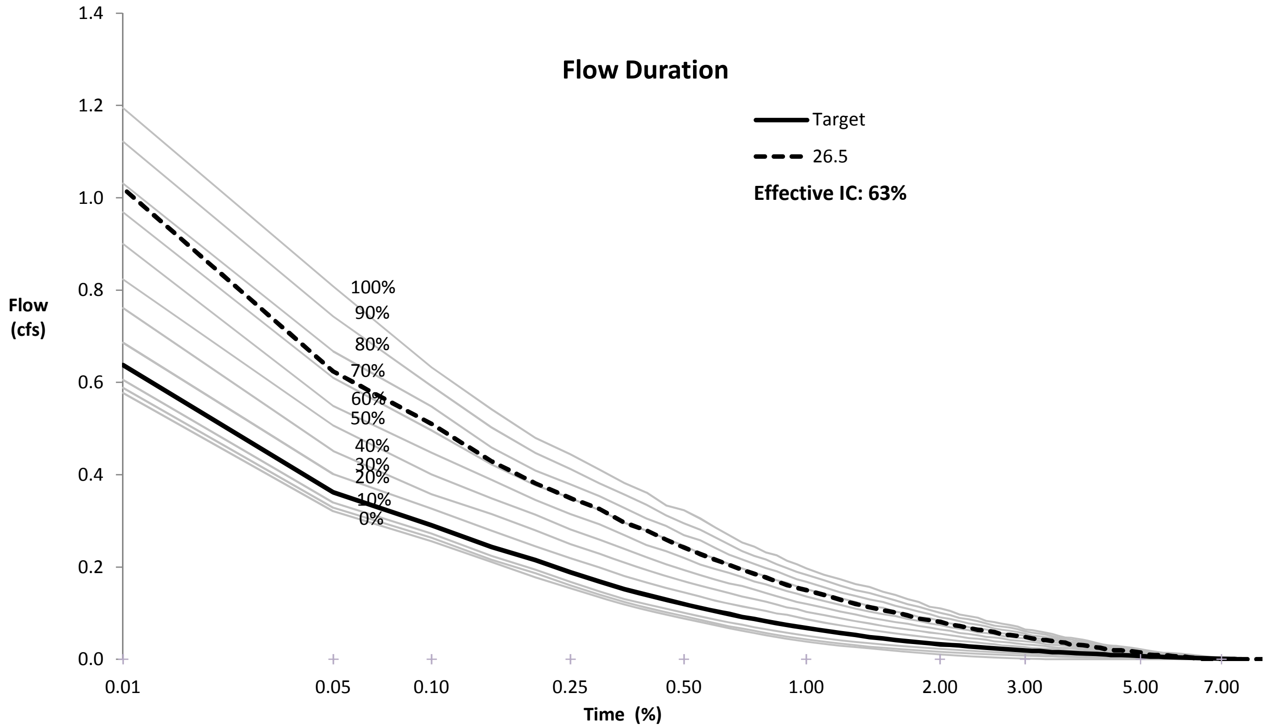
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	0.2	0.0	1
5%IC	0.2	0.0	5
10% IC	0.3	0.0	10
20% IC	0.3	0.1	29
30% IC	0.4	0.1	58
40% IC	0.5	0.2	98
50% IC	0.6	0.3	147
60% IC	0.6	0.4	201
70% IC	0.7	0.5	255
80% IC	0.8	0.6	309
90% IC	0.8	0.7	361
100% IC	0.9	0.8	415
Watershed Load	0.68	0.35	178
BMP Output	0.63	0.40	217
Target	0.34	0.07	27
Reduction %	**7%**	**-17%**	**-22%**
Effective IC	**61%**	**63%**	**63%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		0.3
Watershed IC (no BMP)	66%	0.2
Target IC reduction	71%	0.1
Effective IC w/BMP	61%	0.2
IC Reduction	8%	0.0

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-37 Assessment Model Result Summary for Impervious Cover
26.5 PR BMP 16



Median Annual Load Comparison Table

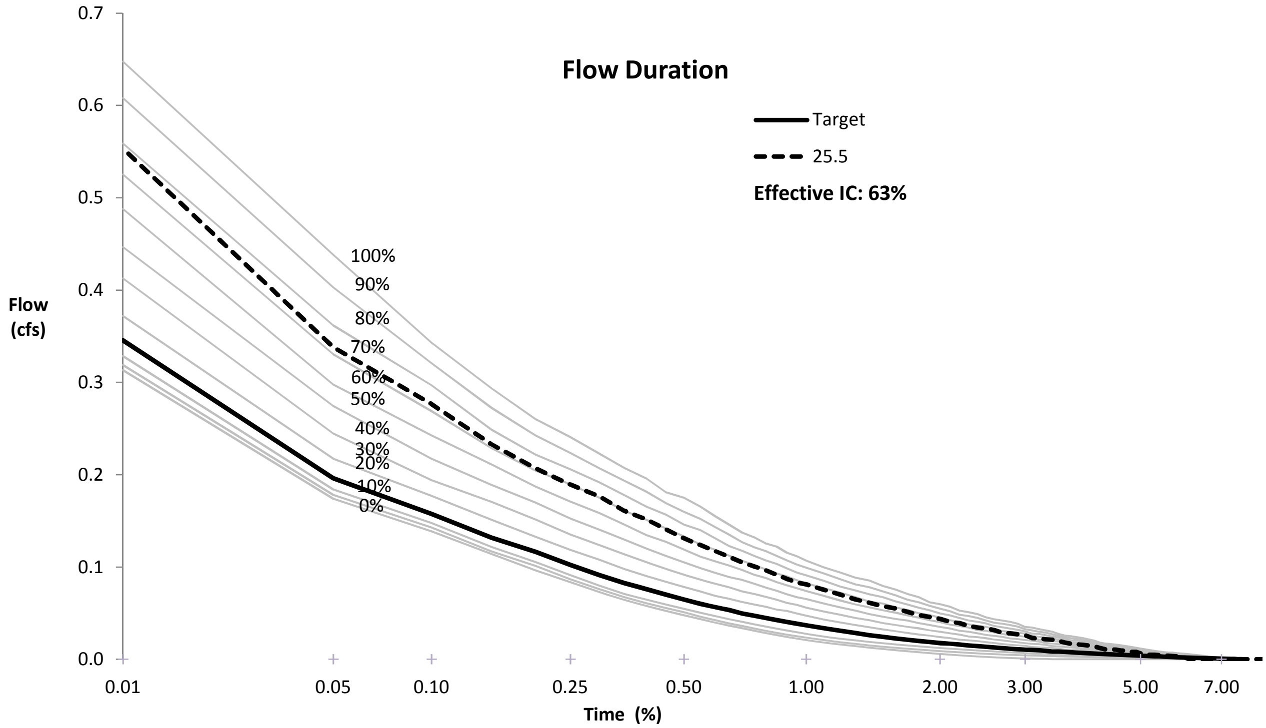
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	1.2	0.1	6
5%IC	1.4	0.1	29
10% IC	1.6	0.2	61
20% IC	2.0	0.4	169
30% IC	2.5	0.7	345
40% IC	2.9	1.2	583
50% IC	3.3	1.7	873
60% IC	3.7	2.2	1,190
70% IC	4.1	2.8	1,511
80% IC	4.5	3.4	1,830
90% IC	4.9	3.9	2,142
100% IC	5.3	4.5	2,458
Watershed Load	4.01	2.05	1,055
BMP Output	3.96	2.53	1,354
Target	2.01	0.40	160
Reduction %	**1%**	**-23%**	**-28%**
Effective IC	**67%**	**65%**	**65%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		1.7
Watershed IC (no BMP)	66%	1.1
Target IC reduction	71%	0.8
Effective IC w/BMP	65%	1.1
IC Reduction	1%	0.0

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-37 Assessment Model Result Summary for Impervious Cover
25.5 PR BMP 17



Median Annual Load Comparison Table

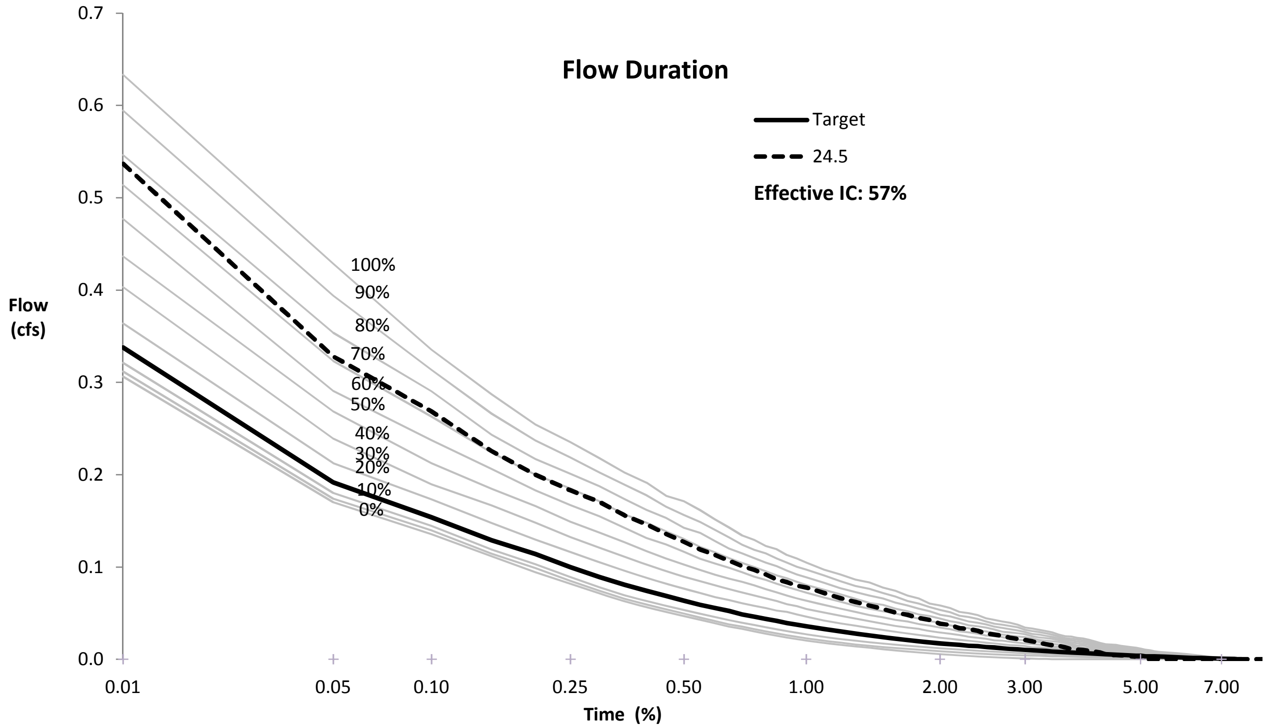
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	0.7	0.0	3
5%IC	0.8	0.1	16
10% IC	0.9	0.1	33
20% IC	1.1	0.2	92
30% IC	1.3	0.4	187
40% IC	1.6	0.6	316
50% IC	1.8	0.9	473
60% IC	2.0	1.2	645
70% IC	2.2	1.5	819
80% IC	2.4	1.8	992
90% IC	2.7	2.1	1,161
100% IC	2.9	2.4	1,333
Watershed Load	2.17	1.11	572
BMP Output	2.12	1.37	735
Target	1.09	0.22	87
Reduction %	**2%**	**-23%**	**-29%**
Effective IC	**66%**	**65%**	**65%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		0.9
Watershed IC (no BMP)	66%	0.6
Target IC reduction	71%	0.4
Effective IC w/BMP	65%	0.6
IC Reduction	2%	0.0

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-37 Assessment Model Result Summary for Impervious Cover
24.5 PR BMP 18



Median Annual Load Comparison Table

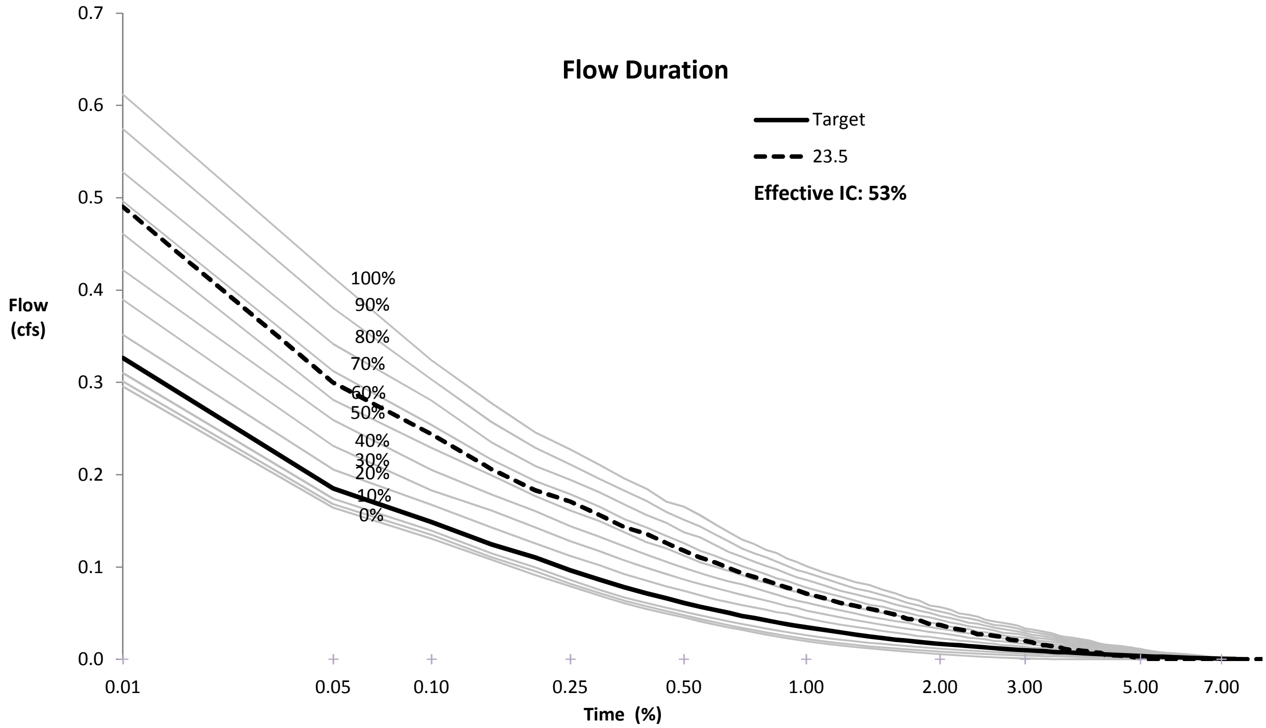
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	0.6	0.0	3
5%IC	0.8	0.1	15
10% IC	0.9	0.1	32
20% IC	1.1	0.2	90
30% IC	1.3	0.4	183
40% IC	1.5	0.6	309
50% IC	1.7	0.9	463
60% IC	2.0	1.2	631
70% IC	2.2	1.5	801
80% IC	2.4	1.8	970
90% IC	2.6	2.1	1,135
100% IC	2.8	2.4	1,303
Watershed Load	2.12	1.09	559
BMP Output	1.91	1.27	681
Target	1.07	0.21	85
Reduction %	**10%**	**-17%**	**-22%**
Effective IC	**58%**	**63%**	**63%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		0.9
Watershed IC (no BMP)	66%	0.6
Target IC reduction	71%	0.4
Effective IC w/BMP	59%	0.5
IC Reduction	10%	0.1

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-37 Assessment Model Result Summary for Impervious Cover
23.5 PR BMP 19



Median Annual Load Comparison Table

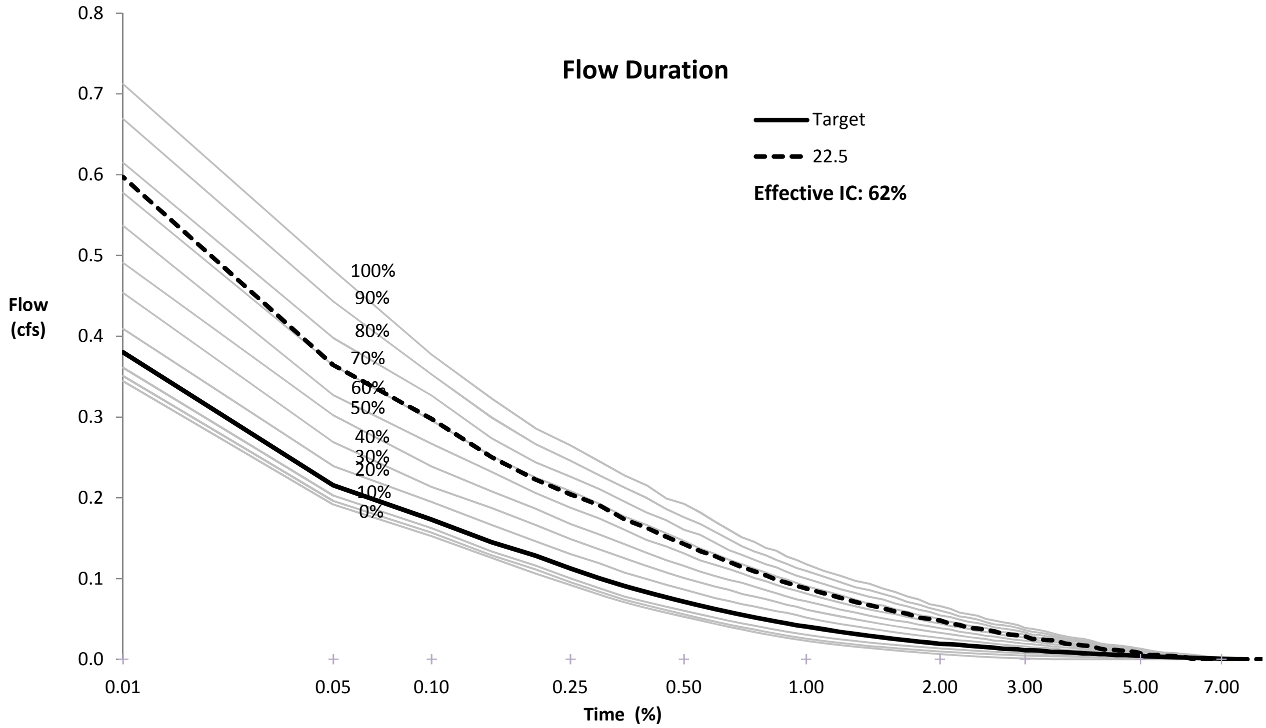
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	0.6	0.0	3
5%IC	0.7	0.1	15
10% IC	0.8	0.1	31
20% IC	1.0	0.2	87
30% IC	1.3	0.4	177
40% IC	1.5	0.6	298
50% IC	1.7	0.9	447
60% IC	1.9	1.1	609
70% IC	2.1	1.4	774
80% IC	2.3	1.7	937
90% IC	2.5	2.0	1,097
100% IC	2.7	2.3	1,259
Watershed Load	1.97	1.04	536
BMP Output	1.77	1.21	650
Target	1.03	0.21	82
Reduction %	**10%**	**-16%**	**-21%**
Effective IC	**55%**	**62%**	**62%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		0.9
Watershed IC (no BMP)	66%	0.6
Target IC reduction	71%	0.4
Effective IC w/BMP	57%	0.5
IC Reduction	14%	0.1

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-37 Assessment Model Result Summary for Impervious Cover
22.5 PR BMP 20



Median Annual Load Comparison Table

Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	0.7	0.1	3
5%IC	0.8	0.1	17
10% IC	1.0	0.1	37
20% IC	1.2	0.2	101
30% IC	1.5	0.4	206
40% IC	1.7	0.7	347
50% IC	2.0	1.0	521
60% IC	2.2	1.3	710
70% IC	2.4	1.7	901
80% IC	2.7	2.0	1,091
90% IC	2.9	2.3	1,277
100% IC	3.2	2.7	1,466
Watershed Load	2.36	1.22	628
BMP Output	2.31	1.50	807
Target	1.20	0.24	95
Reduction %	**2%**	**-23%**	**-28%**
Effective IC	**65%**	**65%**	**65%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		1.0
Watershed IC (no BMP)	66%	0.7
Target IC reduction	71%	0.5
Effective IC w/BMP	64%	0.6
IC Reduction	3%	0.0

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
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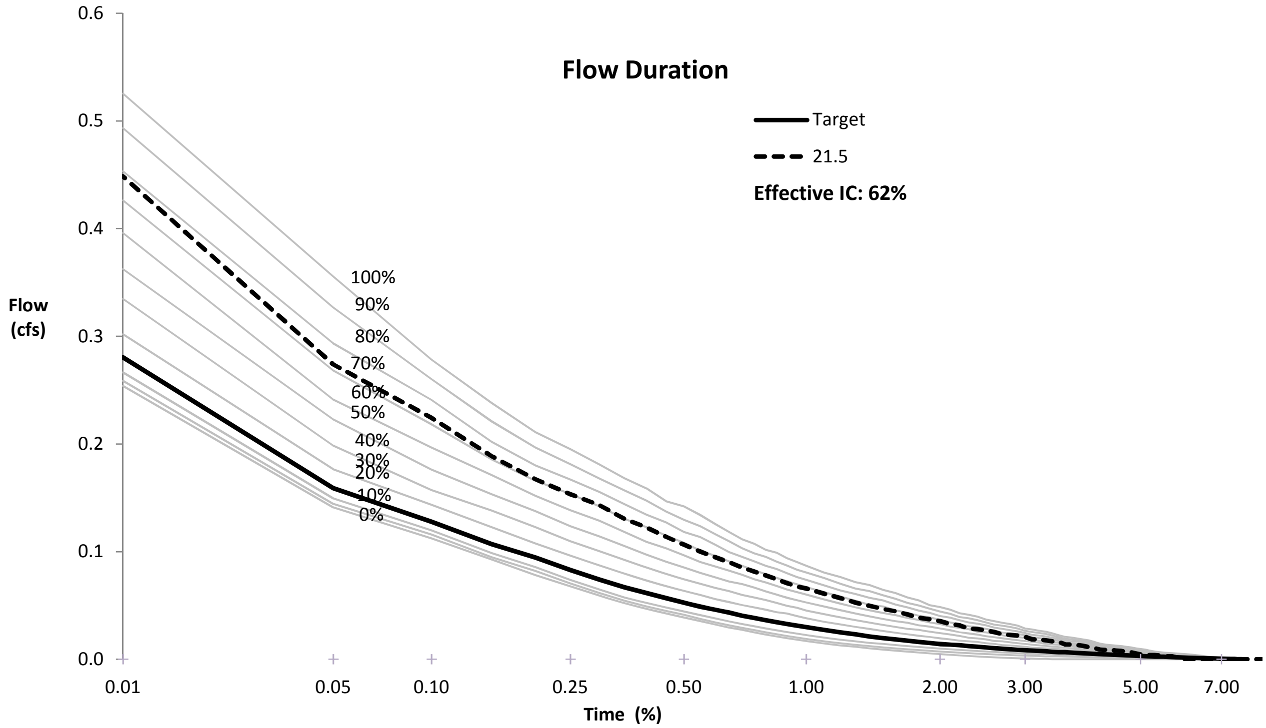
MA93-37 Assessment Model Result Summary for Impervious Cover
21.5 PR BMP 21



Median Annual Load Comparison Table

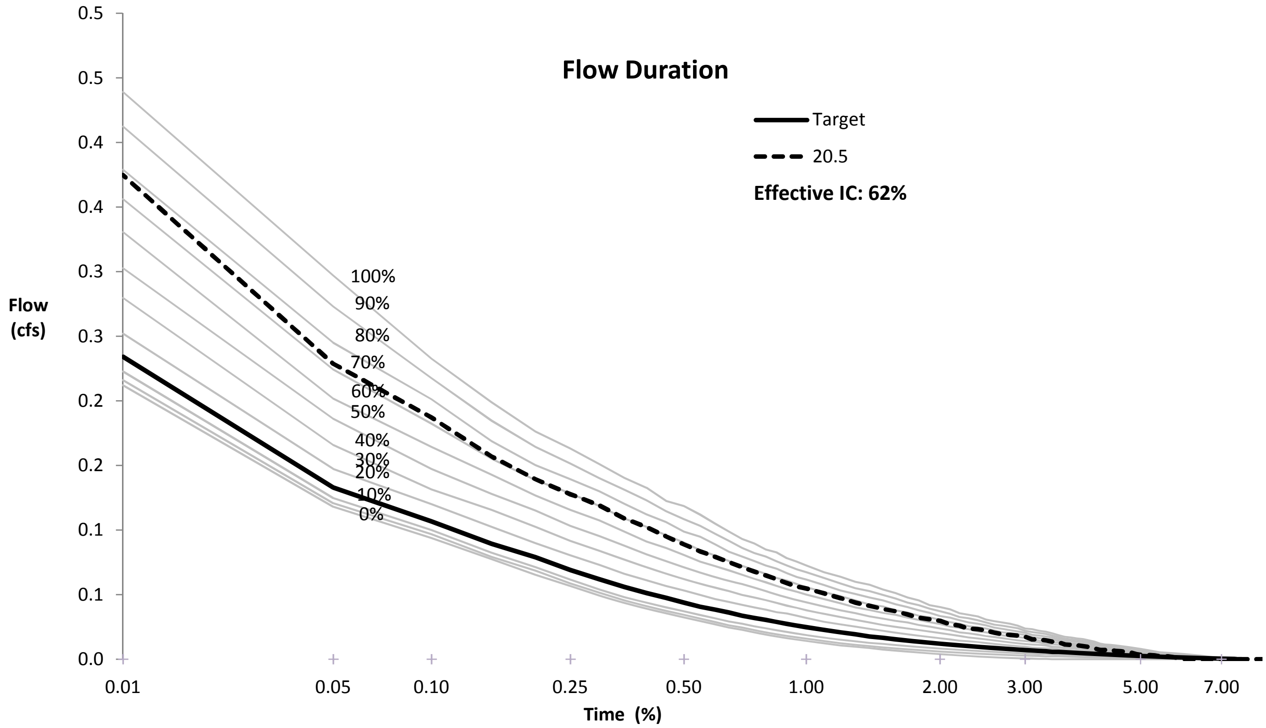
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	0.5	0.0	3
5%IC	0.6	0.1	13
10% IC	0.7	0.1	27
20% IC	0.9	0.2	74
30% IC	1.1	0.3	152
40% IC	1.3	0.5	256
50% IC	1.4	0.7	384
60% IC	1.6	1.0	523
70% IC	1.8	1.2	664
80% IC	2.0	1.5	805
90% IC	2.2	1.7	942
100% IC	2.3	2.0	1,081
Watershed Load	1.76	0.90	464
BMP Output	1.71	1.11	595
Target	0.88	0.18	70
Reduction %	**3%**	**-23%**	**-28%**
Effective IC	**65%**	**65%**	**65%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		0.7
Watershed IC (no BMP)	66%	0.5
Target IC reduction	71%	0.3
Effective IC w/BMP	64%	0.5
IC Reduction	3%	0.0

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-37 Assessment Model Result Summary for Impervious Cover
20.5 PR BMP 22



Median Annual Load Comparison Table

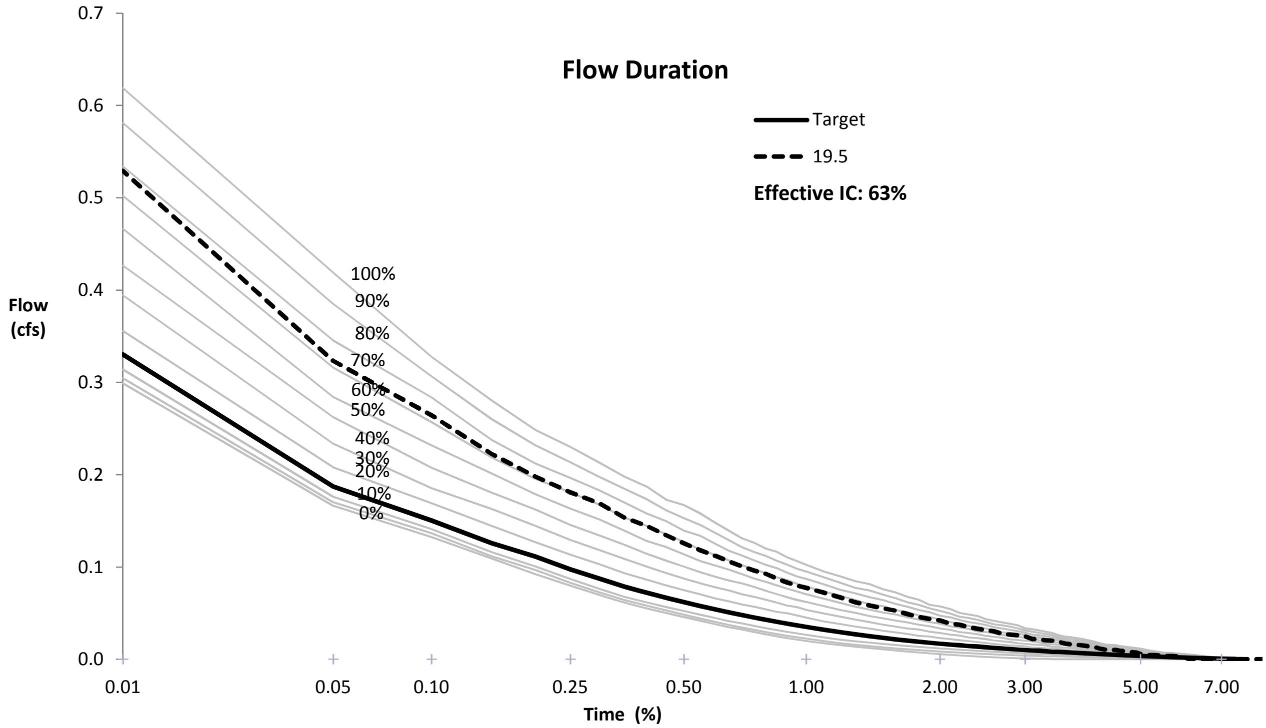
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	0.4	0.0	2
5%IC	0.5	0.1	11
10% IC	0.6	0.1	22
20% IC	0.8	0.2	62
30% IC	0.9	0.3	127
40% IC	1.1	0.4	214
50% IC	1.2	0.6	321
60% IC	1.4	0.8	437
70% IC	1.5	1.0	555
80% IC	1.6	1.2	673
90% IC	1.8	1.4	787
100% IC	1.9	1.6	903
Watershed Load	1.47	0.75	388
BMP Output	1.42	0.92	495
Target	0.74	0.15	59
Reduction %	**3%**	**-23%**	**-28%**
Effective IC	**65%**	**65%**	**65%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		0.6
Watershed IC (no BMP)	66%	0.4
Target IC reduction	71%	0.3
Effective IC w/BMP	64%	0.4
IC Reduction	3%	0.0

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-37 Assessment Model Result Summary for Impervious Cover
19.5 PR BMP 23



Median Annual Load Comparison Table

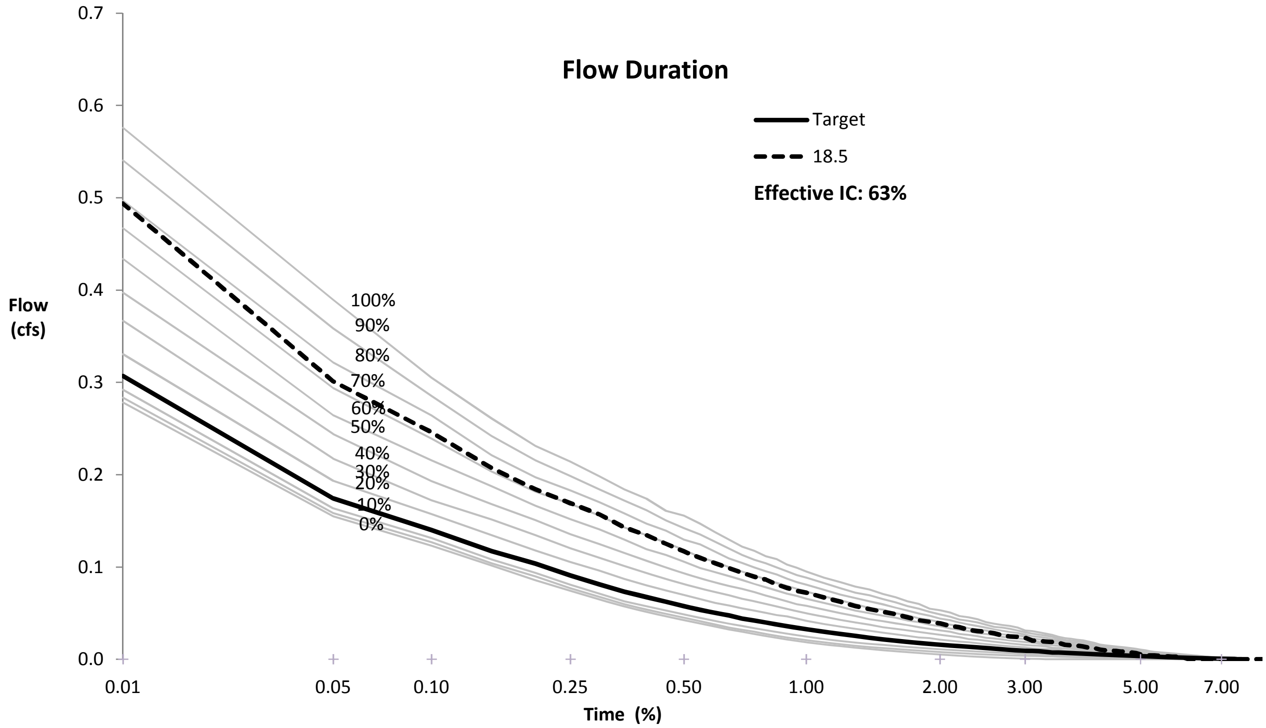
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	0.6	0.0	3
5%IC	0.7	0.1	15
10% IC	0.8	0.1	32
20% IC	1.1	0.2	88
30% IC	1.3	0.4	179
40% IC	1.5	0.6	302
50% IC	1.7	0.9	452
60% IC	1.9	1.2	617
70% IC	2.1	1.5	783
80% IC	2.3	1.7	948
90% IC	2.5	2.0	1,110
100% IC	2.7	2.3	1,274
Watershed Load	2.08	1.06	546
BMP Output	2.03	1.31	702
Target	1.04	0.21	83
Reduction %	**2%**	**-23%**	**-29%**
Effective IC	**66%**	**65%**	**65%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		0.9
Watershed IC (no BMP)	66%	0.6
Target IC reduction	71%	0.4
Effective IC w/BMP	65%	0.6
IC Reduction	2%	0.0

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-37 Assessment Model Result Summary for Impervious Cover
18.5 PR BMP 24



Median Annual Load Comparison Table

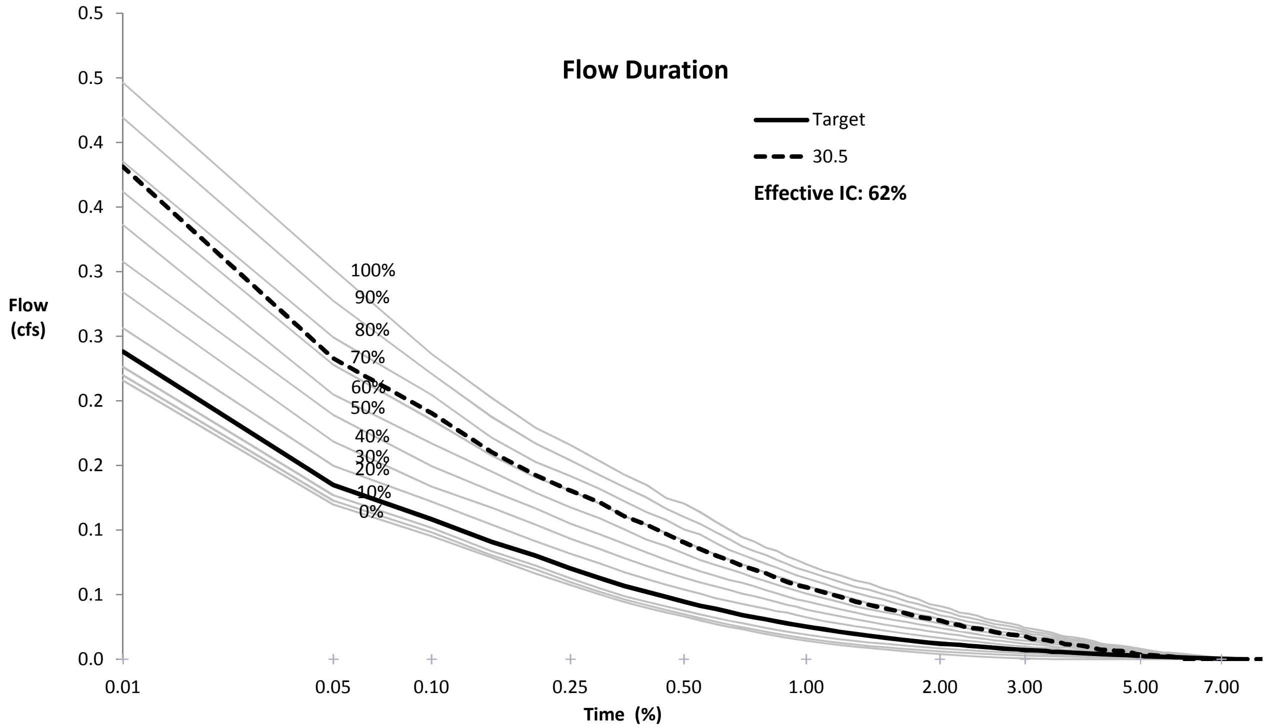
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	0.6	0.0	3
5%IC	0.7	0.1	14
10% IC	0.8	0.1	30
20% IC	1.0	0.2	82
30% IC	1.2	0.4	166
40% IC	1.4	0.6	281
50% IC	1.6	0.8	421
60% IC	1.8	1.1	574
70% IC	2.0	1.3	728
80% IC	2.2	1.6	882
90% IC	2.4	1.9	1,032
100% IC	2.6	2.2	1,185
Watershed Load	1.93	0.99	508
BMP Output	1.88	1.22	653
Target	0.97	0.19	77
Reduction %	**3%**	**-23%**	**-29%**
Effective IC	**66%**	**65%**	**65%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		0.8
Watershed IC (no BMP)	66%	0.5
Target IC reduction	71%	0.4
Effective IC w/BMP	65%	0.5
IC Reduction	2%	0.0

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-37 Assessment Model Result Summary for Impervious Cover
30.5 PR BMP 25



Median Annual Load Comparison Table

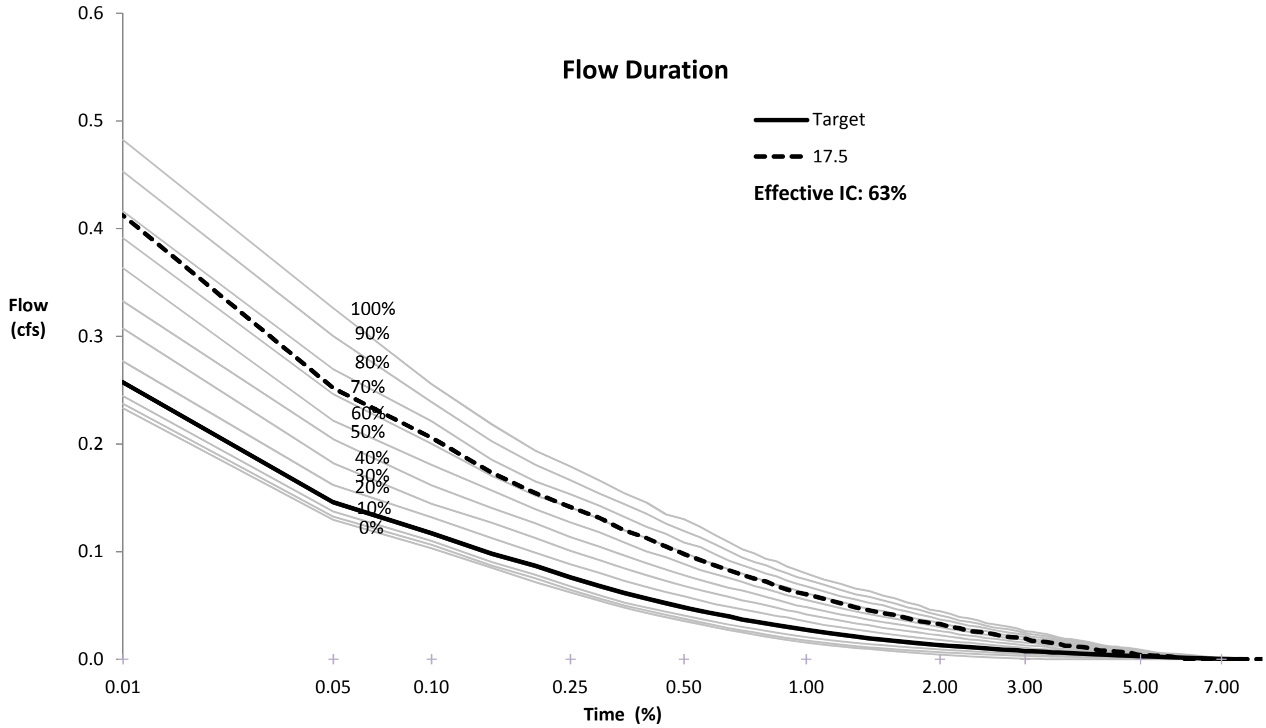
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	0.4	0.0	2
5%IC	0.5	0.1	11
10% IC	0.6	0.1	23
20% IC	0.8	0.2	63
30% IC	0.9	0.3	129
40% IC	1.1	0.4	218
50% IC	1.2	0.6	326
60% IC	1.4	0.8	445
70% IC	1.5	1.0	564
80% IC	1.7	1.3	684
90% IC	1.8	1.5	800
100% IC	2.0	1.7	918
Watershed Load	1.50	0.76	394
BMP Output	1.45	0.94	504
Target	0.75	0.15	60
Reduction %	**3%**	**-23%**	**-28%**
Effective IC	**65%**	**65%**	**65%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		0.6
Watershed IC (no BMP)	66%	0.4
Target IC reduction	71%	0.3
Effective IC w/BMP	64%	0.4
IC Reduction	3%	0.0

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-37 Assessment Model Result Summary for Impervious Cover
17.5 PR BMP 26



Median Annual Load Comparison Table

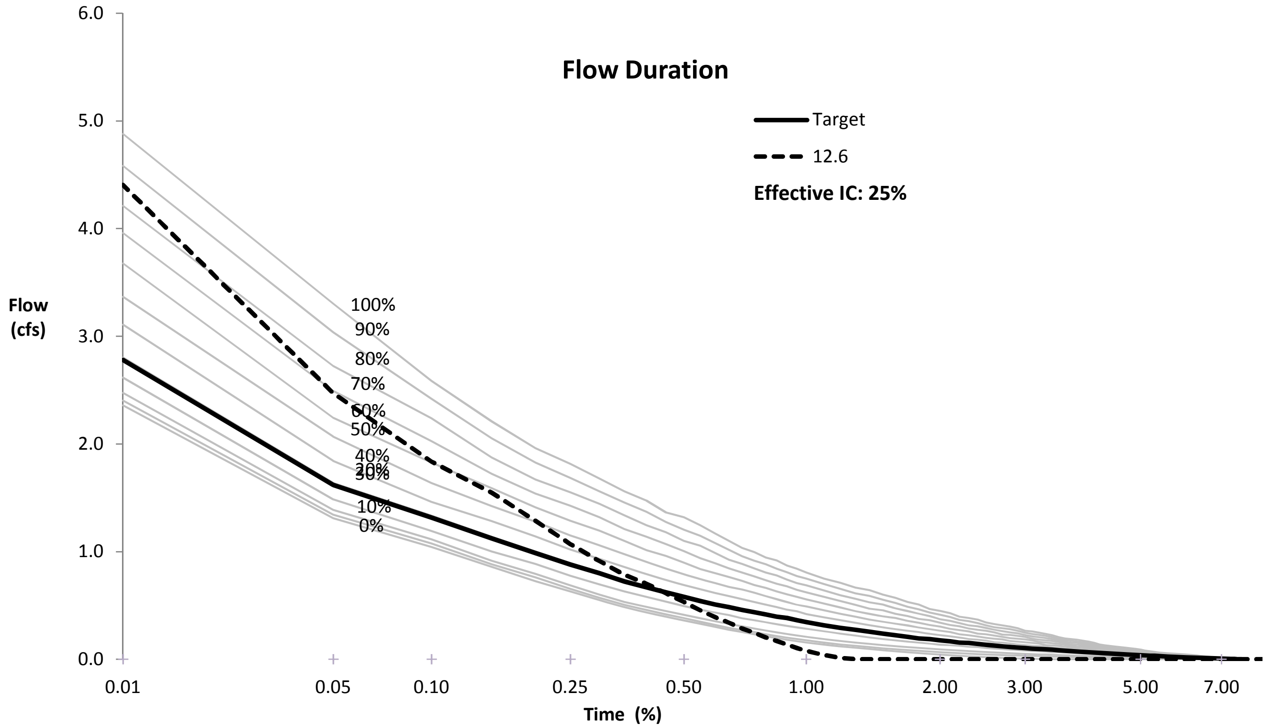
Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	0.5	0.0	2
5%IC	0.6	0.1	12
10% IC	0.7	0.1	25
20% IC	0.8	0.2	68
30% IC	1.0	0.3	139
40% IC	1.2	0.5	235
50% IC	1.3	0.7	352
60% IC	1.5	0.9	480
70% IC	1.6	1.1	610
80% IC	1.8	1.4	739
90% IC	2.0	1.6	864
100% IC	2.1	1.8	992
Watershed Load	1.62	0.83	425
BMP Output	1.57	1.02	546
Target	0.81	0.16	65
Reduction %	**3%**	**-23%**	**-28%**
Effective IC	**65%**	**65%**	**65%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		0.7
Watershed IC (no BMP)	66%	0.4
Target IC reduction	71%	0.3
Effective IC w/BMP	64%	0.4
IC Reduction	3%	0.0

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA93-37 Assessment Model Result Summary for Impervious Cover
12.6 PR BMP 27



Median Annual Load Comparison Table

Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	4.9	0.4	24
5%IC	5.8	0.6	118
10% IC	6.7	0.8	250
20% IC	8.4	1.7	691
30% IC	10.1	3.0	1,410
40% IC	11.8	4.8	2,380
50% IC	13.4	6.9	3,565
60% IC	15.0	9.1	4,861
70% IC	16.7	11.4	6,170
80% IC	18.3	13.8	7,475
90% IC	20.0	16.0	8,747
100% IC	21.6	18.3	10,041
Watershed Load	21.96	13.11	6,998
BMP Output	5.99	1.03	263
Target	9.85	2.87	1,321
Reduction %	**73%**	**92%**	**96%**
Effective IC	**6%**	**12%**	**10%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		6.8
Watershed IC (no BMP)	99%	6.7
Target IC reduction	71%	4.8
Effective IC w/BMP	14%	1.0
IC Reduction	85%	5.7

* Effective IC calculated as follows:
1. Interpolate effective IC separeately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effetive percentage % by using linear interpolation of percentage to closest load/volumevalues
   b. For flow duration, calculate average of individually interpolat4ed values taken at equal probablity interbals (based on Normal distribution)
2. Determine the maximum IC indicator for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

Impaired Waters Assessment for Unnamed Tributary "Town Line Brook" (MA93-51)

Impaired Waterbody

Name: Unnamed Tributary (locally referred to as "Town Line Brook")

Location: Malden, Everett and Revere, MA

Water Body ID: MA93-51

Impairments

The Unnamed Tributary (MA93-51), "Town Line Brook", is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). The Unnamed Tributary (MA93-51) is impaired by the following causes:

- taste and odor
- fecal coliform
- (alteration in stream-side or littoral vegetative covers*)
- (physical substrate habitat alterations*)
- (other flow regime alterations*)
- (debris/floatables/trash*)

Impairments for primary contact, secondary contact and aesthetics are attributed to fecal coliform bacteria, trash and debris, and odor (MassDEP, 2007). The sources of these contaminants are presumed to be discharges from separate storm sewer systems, sanitary sewer overflows, urban runoff/storm sewers and potentially illicit connections (MassDEP, 2007). The Unnamed Tributary iscovered by the Final Pathogen TMDL for the North Coastal Watershed (MassDEP, 2012).

Relevant Water Quality Standards

Water Body Classification: Class SA

Applicable State Regulations:

- *314 CMR 4.05 (3)(b) 5 Solids*. These waters shall be free from floating, suspended and settleable solids in concentrations or combinations that would impair any use assigned to this class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.
- *314 CMR 4.05 (4)(a) 8 Taste and Odor.* None other than of natural origin.
- *314 CMR 4.05 (4)(a) 4 Bacteria*.
    - a. Waters designated for shellfishing: fecal coliform shall not exceed a geometric mean Most Probable Number (MPN) of 14 organisms per 100 ml, nor shall more than 10% of the samples exceed an MPN of 28 per 100 ml, or other values of equivalent protection based on sampling and analytical methods used by the Massachusetts Division of Marine Fisheries and approved by the National Shellfish

Sanitation Program in the latest revision of the Guide For The Control of Molluscan Shellfish (more stringent regulations may apply, see 314 CMR 4.06(1)(d)(5));

- b. at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010, no single enterococci sample taken during the bathing season shall exceed 104 colonies per 100 ml, and the geometric mean of the five most recent samples taken within the same bathing season shall not exceed a geometric mean of 35 enterococci colonies per 100 ml. In non bathing beach waters and bathing beach waters during the non bathing season, no single enterococci sample shall exceed 104 colonies per 100 ml and the geometric mean of all samples taken within the most recent six months typically based on a minimum of five samples shall not exceed 35 enterococci colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department.

- *314 CMR 4.05 (5)(b) Bottom Pollutants or Alterations*. All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.

Site Description

The Unnamed Tributary, locally known as “Town Line Brook” (MA93-51) is a tidal river that extends from Route 99 in Malden 1.6 miles east to its confluence with Pines River (MA93-15) at the Route 1 bridge in Revere (Figure 1). The Unnamed Tributary (MA93-51) watershed includes urban, industrial and densely developed residential areas in the Towns of Malden, Everett and Revere (Figure 1). Much of the watershed is drained through Municipal Separate Storm Sewer Systems (MS4s); however, maps of stormwater system infrastructure and catchments were not available to assist with the delineation of the watershed. Based on the USGS Data Series 451 watershed delineations (USGS, 2009), the watershed contributing to the Unnamed Tributary is approximately 2,730 acres and it includes areas in Malden, Revere, Everett and Melrose.

MassDOT’s property that directly contributes stormwater runoff to the Unnamed Tributary is comprised of approximately 0.26 miles of Squire Road (Route 60) from the Route 1 rotary to the Malden and Revere boundary *(*Figure 2*).* This road is a divided road with turning lanes into adjacent commercial properties and includes portions of the western side of the rotary on and off ramps (Figure 2). East of the Unnamed Tributary, stormwater drains from this road segment through catch basins and connecting storm drain pipes to a trunk line located along the northern side of the road. This trunk line discharges directly into the Unnamed Tributary at the bridge (Figure 2). West of the Unnamed Tributary, stormwater drains from this road segment through catch basins and connecting storm drains to a trunk line located along the northern side of the road that discharges directly into the Unnamed Tributary at the bridge. According to MassDOT drainage plan sets 9161, 6899 and 4618, stormwater runoff from Route 1 is not conveyed to the Unnamed Tributary.

Assessment under BMP 7U

The following impairment for the Unnamed Tributary (MA93-51) has not been addressed by a TMDL. Therefore, MassDOT assessed the impairment using the approach described in BMP 7U of MassDOT’s Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT’s Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of stormwater on many impairments. For this water body, MassDOT used the IC method to assess the following impairment:

- taste and odor

According to MassDEP's final *Massachusetts Year 2012 Integrated List of Waters*, the causes of the water quality impairments; alteration in stream-side or littoral vegetative covers, physical substrate habitat alterations, other flow regime alterations, and debris/floatables/trash are not caused by pollutants (MassDEP, 2013). Therefore, these causes are not considered further in this assessment.

The primary and secondary contact impairment from the presence of fecal coliform is assessed separately in the section titled Assessment of Pathogen Impairment.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the IC reduction required to ensure that stormwater is not the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% IC, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

Assessment

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451 (USGS, 2009). When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. IC data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer.

In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which IC would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective IC reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective IC reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective IC reductions is described in BMP 7U. When the reduction in effective IC achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for the Unnamed Tributary (MA93-51):

Table 1. Site Parameters for Unnamed Tributary (MA93-51)

Total Watershed and Subwatershed		
Watershed Area	2,730	acres
Impervious Cover (IC) Area	1,300	acres
Percent Impervious	47.5*	%
IC Area at 9% Goal	246	acres
Target Reduction % in IC	81.0	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	2.1	acres
MassDOT's Target Reduction in Effective IC (81.0% of DOT Directly Contributing IC)	1.7	acres

*****Rounding accounts for differences in calculations.

The subwatershed is greater than 9% impervious cover, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 81.0%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 1.7 acres.

<u>Existing BMPs</u>

There are no existing BMPs in the Unnamed Tributary (MA93-51) directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to the Unnamed Tributary.

Mitigation Plan

There are no existing structural BMPs in place to mitigate the effects of MassDOT impervious surfaces that directly discharge to the Unnamed Tributary (MA93-51). Therefore, MassDOT considered the implementation of additional BMPs to reach the target reduction of 1.7 acres.

Based on review of the MassDOT directly contributing drainage area, the installation of structural BMPs to address the impairments of the Unnamed Tributary is not feasible due to the direct connection of the storm drainage system from Squire Road (Route 60) to the Unnamed Tributary and the lack of available right-of-way along this highly developed section of road. The 80-foot right-of-way for Squire Road is used in this area for travel lanes, passing lanes and turning lanes. Also, the locations of the outfalls from the storm drainage system in this area do not provide adequate areas for end of pipe treatment.

Assessment of Pathogen Impairment under BMP 7R

MassDOT assessed the pathogen impairment using the approach described in BMP 7R of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and*

Mitigation Plan), which applies to impairments that have been assigned to a water body covered by a final TMDL. Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by an order of magnitude within a given storm event at a single location (MassDEP, 2009b). Therefore, it is difficult to predict pathogen concentrations in stormwater with accuracy. Due to this difficulty, MassDOT generally will not conduct site specific assessments of loading at each location impaired for pathogens. Instead these sites will be assessed collectively based on available information on pathogen loading from highways, MassDOT actions, and information available from EPA and DEP. Based on this information MassDOT developed an approach to be consistent with relevant TMDL and permit condition requirements and an iterative adaptive management approach to stormwater management.

In addition, while there is a positive relationship between IC and pathogen loading, the relationship is not as direct as other impairments. According to the Center for Watershed Protection "…Other studies show that concentrations of bacteria are typically higher in urban areas than rural areas (USGS, 1999), but they are not always directly related to IC (CWP, 2003)." Therefore, DOT did not rely solely on the IC method to assess pathogen impairments. Instead, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

Pathogens in MassDOT Discharge

A study conducted on MassDOT's South East Expressway measured bacterial concentrations in stormwater runoff (Smith, 2002). This study found a geometric mean of 186 fecal coliforms/100 ml. Concentrations of pathogens in stormwater runoff from roadways can vary widely and pathogen concentrations in runoff across the state likely deviate significantly from this stretch of roadway's specific estimate. Event mean concentrations of fecal coliform bacteria in urban stormwater from other sources ranging between 14,000 and 17,000 fecal coliform organisms/100 mL have been reported (MassDEP, 2009b). These data suggest that pathogen loading from highways may be lower than other urban areas.

Consideration of the potential sources of pathogens supports the idea that pathogens are present in lower concentrations in highway runoff since potential pathogen sources are likely to be less prevalent in the highway environment than along other urban roadways:

- <u>Illicit discharges:</u> Due to the typical setback of highways from residential and commercial developments and the stand alone nature of the drainage system, the potential for illicit discharges (e.g. sewer connections, laundry tie-ins) is much lower than in other stormwater systems. This has been confirmed by MassDOT's illicit discharge detection on many miles of urban roadways within a broad range of areas across Massachusetts. After assessment of almost 140 miles, and investigation of more than 2,500 stormwater features, MassDOT's consultant performing the broad scope reviews has found no confirmed illicit discharges.
- <u>Limited Sewer Utilities in Road Right of Ways:</u> Since DOT does not provide sewer services, many MassDOT roads do not have sewer utilities within the road's right of way; thereby eliminating the chance of cross-connections or leaking pipes as a source of pathogens into the stormwater system.
- <u>Pet waste:</u> Pets are only present on highways in rare instances. In urban residential areas pets and their associated waste are much more common. MassDOT is aware that pet waste at road side rest stops may represent a potential source of pathogens to stormwater in certain situations.
- <u>Wildlife:</u> Highways are not generally an attractive place for wildlife. Wildlife generally avoids highways and only occasionally crosses them.

The dearth of pathogen sources on highways and the relatively low concentrations of pathogens measured in the South East Expressway study together suggest that pathogen loading from stormwater runoff from highways is lower than other urban sources.

Furthermore, in almost all cases the contribution of pathogens from MassDOT to a specific water body is likely to be very small relative to other sources of pathogens in the watershed. Since MassDOT urban roadways are linear and usually cross watersheds, they represent a small fraction of the receiving water body's watershed. The water quality within these water bodies is dependent on discharge from various sources, including discharges from other stormwater systems and a large number of other factors.

Assessment

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

TMDLs for pathogen impairments in Massachusetts recognize that pathogens are highly variable and difficult to address and emphasize the need for an iterative adaptive management approach to address pathogens. Examples of relevant language from these TMDLs are included below:

- "given the vast potential number of bacteria sources and the difficulty of identifying and removing them from some sources such as stormwater require an iterative process and will take some time to accomplish. While the stated goal in the TMDL is to meet the water quality standard at the point of discharge it also attempts to be clear that MassDEP's expectation is that for stormwater an iterative approach is needed…" (MassDEP, 2009a)
- "The NPDES permit does not, however, establish numeric effluent limitations for stormwater discharges. Maximum extent practicable (MEP) is the statutory standard that establishes the level of pollutant reductions that regulated municipalities must achieve. The MEP standard is a narrative effluent limitation that is satisfied through implementation of SWMPs and achievement of measurable goals."(MassDEP, 2009b)
- "Although the TMDL presents quantified WLAs for stormwater that are set equivalent to the criteria in the Massachusetts Water Quality Standards, the Phase II NPDES permits will not include numeric effluent limitations. Phase II permits are intended to be BMP based permits that will require communities to develop and implement comprehensive stormwater management programs involving the use of BMPs. Massachusetts and EPA believe that BMP based Phase II permits involving comprehensive stormwater management together with specific emphasis on pollutants contributing to existing water quality problems can be consistent with the intent of the quantitative WLAs for stormwater discharges in TMDLs." (MassDEP, 2002).

This language clearly indicates that an iterative adaptive management approach is the appropriate way to address discharges to pathogen impaired waters. The recommendations in pathogen TMDLs for waters in Massachusetts generally require development and implementation of stormwater management programs, illicit discharge detection and elimination efforts, and in some cases installing BMPs to the maximum extent practicable.

The draft North Coastal Watershed General MS4 permit and the draft Interstate, Merrimack, and South Coastal (IMS) watershed permits contain specific requirements for compliance with pathogen TMDLs (in Appendix G). While these permits are still in draft form, MassDOT believes they represent the best available guidance on what EPA believes is appropriate for addressing stormwater discharges to pathogen-impaired waters. Section 2.2.1(c) of the permit states "For any discharge from its MS4 to impaired waters with an approved TMDL, the permittee shall comply with the specific terms of Part 2.1 of this permit. In addition, where an approved TMDL establishes a

WLA that applies to its MS4 discharges, the permittee shall implement the specific BMPs and other permit requirements identified in Appendix G to achieve consistency with the WLA." Appendix G references a number of programmatic BMPs that are necessary to address pathogen loading. These cover the following general topics:

- Residential educational program
- Illicit connection identification, tracking and removal
- Pet waste management

Mitigation Plan

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Stormwater Management Plan (SWMP) including educational programs, illicit connection review and source control. The specific BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In
- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

In addition, the structural BMPs that will be considered to reduce the IC will also have the effect of reducing pathogen loads.

MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations. MassDOT's existing stormwater management plan outlines BMPs that include education and illicit discharge detection and elimination. MassDOT will be implementing a pet waste management program at its rest stops that have discharges to pathogen impaired waters.

Conclusions

MassDOT used the IC Method to assess the Unnamed Tributary (MA93-51) for the impairments identified in MassDEP's final *Massachusetts Year 2012 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed by 1.7 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to the Unnamed Tributary to identify existing BMPs and found that no BMPs exist to reduce effective IC. This information is summarized in Table 2 below.

Table 2. Effective IC Reductions under Existing & Proposed Conditions

IC in Directly Contributing Watershed	2.1	acres
Target Reduction in Effective IC	1.7	acres
IC Effectively Reduced by Existing BMPs	0	acres
IC Remaining to Mitigate	**1.7**	**acres**

MassDOT should reduce its effective IC within the directly contributing watershed by an additional 1.7 acres to achieve the targeted reduction in IC. However, due to the limited land area available within the MassDOT right-of-way and the direct connection from Squire Road storm drains to the Unnamed Tributary, there are no feasible options for the removal of effective IC by structural BMPs. Therefore, no additional actions will be taken as part of the Retrofit Initiative of the MassDOT Impaired Waters program for this water body.

MassDOT has concluded based on review of the draft North Coastal Watershed General MS4 permit, the draft Interstate, Merrimack, and South Coastal watershed permits, and pathogen TMDLs for Massachusetts waters, that the BMPs outlined in the stormwater management plan and those under consideration for reducing effective IC from MassDOT areas are consistent with its existing permit requirements. MassDOT believes that these measures achieve pathogen reductions (including fecal coliform) to the maximum extent practicable and are consistent with the intent of its existing stormwater permit and the applicable Pathogen TMDLs.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of additional BMPs, and finalized assessments including reductions achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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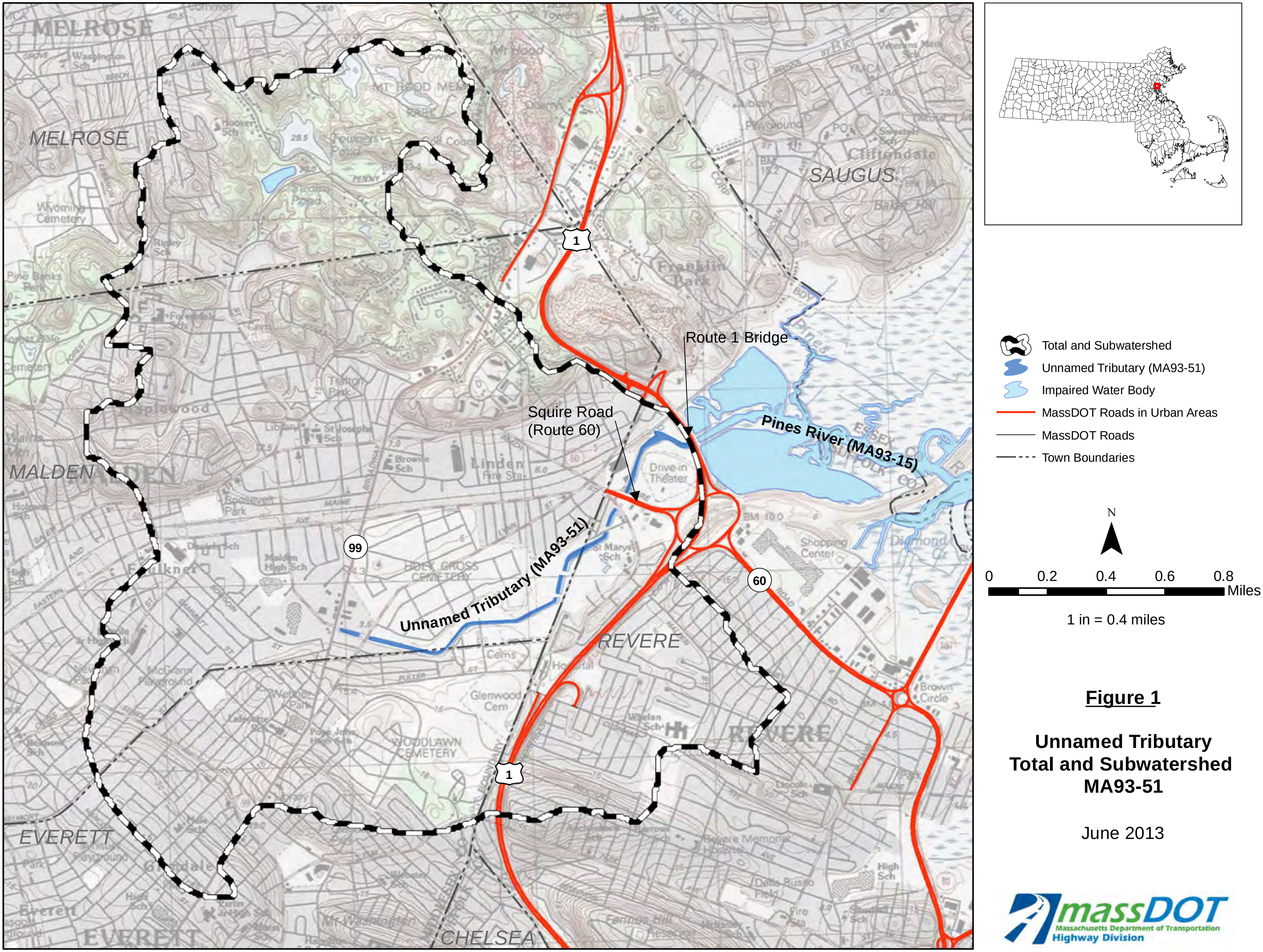
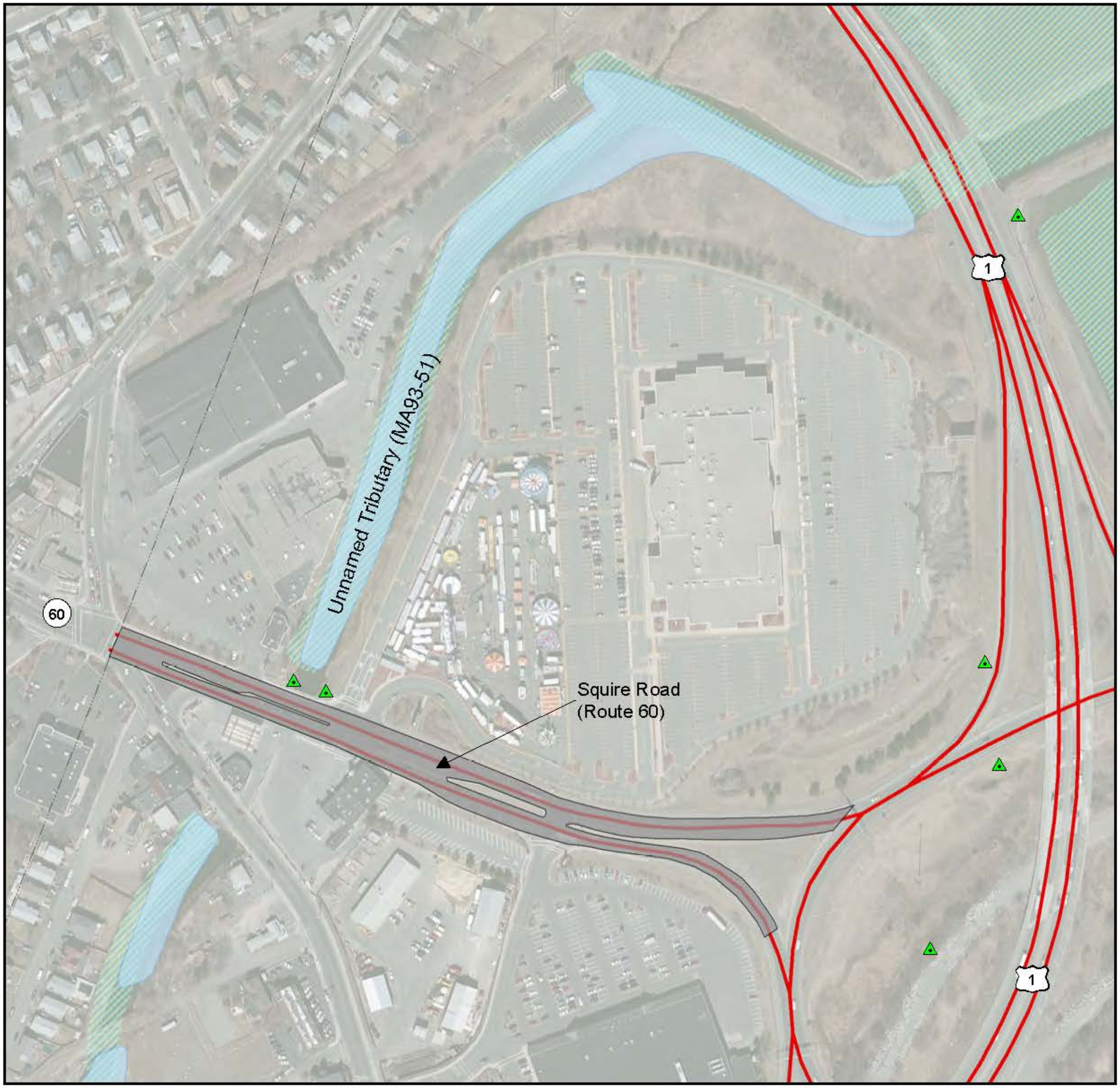


Figure 1

Unnamed Tributary
Total and Subwatershed
MA93-51

June 2013

massDOT Massachusetts Department of Transportation Highway Division



Stormwater Outfall

MassDOT Direct IC Watershed

Impaired Water Body

NWI Wetland Areas

MassDOT Roads in Urban Areas

Town Boundaries

N

0 125 250 375 500 Feet

1 inch = 250 feet

Figure 2

Unnamed Tributary
MA93-51
MassDOT Directly
Contributing Watershed

June 2013

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