Attachment 2:

Progress Reports

List of Impaired Water Bodies

Waterbody ID	Waterbody Name
MA34-05	Connecticut River
MA35056	Parker Pond
MA35101	Whitney Pond
MA70-03	Dorchester Bay
MA71-05	Malden River
MA73-03	Neponset River
MA73-04	Neponset River
MA73-22	Pequid Brook
MA74-02	Weir River and MA74011 Foundry Pond
MA74-16	Accord Brook
MA84A-02	Merrimack River
MA84A-03	Merrimack River
MA84A-04	Merrimack River
MA84A-29	Lowell Canals
MA93-39	Proctor Brook

Impaired Waters Assessment for Connecticut River (MA34-05) – Progress Report

Impaired Water Body

Name: Connecticut River

Location: Agawam, West Springfield, Springfield, Longmeadow, Holyoke, Chicopee and South Hadley, MA

Water Body ID: MA34-05

Impairments

The Connecticut River (MA34-05) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). Segment MA34-05 of the Connecticut River is impaired for the following:

- PCB in fish tissue
- Escherichia coli
- Total Suspended Solids (TSS)

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *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.*
  - 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.

Site Description

Segment MA34-05 of the Connecticut River begins at the Holyoke Dam in South Hadley, MA and continues 15.9 miles through the towns of Holyoke, Chicopee, West Springfield, Springfield, Agawam, and Longmeadow. The segment ends at the southwest corner of Longmeadow.

The segment of the Connecticut River upstream of Segment MA34-05 is Segment MA34-04. While this assessment addresses only the impairments of Segment MA34-05, the upstream river segment is included in the subwatershed of Segment MA34-05, as shown in Figure 1 since the watershed is based on the USGS “ds451 hydro units” GIS layer.

MassDOT owns several urban roadways in the subwatershed of Segment 34-05, including portions of Route 141, Easthampton Road ramps, Lyman Street, Cabot Street, McKinstry Avenue, Route 116, Route 202, Route 33, Route 202, Interstate 91 (I-91), Interstate 391 (I-391), Route 5, Interstate 90 (I-90), Interstate 291 (I-291), Route 57, Route 159 and River Road. The drainage along each roadway is briefly described below. The directly contributing MassDOT watershed areas are shown in Figures 2 through 13.

We have not included portions of MassDOT roadways which drain to combined sewer (CSO) drainage systems and are treated by local waste water treatment plants (WWTP). The intent of the Impaired Waters Program Retrofit Initiative is to construct storm water best management practices (BMPs) in locations where currently impaired waters are receiving direct runoff from MassDOT roads. Since areas draining to CSOs are receiving treatment through the WWTP, and since separation of waste water and storm water systems is a large undertaking beyond the scope of the Retrofit Initiative, MassDOT has decided to assess portions of MassDOT roads in urban areas

draining to CSOs during more wholesale Programmed Projects rather than as part of the Retrofit Initiative

I-91 and Ramps

I-91 is a major highway which runs adjacent to the Connecticut River for much of its length. For the portion of I-91 and its ramps shown in Figures 2 and 3, much of the stormwater is captured by singular catch basins connected to pipes perpendicular to the roadway which discharge to adjacent vegetated areas. There are also drainage systems in which stormwater is captured by catch basins and then conveyed to trunklines located along the roadway. One of the trunklines discharges to a small pond west of the river. The rest of these trunklines also discharge to vegetated areas along the side of the road. In addition, some stormwater is captured by combined sewer systems (CSO). Since none of these drainage systems directly drain to Segment 34-05, they were not included as directly contributing MassDOT IC area.

For the portion of I-91 shown in Figures 6 through 8 as well as the portion of I-91 labeled “a” in Figure 9, there are many different drainage systems that capture and discharge stormwater to Segment MA34-05. The I-91 bridge shown in Figure 6, which spans the river, drains to Segment MA34-05 via a trunkline outlet, which receives stormwater from scuppers along the bridge. These portions were included as directly contributing IC area and are shaded gray in the figures. The urban portions of I-91 and its ramps shown in figures 6 through 9 that are not shaded in were not included as directly contributing IC area. Based on field observations and drainage information from the surrounding municipalities, catch basins on these portions of roadway connect to CSO systems owned by the corresponding municipality or discharge to other water bodies, wetlands or land areas instead of directly to the river.

For the portion of I-91 labeled “b” in Figures 9 and 10, drainage plans dated 1972 indicate that a major trunkline along I-91 discharges stormwater to the Connecticut River via an outfall located adjacent to the I-91 southbound lanes between the ramp for Rte 5 southbound to I-91 northbound and the ramp for I-91 northbound to Rte 5 northbound. An outfall from drainage along I-91 northbound and southbound could not be identified in this area due to biological restrictions (i.e. excessive poison ivy). However, an outfall from the ramp for Rte 5 southbound to I-91 northbound was identified in this grassy area. Water from this outfall flows to a conveyance ditch with standing water. Although it could not be investigated in the field, there is likely a culvert under the ramp that carries water from this ditch directly to the Connecticut River. Therefore, this ditch in the grassy area downstream of the suspected outfall location supports what is shown on the plans. Thus, this portion of I-91 was also included as directly contributing MassDOT property in this assessment.

There is a different drainage system along the portion of I-91 labeled “c” in Figure 10. Outfalls for this system could not be confirmed in the field due to a chain-link fence along the highway. However, because the Connecticut River runs adjacent and in close proximity to I-91 along this area, this portion of I-91 likely discharges to the river. Therefore, this portion of I-91 was included as directly contributing MassDOT property in this assessment.

The portion of I-91 labeled “d” in Figures 10 and 11 runs adjacent to the Connecticut River. During the field visit, AECOM staff determined that the available plans did not match the drainage system out in the field. Therefore, the staff attempted to open the drainage manholes to verify the direction of flow and outfall locations, but the manholes were sealed. In addition, the field teams could not locate the final outfalls from this section of road due to a chain-link fence along the roadway. However, due to the proximity of the roadway to the river, this portion of I-91 is included as directly contributing MassDOT area.

South of this stretch, I-91 begins to veer farther from the river (see the portion of I-91 labeled "e" in Figure 11). At the Massachusetts-Connecticut line, I-91 is 4,300 feet away from the river. There are fields, wooded areas, wetlands, water bodies, roads and a railroad separating I-91 from the river along this stretch. Again, during the field visit, the staff attempted to open the drainage manholes to verify the direction of flow and outfall locations, but the manholes were sealed. A review of the general topography led the staff to make an educated assumption that the road drains to the low spots along this stretch of roadway and discharges to the wooded areas and wetlands adjacent to the highway. Although no outfalls were confirmed in the field due to biological restrictions (i.e. excessive poison ivy), this this section of I-91 was assumed to discharge to adjacent wooded areas and wetlands and thus was not included as directly contributing MassDOT property in this assessment.

The portion of I-91 labeled "f" in Figure 12 is urban. There are fields, wooded areas, wetlands, water bodies, a railroad and roads separating this portion of I-91 from the river. During the field visit, AECOM staff determined that the available plans did not match the drainage system existing in the field. Therefore, the staff attempted to open the drainage manholes to verify the direction of flow and outfall locations, but the manholes were sealed. Even after careful review, the field teams could not locate the final outfalls from this section of road. A review of the general topography led the staff to make an educated assumption that the road drains to the low spots along this stretch of roadway and discharges to the wooded areas and wetlands adjacent to the highway. Since, under this assumption, the road does not drain directly to the Connecticut River, this portion of I-91 was not included as directly contributing IC area.

Route 5

The Northampton Street portion of Route 5 (shown in Figure 2) is located where Route 5 is adjacent to Segment MA34-04 of the Connecticut River and is over 9,800 feet away from the assessment segment (MA34-05). Based on the field investigation, the stormwater from this portion of roadway either discharges to one of the non-impaired streams which flows under Route 5, or to nearby Segment MA34-04 (upstream segment). Therefore, it was not included as directly contributing IC area in this assessment.

The drainage system along the southern Northampton Street portion of Route 5 (shown in Figure 3) connects to the Town of Holyoke drainage system. This town system discharges directly to Segment MA34-04, the segment of the Connecticut River upstream of Segment MA34-05. Therefore, this portion of roadway was not included as directly contributing IC area.

The urban area bridge along the Ingleside Street portion of Route 5 is located approximately 970 feet from Segment MA34-05, as shown in Figure 4. It appears that stormwater from this bridge is conveyed to the river. This bridge was therefore included as directly contributing MassDOT IC area.

Main Street is the portion of Route 5 in Holyoke shown in Figure 5. Storm water from this portion of Route 5 discharges to a wetland area. Therefore, this section of Route 5 was not included as direct in this assessment.

Riverdale Street is the portion of Route 5 in West Springfield shown in Figure 5. Stormwater along the Riverdale Street portion is conveyed to non-impaired streams which pass under Route 5 or to wetland areas. This portion of roadway was not included as directly contributing IC area.
The urban portion of Route 5 shown in Figure 6 discharges stormwater to non-impaired streams which cross under the roadway. This portion was not included as directly contributing IC area in this assessment.

Route 5 runs directly adjacent to Segment MA34-05 of the Connecticut River for much of its length in Figures 7 and 8. The shaded portion of Route 5 in these figures discharges stormwater directly to the river. Much of the drainage along this portion of Route 5 consists of lines of catch basins located perpendicular to the length of the roadway and are connected by a pipe which discharges at the river bank.

There are two traffic circles along Route 5. One is shown in Figures 7 and 8 and the other is shown in Figure 9. Portions of these traffic circles discharge stormwater to the river via drainage systems along Route 5 and its ramps. Stormwater along the other portions of these traffic circles is collected by catch basins that connect to West Springfield drainage systems which discharge to segment 34-05. Therefore, all of the traffic circles were included as directly contributing MassDOT IC area in this assessment.

A system of drainage features in the rotary connecting River Road, Route 57 and Route 5 discharges storm water to the Westfield River, which is not impaired (See Figure 10). Stormwater from the portion of Route 5 within the rotary/ramp interchange is captured by catch basins in this system. Therefore, Route 5 was not included as directly contributing MassDOT property in this assessment.

Route 141

MassDOT owns two small urban area bridges on Appleton Street, a portion of Route 141. These bridges, shown in Figure 3, are located over canals that convey water to Segment MA34-05 of the Connecticut River. However, the stormwater from these bridges enters CSO systems that discharge to the WWTP located adjacent to the Connecticut River. Therefore, these bridges were not included as directly contributing MassDOT property in this assessment.

A small portion of the Grattan Street section of Route 141 contributes stormwater directly to the Connecticut River via a piped system. This portion was included as direct IC area and is shown in Figure 4.

Lyman Street Bridge (Figure 3)

MassDOT owns two small urban bridges on Lyman Street. These bridges are located over canals that convey water to Segment MA34-05 of the Connecticut River. However, the stormwater from these bridges enters CSO systems that convey the stormwater to the WWTP located adjacent to the Connecticut River. Therefore, these bridges were not included as directly contributing MassDOT property in this assessment.

Easthampton Road Ramps (Figure 3)

The drainage systems along the ramps to and from Easthampton Road connect to the Town of Holyoke drainage system. This town system discharges directly to Segment MA34-04, the segment of the Connecticut River upstream of Segment MA34-05. Therefore, these portions of roadway were not included as directly contributing IC area.

Route 202 (Figure 3)

Route 202 is located perpendicular to the Connecticut River, spanning both sides of the river and crossing the river by bridge. As can be seen in Figure 3, the bridge crosses Segment MA34-04, the segment of the river upstream of Segment MA34-05. Also, according to MassDOT drainage plans

(5153) dated 1958, stormwater from Route 202 is conveyed to the segment upstream of Segment MA34-05 via catch basins that outfall to paved ditches. Therefore, Route 202 was not included as directly contributing MassDOT property in this assessment.

Route 116

Stormwater from the urban portion of Route 116 in Figure 6 is captured by catch basins and is piped along Route 116 towards a 42-inch reinforced concrete pipe, which discharges directly to Segment MA34-05. Therefore, this portion of Route 116 was included as directly contributing MassDOT IC area in this assessment.

The urban portion of Bridge Street/North Bridge Street along Route 116, shown in Figure 13, crosses over segment MA34-05 via a bridge. The highest point along the bridge is at its center. Scuppers along the bridge convey stormwater to drainage features at both ends of the bridge. At the south end of the bridge, the features discharge stormwater to the river. At the north end of the bridge, features discharge stormwater to a separate tributary which flows into the river. However, this tributary is well-channelized and flows a short distance before merging with the river. This portion of Route 116 was included as directly contributing MassDOT property in this assessment.

The Cabot Street portion of Route 116 shown in Figure 4 includes a bridge that crosses the Connecticut River as well as a small bridge over a canal that flows to the river. According to Holyoke city drainage plans, combined sewer systems in this area convey stormwater to the WWTP at the bank of Segment MA34-05. Therefore, the Cabot Street portion of Route 116 was not included as directly contributing MassDOT property in this assessment.

I-391

The majority of the portion of I-391 and its ramps in Figure 4 discharge stormwater directly to Segment MA34-05 and are included as directly contributing MassDOT property in this assessment. The drainage systems are comprised of catch basins that connect to trunklines conveying stormwater to the river. A small section of I-391 and a ramp discharge stormwater to wetlands adjacent to the ramp. These sections were not included as direct IC in this assessment.

Stormwater from the portion of I-391 in Figure 6 labeled “a” discharges to a non-impaired stream and pond. This portion was not included as directly contributing IC area.

The portion of I-391 labeled “b” in Figure 6 contributes stormwater directly to Segment MA34-05. Stormwater along this section of roadway is collected by catch basins and is then piped to a 42” reinforced concrete pipe that discharges directly to the river.

The portion of I-391 labeled “c” in Figure 6 also contributes stormwater directly to the river. Along this section, stormwater is captured by catch basins and piped to a ditch on the west side of the roadway. It is conservatively assumed that stormwater that enters this ditch merges with an existing stream flowing towards the river, is culverted beneath Route 116, and likely discharges at the river. Therefore, this roadway is included as directly contributing MassDOT IC area for this assessment.

I-90 (Figure 5)

The I-90 bridge over Segment MA34-05 and small portions of I-90 east and west of the bridge are included as directly contributing MassDOT IC area in this assessment. Stormwater from the I-90 bridge is captured by scuppers along both sides of the bridge. Stormwater along the portions of I-

90 east and west of the river is captured by catch basins that discharge to ditches located adjacent to the roadway that convey stormwater to the river.

Route 33 (Figure 13)

There are two separate portions of Route 33 within the subwatershed of MA34-05, each over 0.9 miles away from the Connecticut River. Commercially and residentially developed land separates Route 33 from the river. Based on drainage plans dated 1975, trunklines along Route 33 conveystormwater along the roadway and outside of the subwatershed. Therefore, Route 33 was not included as directly contributing IC area in this assessment.

Ramps at Route 5/I-90/I-91 Interchange (Figure 5)

The ramp interchange for Route 5, I-90 and I-91 consists of a number of ramps, many of which fall within the subwatershed of Segment MA34-05. Two of these ramps and a portion of a straight-of-way area contribute stormwater directly to the river. Stormwater from these ramps is captured by catch basins, which discharge to outfalls in ditches along the ramps. Ditches along the outside of the ramps discharge stormwater directly to the river and the ditch inside the ramp conveys water to a culvert which then flows to the river.

McKinstry Avenue (Figure 4)

A small bridge on McKinstry Avenue is owned by MassDOT. Based on the slope of this road, it is likely that stormwater from the bridge flows west along McKinstry Avenue and is piped directly to the river. Therefore, this bridge was included as directly contributing IC area.

I-291

The drainage system along the majority of I-291 within the subwatershed of MA34-05 consists of catch basins and pipes along the ramp, connectors, and main roadway, which convey stormwater to a main trunkline that discharges directly to Segment MA34-05. As shown in Figures 7 and 8, stormwater from some of the MassDOT-owned ramps along I-291 enter catch basins, which are part of the Springfield municipal drainage system, which is conservatively assumed to discharge to the river; therefore, these ramps were included as directly contributing IC area. However, some ramps have catch basins which are known to drain to a CSO system that conveys stormwater and sewerage to the WWTP in Springfield. Thus, these areas of I-291 were not included as directly contributing MassDOT IC area.

Route 20 (Figure 7)

The urbanized portion of MassDOT-owned Route 20 within the subwatershed consists of three bridges. One of these bridges spans the Connecticut River, one crosses over I-91 northeast of river, and the third is located on Route 20 between the two aforementioned bridges. The bridge over the river discharges stormwater directly to the river via scuppers that drop into the river below. There are no drainage features on the bridge over I-91. Stormwater from half of this bridge likely enters the drainage system on the ramps to I-91, which discharges directly to the river. Because Route 20 northeast of the bridge over the river is sloped down towards the river, it is conservative to assume that stormwater from the other half of this bridge discharges directly to the river. Similarly, there are no drainage features on the bridge between the two aforementioned bridges, and it is therefore also conservative to assume that stormwater from this bridge enters the river. Thus, the three bridges on Route 20 were included as directly contributing IC area in this assessment.

Memorial Bridge (Figure 8)

The Memorial Bridge spans Segment MA34-05 of the Connecticut River. Scuppers along the bridge capture stormwater which ultimately discharges to the river. The northeast continuation of the Memorial Bridge also discharges stormwater directly to the river. Stormwater along this portion is captured by catch basins connected to a trunkline, which can be seen suspended under the northeast end of the bridge. This pipe discharges to the river. Therefore, the Memorial Bridge and its continuation of roadway were included as directly contributing IC area.

River Road

As shown in Figures 10 and 11, the majority of River Road discharges stormwater directly to the Connecticut River. Stormwater from the northern portion of River Road is collected in catch basins and is piped to two outfalls on the riverbank, one on each side of the Route 5 bridge located over River Road and the Connecticut River. River Road is located directly adjacent to the river for approximately 2.2 miles and veers farther from the river as it approaches Route 159. Where the road runs close to the river, frequent, individual piped systems convey storm water from a catch basin to an outfall at the river via pipes perpendicular to the centerline of the roadway. Where the river is farther from the roadway, stormwater drains to a series of multiple catch basins connected by a pipe system that conveys water to larger outfalls at the river.

Route 57 (Figure 10)

A system of drainage features in the rotary connecting River Road, Route 57 and Route 5 discharges storm water to the Westfield River, which is not impaired. Before the merge of Route 57 with the rotary, a 30 to 36-inch pipe conveys drainage from Route 57 towards the Westfield River, perpendicular to the centerline of the roadway. An outfall was not identified in the field, however, based on the direction of this pipe, it either flows north towards the Westfield River, likely discharging there, or connects to the drainage system in the rotary, which discharges to the Westfield River. In either case, the storm water from Route 57 does not directly discharge to the Connecticut River.

Main Street (Route 159) (Figure 11)

Storm water from Route 159 is collected in catch basins and discharges to various non-impaired streams which flow under or in close proximity to the roadway. Therefore, Route 159 is not included as directly contributing MassDOT property in this assessment.

Assessment under BMP 7U

None of the impairments for Segment 34-05 of the Connecticut 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:

- Total Suspended Solids (TSS).

MassDOT also 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 storm water 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 *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 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.

Using this approach, MassDOT derived the following site parameters for Segment MA34-05 of the Connecticut River:

Table 1. Site Parameters for Connecticut River (MA34-05)

Type	Parameter	Quantity	Unit of Measure
Subwatershed	Subwatershed Area	22,046	acres
Subwatershed	Impervious Cover (IC) Area	6,416	acres
Subwatershed	Percent Impervious	29.1*	%
Subwatershed	IC Area at 9% Goal	1,984	acres
Subwatershed	Target Reduction% in IC	69*	%
Reductions Applied	MassDOT's IC Area Directly Contributing to Impaired Segment	237.8	acres
Reductions Applied	MassDOT's Target Reduction in Effective IC (69.0% of DOT Directly Contributing IC)	164.3	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 69.0%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage.

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 are assessed 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, and has a pet waste management program underway to address this source where necessary.
- 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 pet waste management program at its rest stops that have discharges to pathogen impaired waters.

Conclusions

MassDOT used the IC Method to assess Segment (MA34-05) of the Connecticut 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 164.3 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed and did not identify any existing BMPs. This information is summarized in Table 2 below.

Table 2. Effective IC Reductions under Existing & Proposed Conditions

Parameter	Quantity	Unit of Measure
IC in Directly Contributing Watershed	237.8	acres
Target Reduction in Effective IC	164.3	acres
IC Effectively Reduced by Existing BMPs	0	acres
IC Remaining to Mitigate with Proposed BMPs	164.3	acres

MassDOT should reduce its effective IC within the directly contributing watershed by 164.3 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.

Portions of MassDOT urban area roads that drain to combined sewer systems will be addressed during work under the Programmed Project Initiative of the Impaired Waters Program. 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 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 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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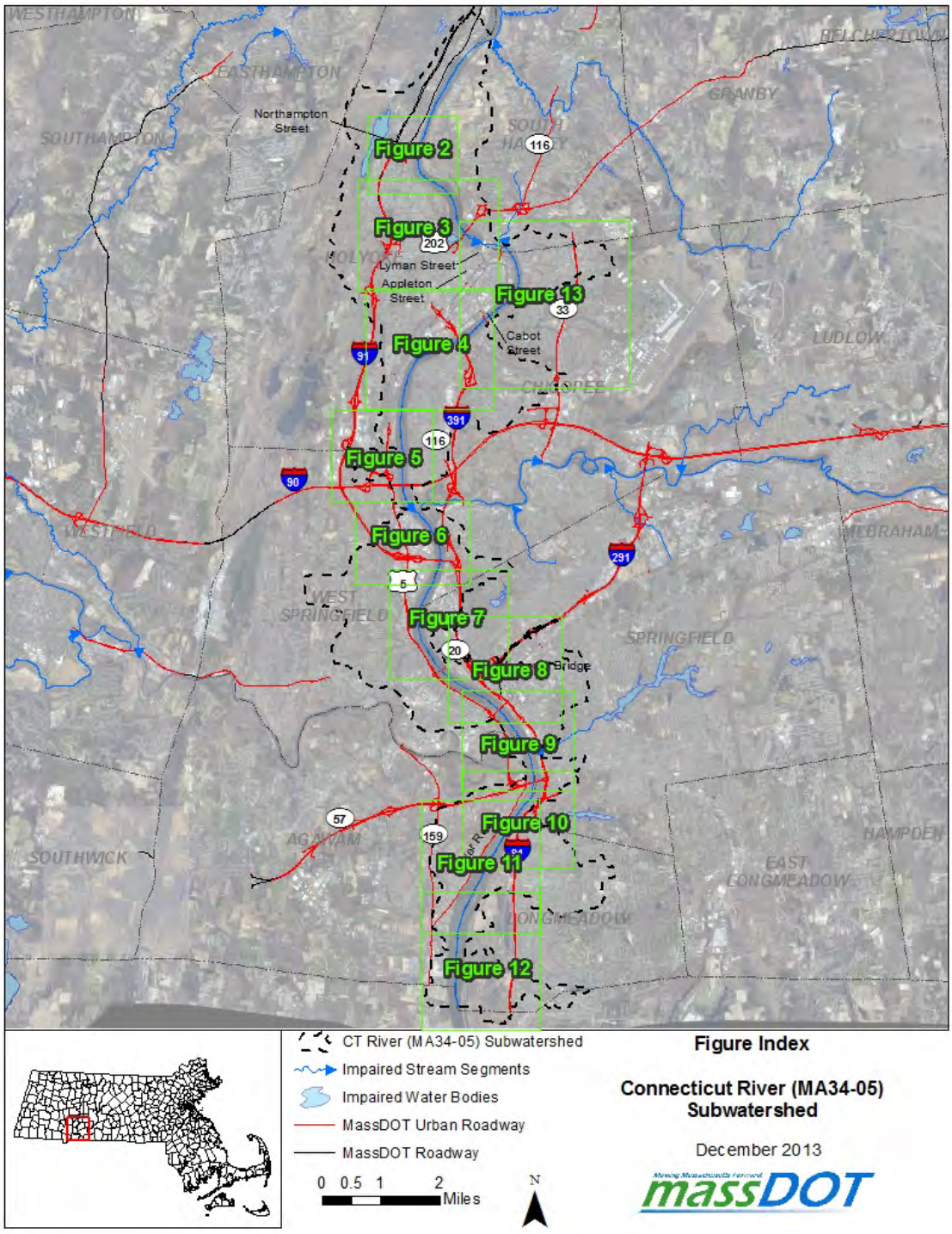


Figure 2
Figure 3
Figure 4
Figure 5
Figure 6
Figure 7
Figure 8
Figure 9
Figure 10
Figure 11
Figure 12
Figure 13
Northampton Street
Lyman Street
Appleton Street
Cabot Street
Bridge
CT River (MA34-05) Subwatershed
Impaired Stream Segments
Impaired Water Bodies
MassDOT Urban Roadway
MassDOT Roadway
0 0.5 1 2 Miles
N
Figure Index
Connecticut River (MA34-05) Subwatershed
December 2013
massDOT

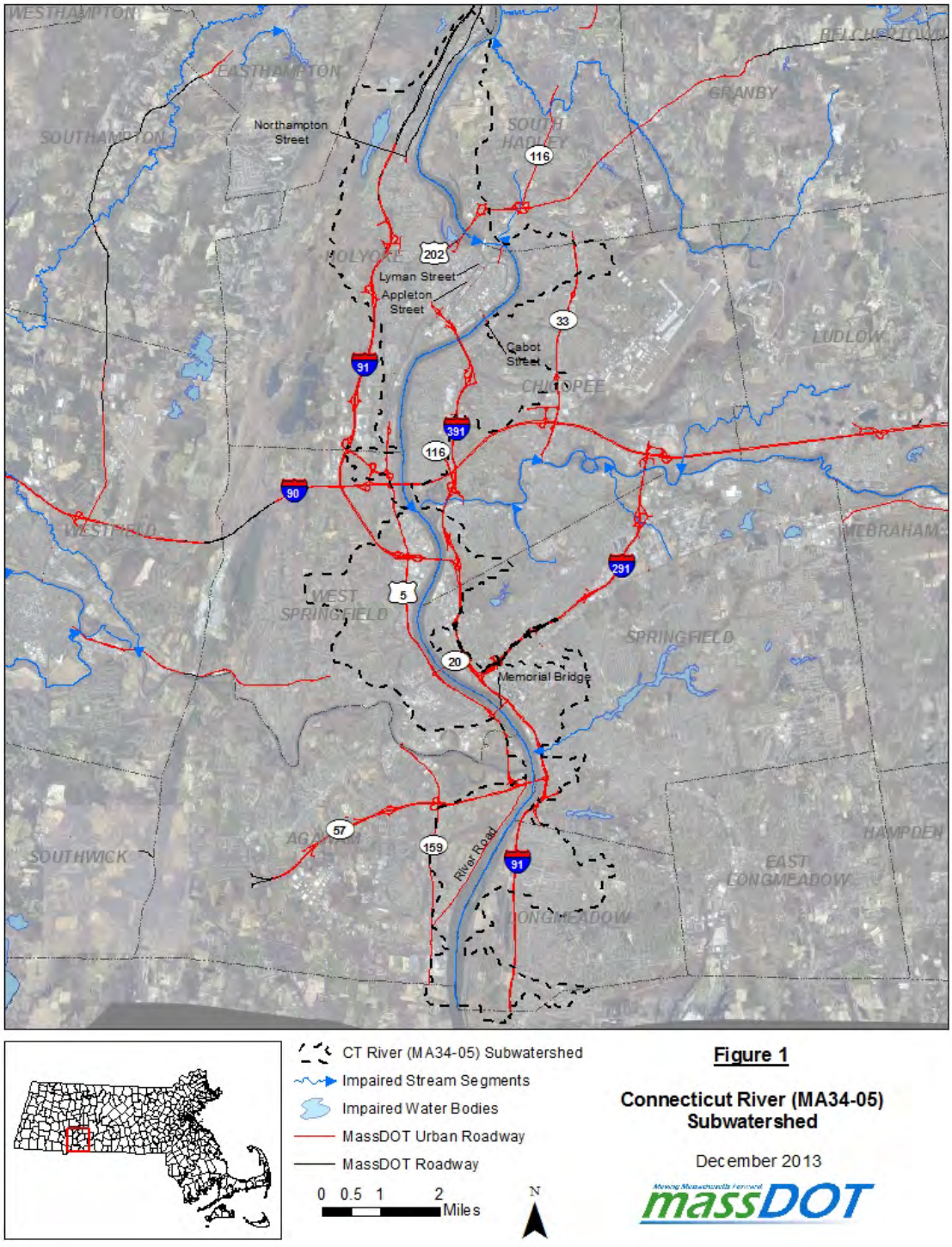


Figure 1

Connecticut River (MA34-05) Subwatershed

December 2013

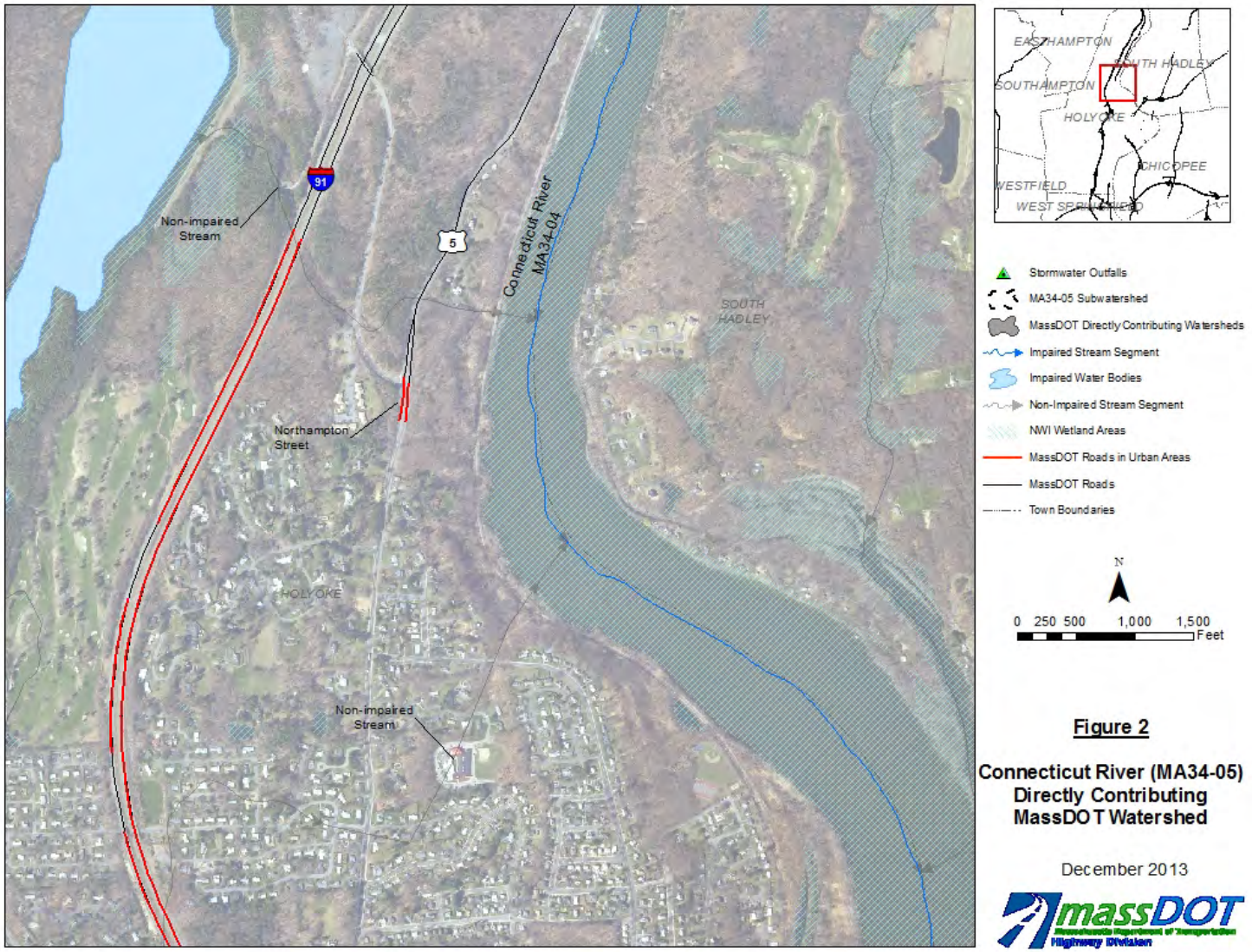
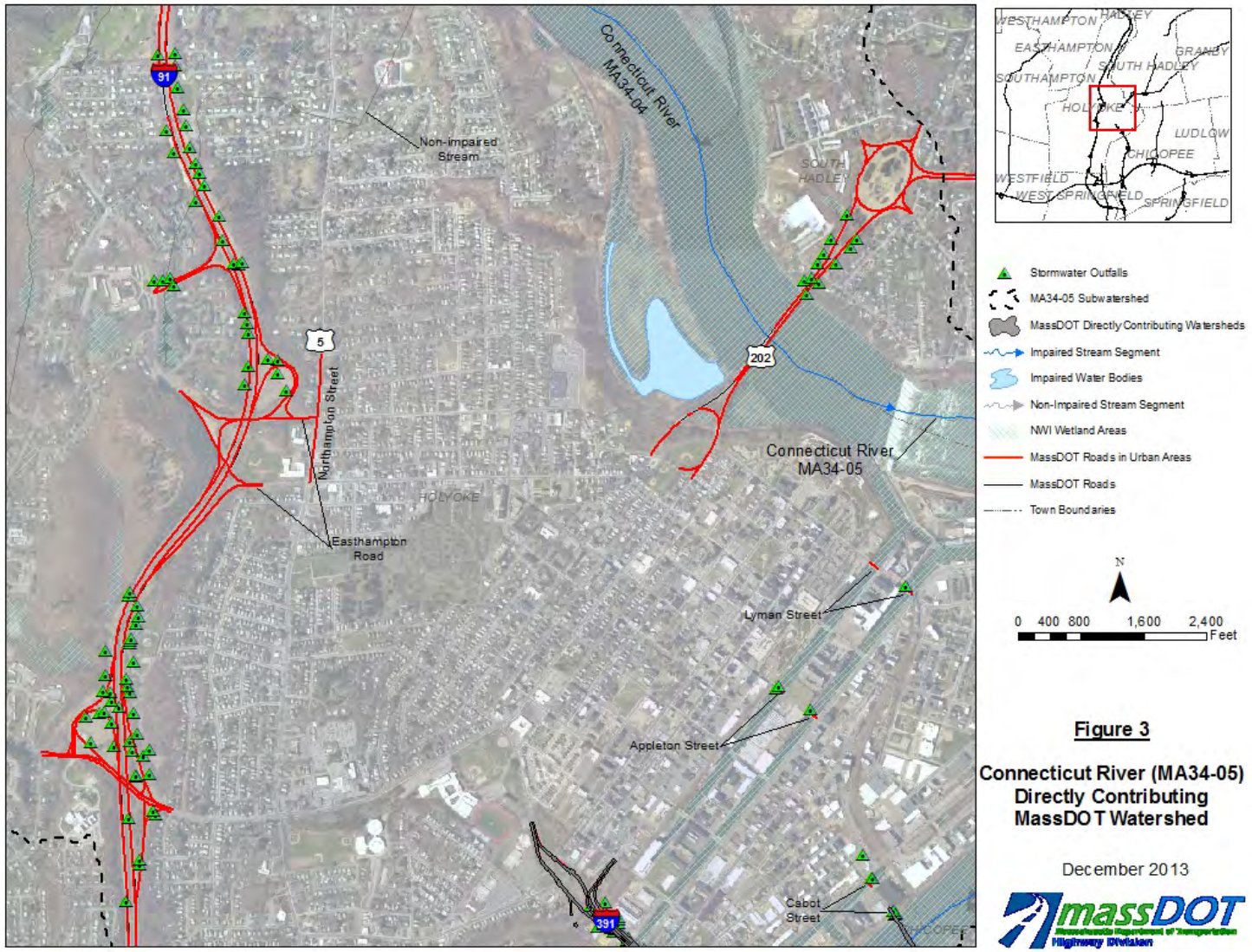


Figure 2

Connecticut River (MA34-05) Directly Contributing MassDOT Watershed

December 2013



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Connecticut River (MA34-05) Directly Contributing MassDOT Watershed

December 2013

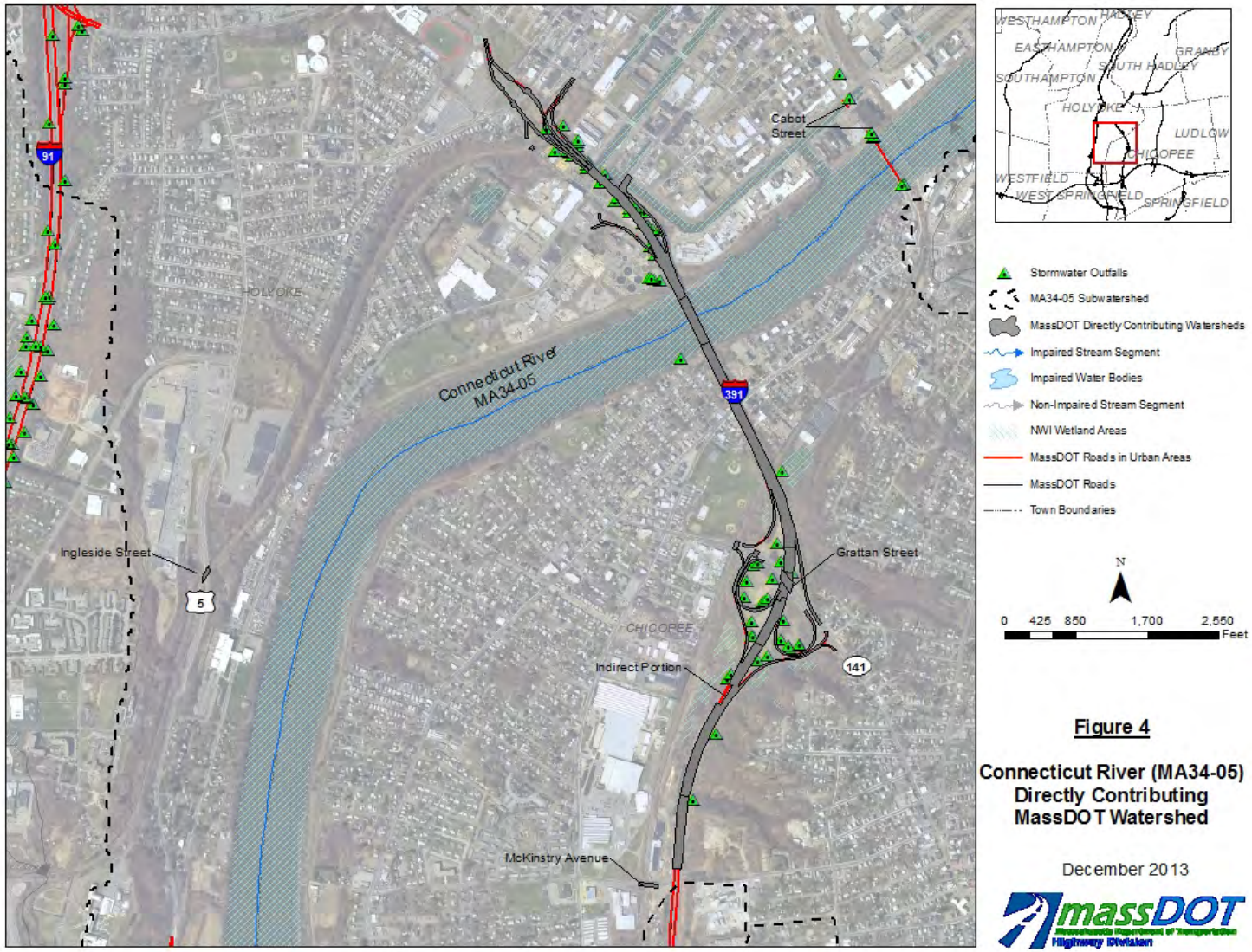

Figure 4

Connecticut River (MA34-05) Directly Contributing MassDOT Watershed

December 2013

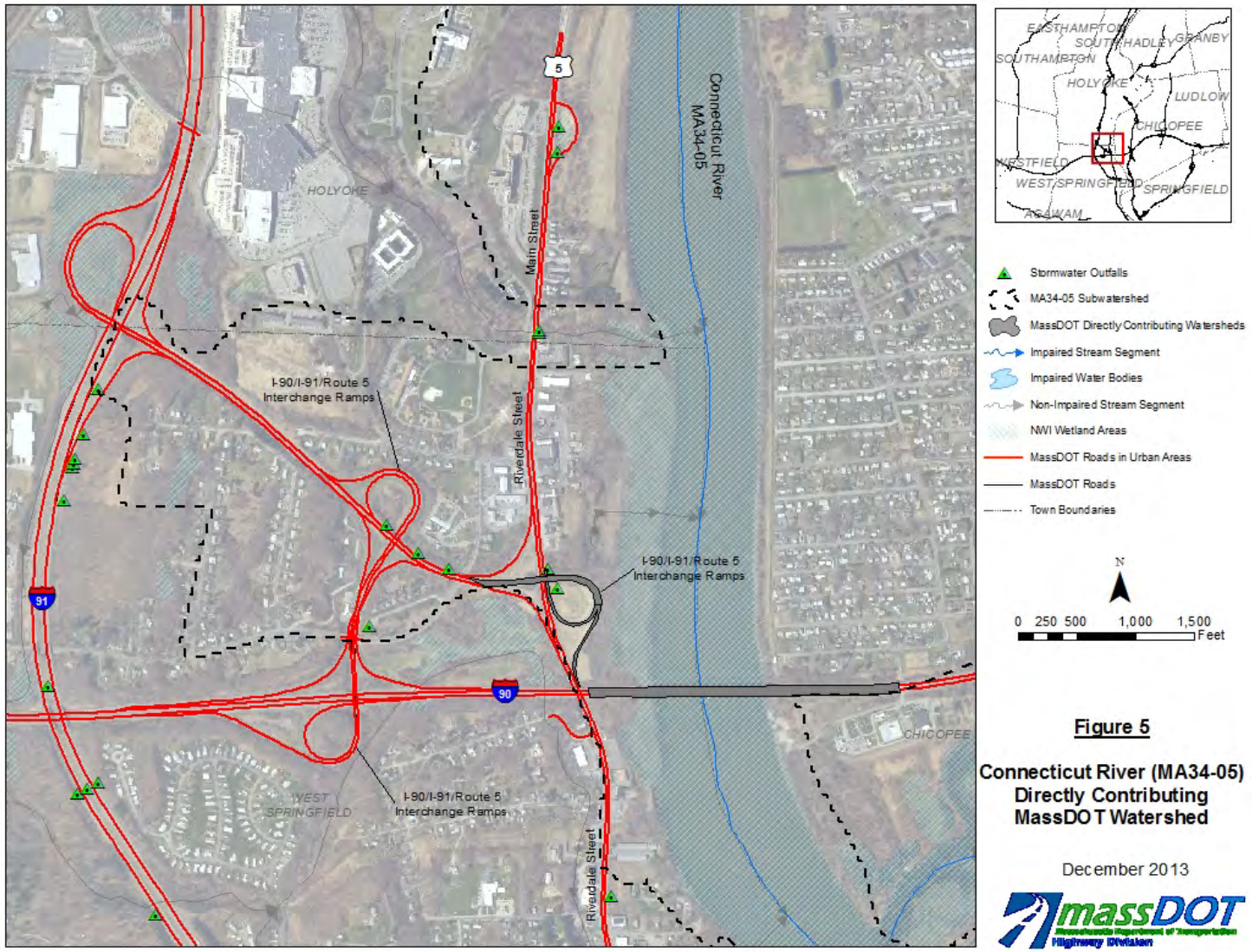

Figure 5

Connecticut River (MA34-05) Directly Contributing MassDOT Watershed

December 2013

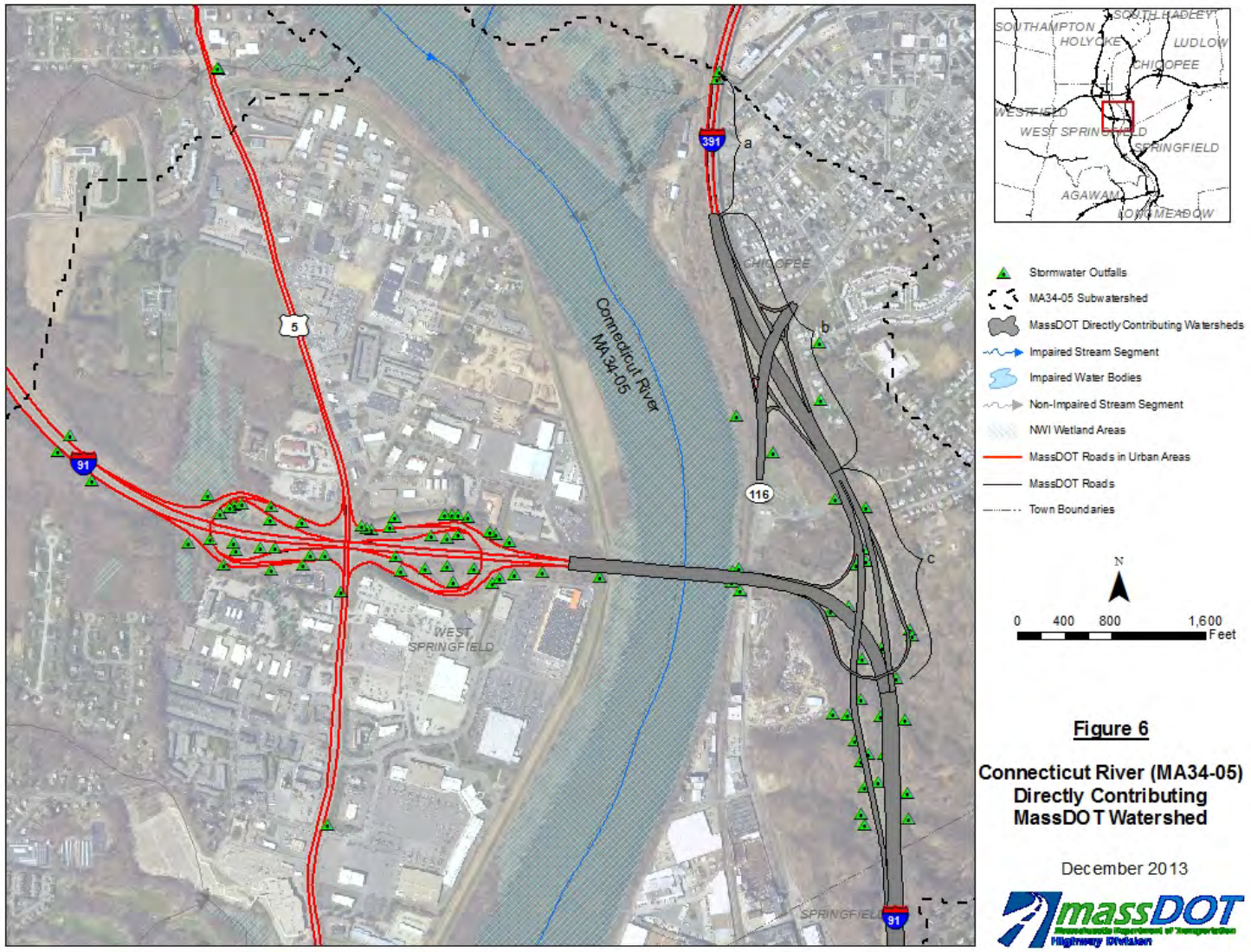

Figure 6

Connecticut River (MA34-05)
Directly Contributing
MassDOT Watershed

December 2013

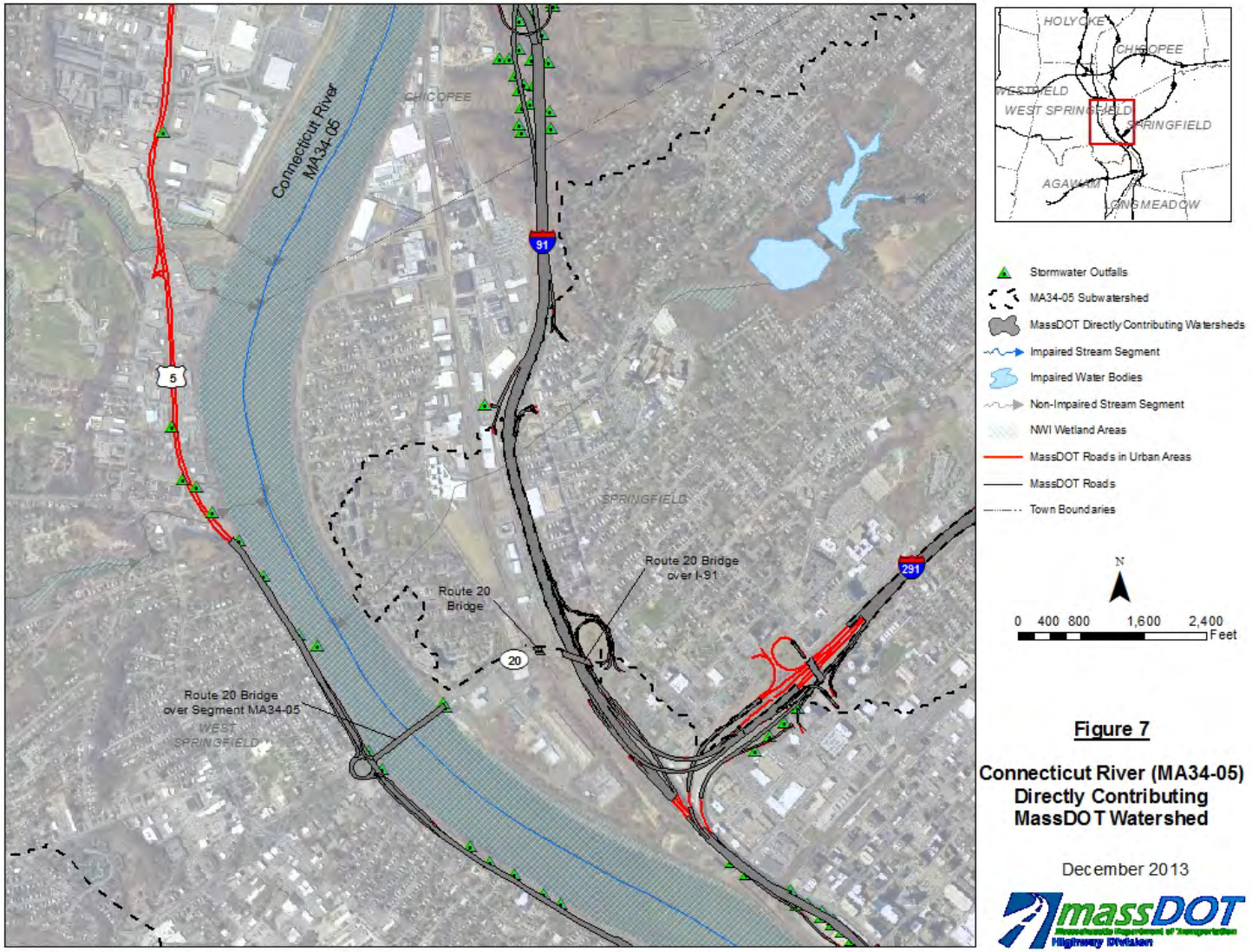

Figure 7

Connecticut River (MA34-05) Directly Contributing MassDOT Watershed

December 2013

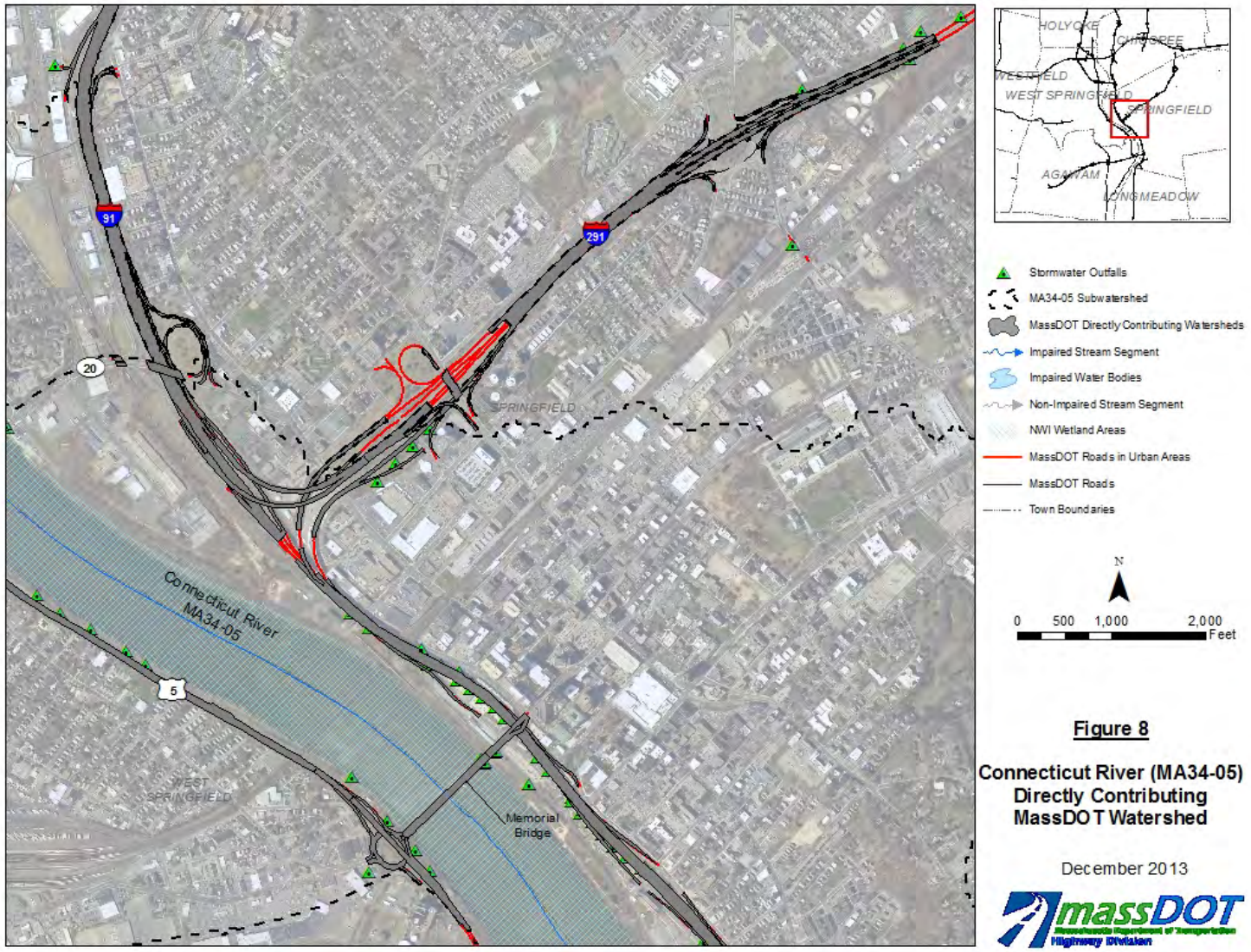

Figure 8

Connecticut River (MA34-05)
Directly Contributing
MassDOT Watershed

December 2013

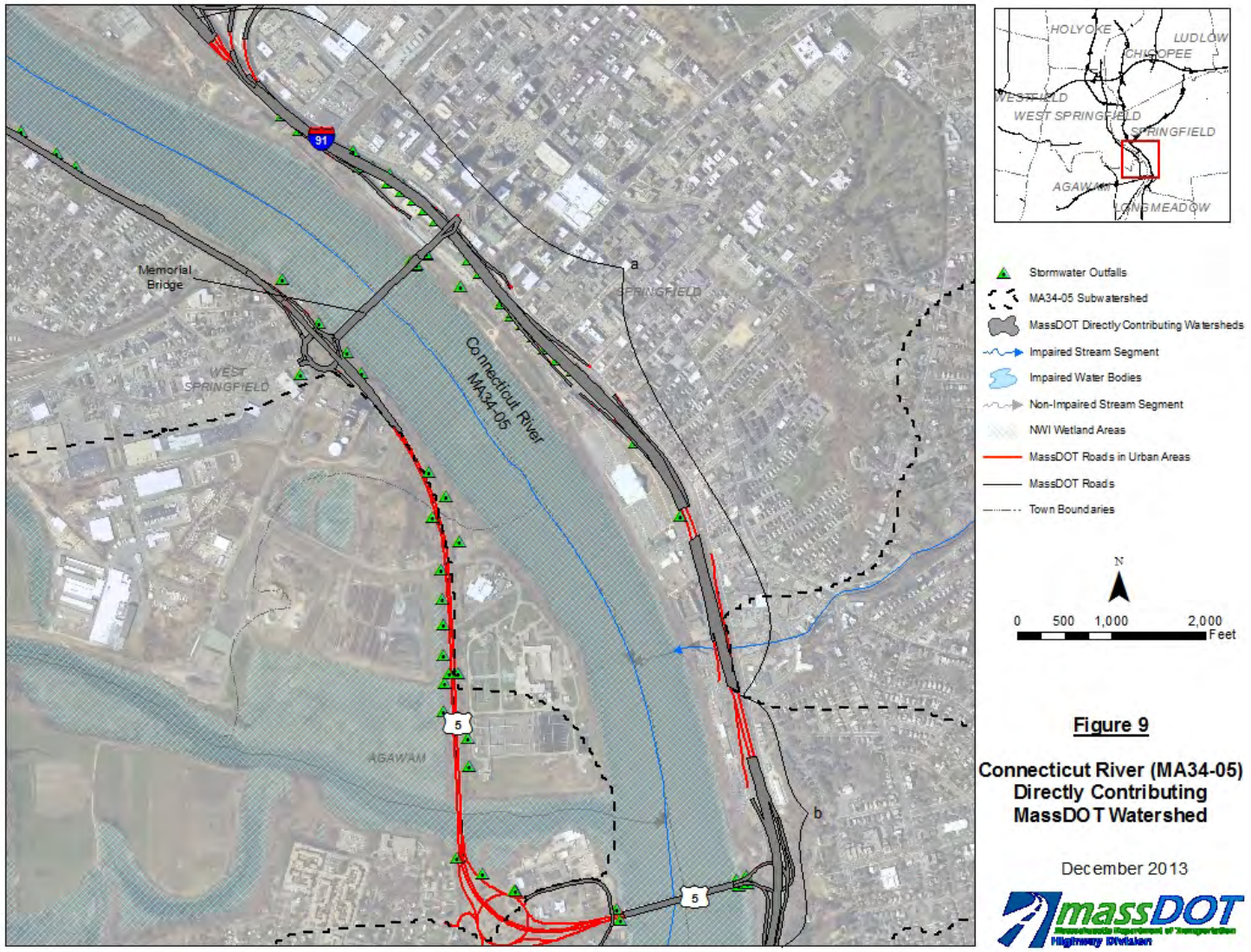

Figure 9

Connecticut River (MA34-05) Directly Contributing MassDOT Watershed

December 2013

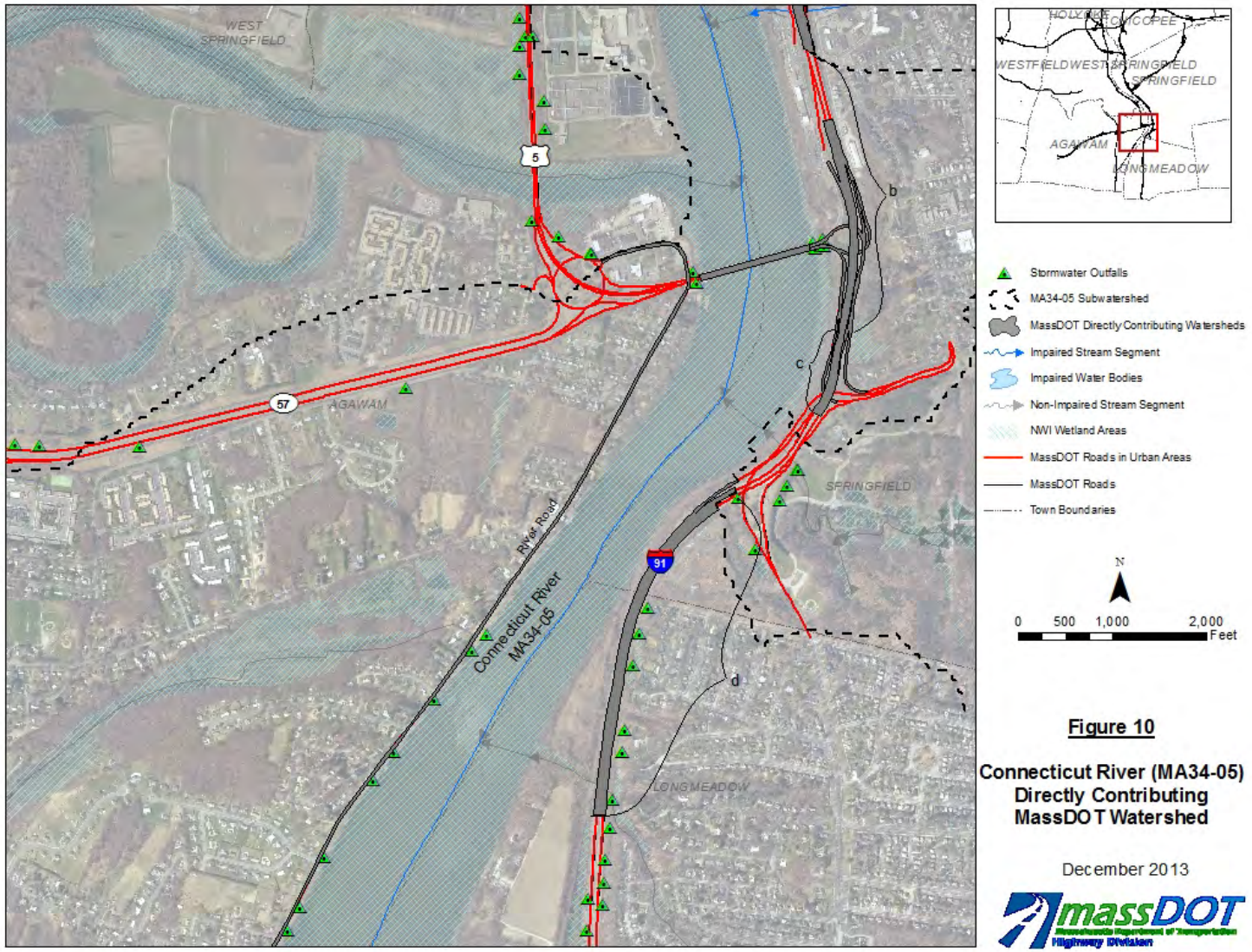

Figure 10

Connecticut River (MA34-05) Directly Contributing MassDOT Watershed

December 2013

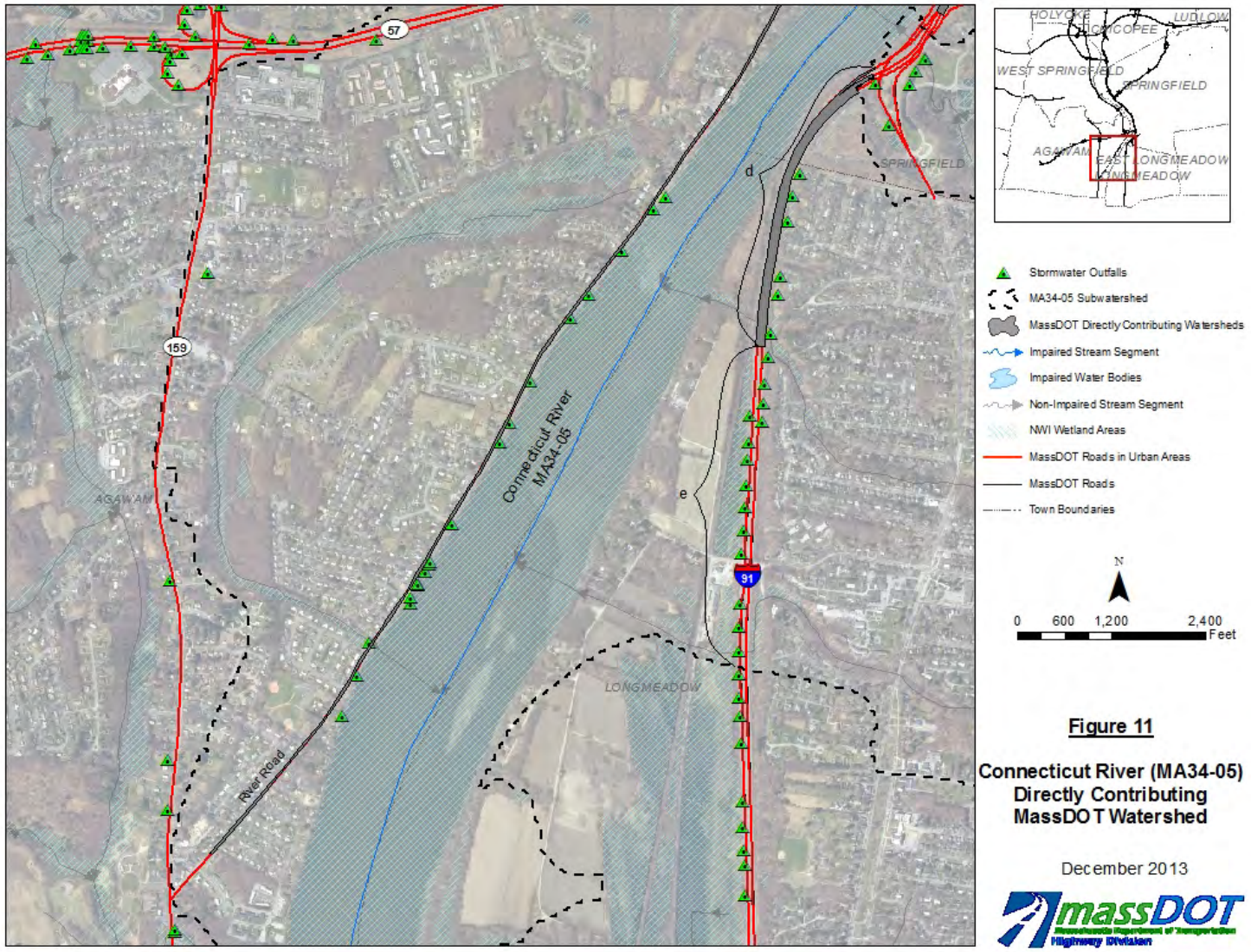

Figure 11

Connecticut River (MA34-05) Directly Contributing MassDOT Watershed

December 2013

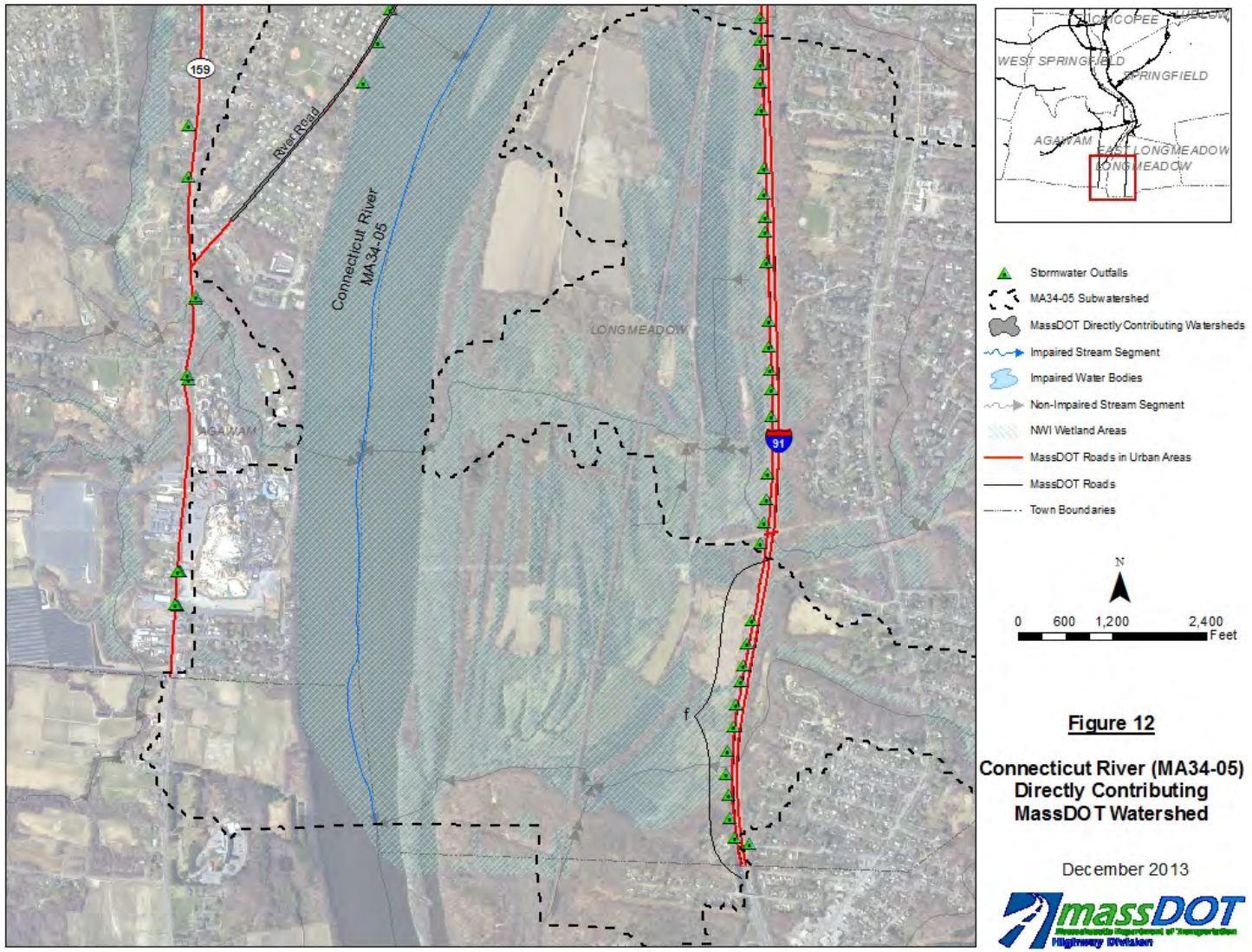

Figure 12

Connecticut River (MA34-05) Directly Contributing MassDOT Watershed

December 2013

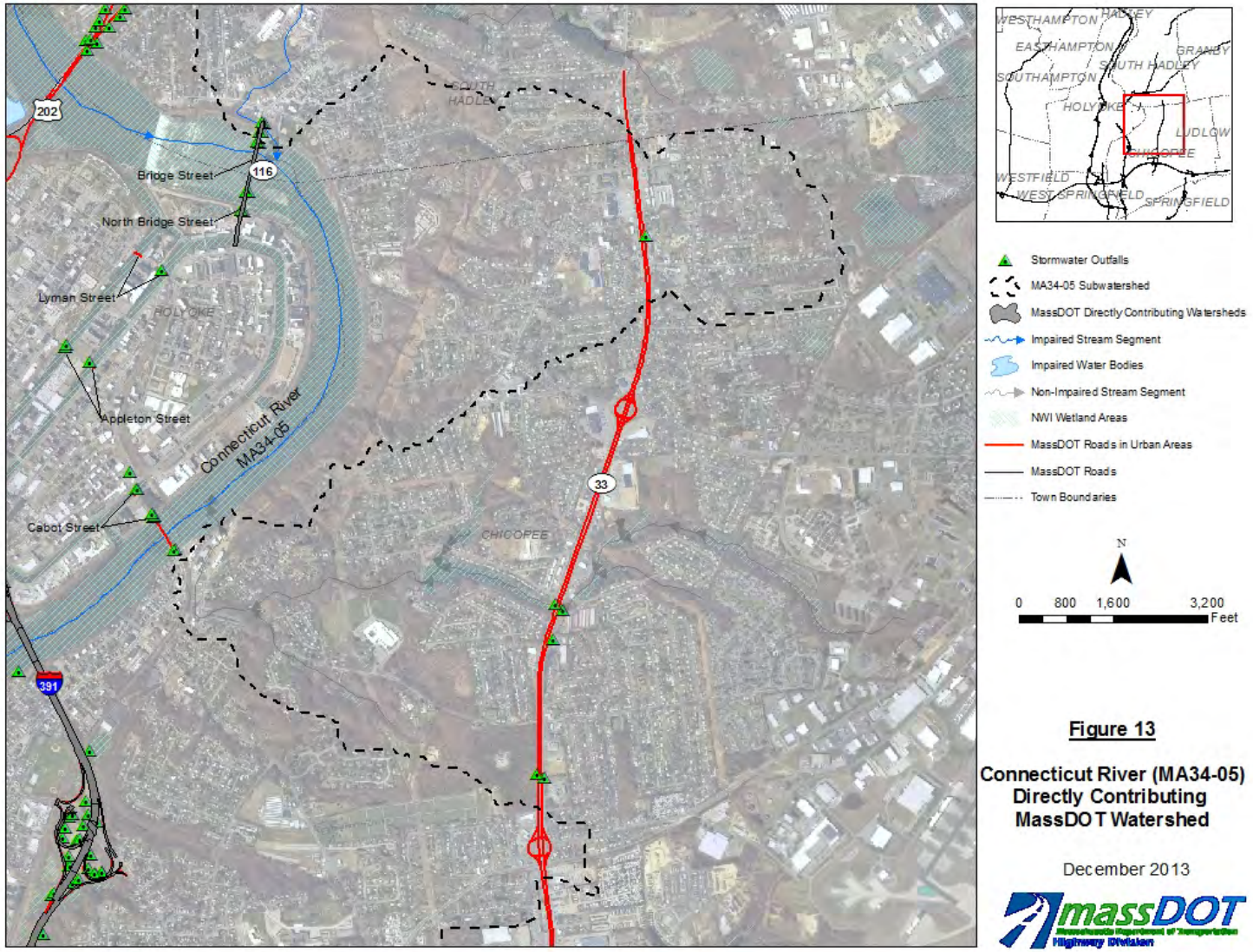

Figure 13

Connecticut River (MA34-05) Directly Contributing MassDOT Watershed

December 2013

Impaired Waters Assessment for Parker Pond (MA35056) – Progress Report

Impaired Water Body

Name: Parker Pond

Location: Gardner, MA

Water Body ID: MA35056

Impairments

Parker Pond (MA35056) is listed under Category 4a, "TMDL is Completed", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). Parker Pond is impaired for the following:

- (non-native aquatic plants*)
- Aquatic Plants (Macrophytes)

Parker Pond is covered by a Total Maximum Daily Load (TMDL) for phosphorus according to MassDEP's *Total Maximum Daily Loads of Phosphorus for Selected Millers Basin Lakes* [CN123.2] (MassDEP, May 8, 2003).

According to MassDEP's *Millers River Watershed 2000 Water Quality Assessment Report* (MassDEP, 2004), Parker Pond is impaired due to an infestation of the non-native aquatic species *Cabomba caroliniana.*

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

Parker Pond (MA35056) is a water body of approximately 32.19 acres located in the Millers River Watershed in Gardner, MA. The lake is located approximately 0.95 miles east of Crystal Lake and is fed from the north by Wilder Brook and Perley Brook and flows southward to outlet at the Otter River to the south. The total watershed draining to Parker Pond is approximately 6.87 square miles (4,397 acres). Parker Pond's total and subwatershed are the same, as shown in **Figure 1**.

MassDOT-owned Route 68 (West Street) crosses Perley Brook at the north end of Parker Pond. This section of Route 68 is a two lane roadway with a catch basin on the bridge discharging directly into Parker Pond. There is an additional catch basin on the south side of the road, east of Parker Pond that drains to an outfall along the southern side of the roadway near Parker Pond. These outfalls are displayed in **Figure 2**. The next catch basins both east and west of Parker Pond outlet on the southern side of Route 68, and ultimately drain to Parker Pond. However, a site visit on October 21, 2013 confirmed these outfalls were too far to be considered directly contributing to Parker Pond. The directly contributing DOT watershed covers 2.4 acres of Route 68.

Assessment under BMP 7R

The TMDL for phosphorus for Parker 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 are non-pollutant stressors which indicates that restoration will require measures other than TMDL development and implementation. As a result, MassDOT has concluded that stormwater runoff from its roadways does not contribute to this impairment found in Parker Pond.

TMDL

The Massachusetts Department of Environmental Protection's (MassDEP) TMDL report titled *Total Maximum Daily Loads of Phosphorus for Selected Millers Basin Lakes* [CN123.2] (MassDEP, May 8, 2003) can be summarized as follows:

- Pollutant of Concern: Phosphorus
- Impairment for Parker Pond Addressed in TMDL: aquatic plants (macrophytes)
- Applicable Waste Load Allocation (WLA): See Tables 4.17 (page 81) and V.17 (page 120) of TMDL Report.
    - Description of Primary Land Use – 73% forested, 14% urban land use
    - Commercial/Industrial Land Use Current Load (TP): 31 kg/yr (68 lbs/yr)
    - Commercial/Industrial Land Use Target WLA (TP): 6 kg/yr (13 lbs/yr)
    - Commercial/Industrial Area in Watershed: 33.7 ha (83.3 acres)
    - Commercial/Industrial Land Use Target Areal WLA (TP): 0.18 kg/ha/yr (0.16 lb/acre/yr)

Estimated Loading from MassDOT

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

- MassDOT estimated 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 440/5-800-011, "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 Parker Pond is 1.5 acres of impervious area and 0.9 acres of pervious area. The TP loading is 3.0 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 0.16 lb/ac/yr and the total area of MassDOT property within the TMDL watershed directly draining to Parker Pond (2.4 acres). The target TP WLA for MassDOT runoff is 0.4 lb/yr.

Assessment

MassDOT calculated its current TP loading rate (3.0 lb/yr) and its target TP WLA (0.4 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 Parker Pond, this target reduction is 2.6 lb/yr, or 87%. 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).

During a site visit on October 21, 2013, no existing BMPs were identified in the DOT direct watershed to Parker 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	2.4	ac
Target Areal WLA	0.16	lb/ac/yr
Total Estimated Load	3.0	lb/yr
Target Load for MassDOT's Directly Contributing Property	0.4	lb/yr
MassDOT's Required Load Reduction	2.6	lb/yr

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than

the target reduction of 2.6 lb/yr, MassDOT will consider the implementation of additional BMPs.

Conclusions

MassDOT used the TMDL Method to assess Parker Pond (MA35056) for the impairments identified in MassDEP's final *Massachusetts Year 2012 Integrated List of Waters*. Results indicate that MassDOT should reduce its current TP loading rate by 2.6 lb/yr to meet the TMDL for TP. MassDOT evaluated its property within the directly contributing watershed to Parker Pond (MA35056) to identify existing BMPs and found that no BMPs exist to reduce the total phosphorus loading. This is summarized in Table 2 below.

Table 2. TP Load Reductions under Existing and Proposed Conditions

Current Estimated TP Load	3.0	lb/yr
Target Reduction in TP Load	2.6	lb/yr
TP Load Reduction provided by Existing BMPs	0	lb/yr
TP Load Remaining to Mitigate with Proposed BMPs	2.6	lb/yr

To meet the TMDL for phosphorus, MassDOT should reduce its TP loading within the directly contributing watershed by 2.6 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 reductions 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 progress made towards meeting the load reduction, plans for construction of additional BMPs, and finalized assessments. Furthermore, MassDOT will also continue to implement non-structural BMPs that reduce the impacts of stormwater.

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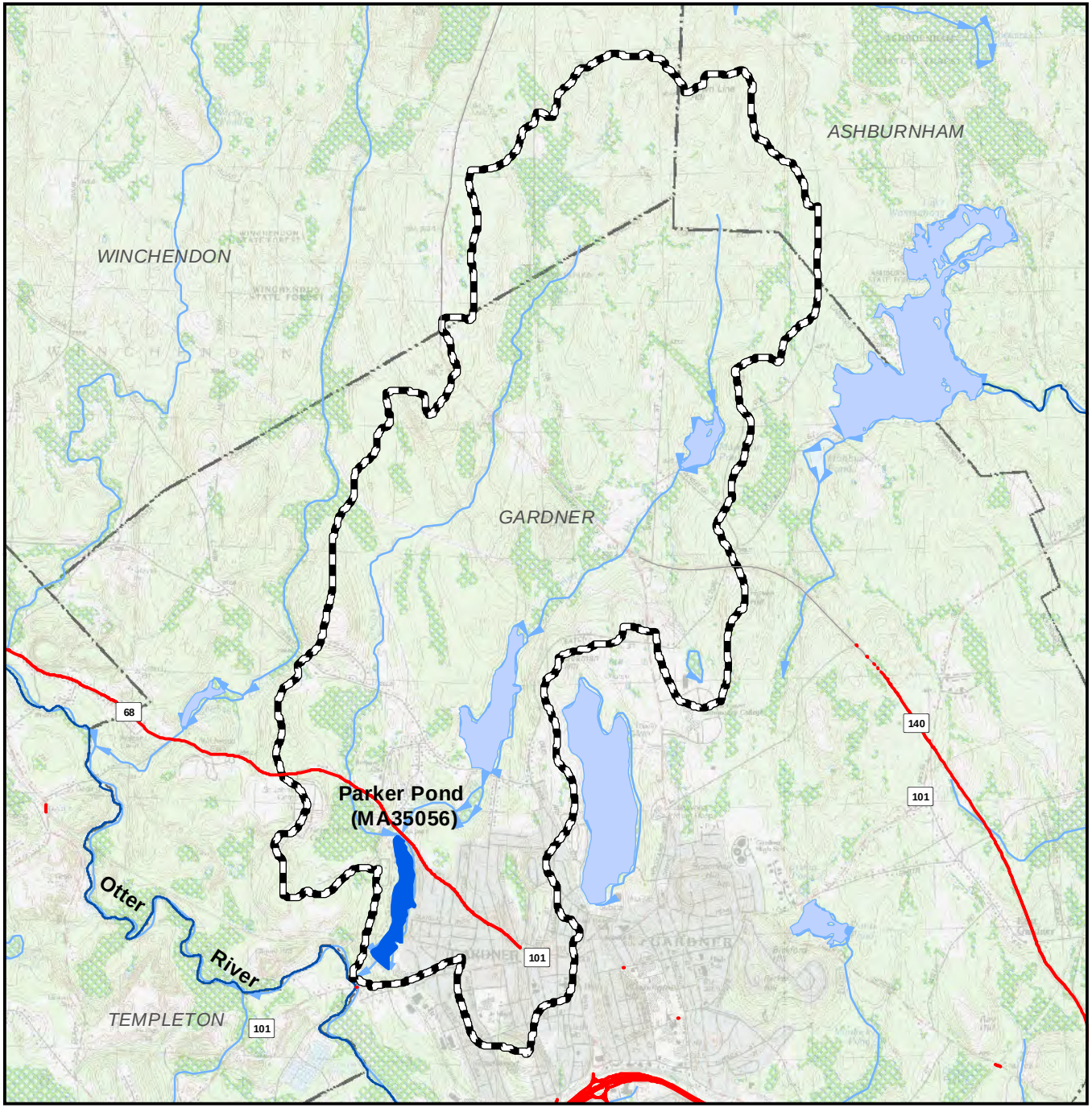
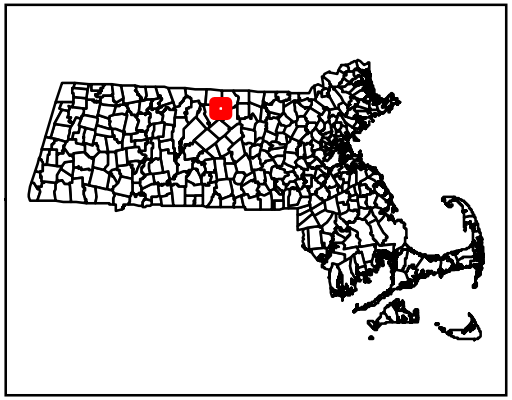




Parker Pond (MA35056)
Impaired Water Bodies
Impaired Stream Segment
Non-Impaired Stream Segment
Total & Subwatershed
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 4,000 8,000

Feet

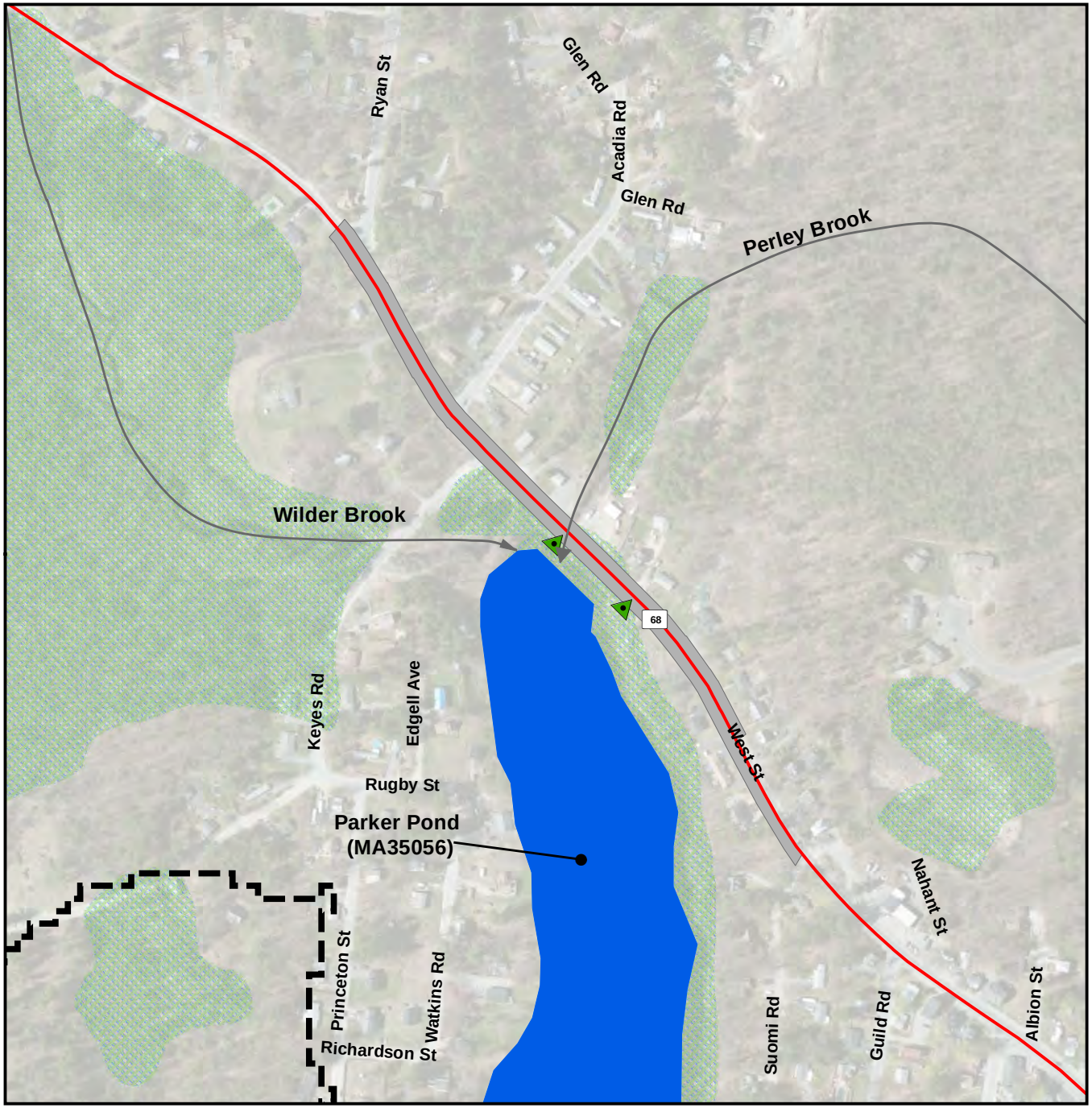
1 Inch = 4,000 Feet

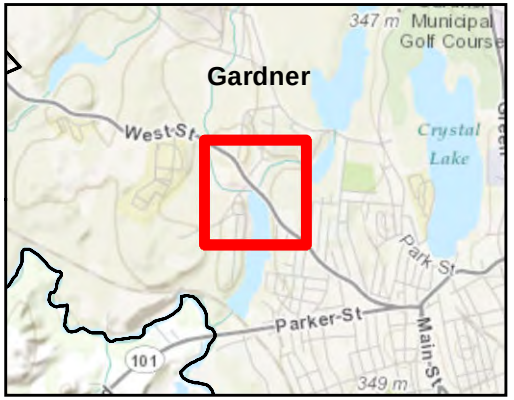
Figure 1

Parker Pond
(MA35056)
Total & Subwatershed

November 2013

massDOT
Massachusetts Department of Transportation





- MassDOT Outfall
- Parker Pond (MA 35056)
- MassDOT Contributing Watershed
- Total & Subwatershed
- NWI Wetland Areas
- Non-Impaired Stream Segment
- MassDOT Roads in Urban Areas

N

0 400 800

Feet

1 Inch = 400 Feet

Figure 2

Parker Pond
(MA35056)
MassDOT Directly
Contributing Watershed

November 2013

massDOT
Massachusetts Department of Transportation

Impaired Waters Assessment for Whitney Pond (MA35101) – Progress Report

Impaired Water Body

Name: Whitney Pond

Location: Winchendon, MA

Water Body ID: MA35101

Impairments

Whitney Pond (MA35101) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). Whitney Pond is impaired for the following:

- Aquatic Plants (Macrophytes)
- Mercury in Fish Tissue
- Turbidity

Whitney Pond is covered by a Total Maximum Daily Load (TMDL) for phosphorus according to MassDEP's *Total Maximum Daily Loads of Phosphorus for Selected Millers Basin Lakes* [CN123.2] (MassDEP, May 8, 2003).

According to MassDEP's *Millers River Watershed 2000 Water Quality Assessment Report* (MassDEP, 2004), Whitney Pond is impaired due to low dissolved oxygen/saturation at depths below 1.0m, low pH and alkalinity, and high color.

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.

- *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 822-R-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

Whitney Pond (MA35101) is a 96.84 acre pond located in the Millers River Watershed in Winchendon, MA. The pond lies between Route 202 (Maple St) and Route 12 (Spring St). Whitney Pond is located approximately 1.2 miles southeast of Whites Mill Pond (**Figure 1**) and is fed by the North Branch Millers River from the north and the Upper Millers River from the east. Whitney Pond outlets into Tannery Pond to the west and eventually into the Middle Millers River. Whitney Pond's total and subwatershed are the same, as shown in **Figure 1**.

MassDOT-owned Route 12 runs in an east-west direction along the south side of Whitney Pond towards the east. This section of Route 12 is a two lane roadway with catch basins on either side of the road draining to outfalls along the northern side of the roadway. The outfalls discharge into a small un-named pond. This pond discharges into Whitney Pond via a culvert located at the northwest end of the un-named pond. These outfalls are displayed in **Figure 2,** and are considered direct discharges to Whitney Pond. As Route 12 continues to the east, it becomes country drainage. The directly contributing DOT watershed covers 1.7 acres of Route 12.

MassDOT-owned U.S. Route 202 runs along the north side of Whitney Pond eastward to the intersection with Glenallen Street. This section of U.S. Route 202 is a curbed two-lane roadway with several catch basins on either side of the road draining to outfalls along the southern side of the roadway. The runoff from these outfalls travel overland a minimum of 450-ft before reaching Whitney Pond. Therefore, runoff from U.S. Route 202 was not considered to be directly contributing to Whitney Pond.

Assessment under BMP 7R

The TMDL for phosphorus for Whitney 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 are non-pollutant stressors which indicates that restoration will require measures other than TMDL development and implementation. As a result, MassDOT has concluded that stormwater runoff from its roadways does not contribute to this impairment found in Whitney Pond.

TMDL

The Massachusetts Department of Environmental Protection's (MassDEP) TMDL report titled *Total Maximum Daily Loads of Phosphorus for Selected Millers Basin Lakes* [CN123.2] (MassDEP, May 8, 2003) can be summarized as follows:

- Pollutant of Concern: Phosphorus
- Impairment for Whitney Pond Addressed in TMDL: aquatic plants (macrophytes) and turbidity
- Applicable Waste Load Allocation (WLA): See Tables 4.27 (page 84) and V.27 (page 130) of TMDL Report.
    - Description of Primary Land Use (excluding water) – 87% forested, 3% urban land use
    - Commercial/Industrial Land Use Current Load (TP): 76 kg/yr (168 lbs/yr)
    - Commercial/Industrial Land Use Target WLA (TP): 5 kg/yr (11 lbs/yr)
    - Commercial/Industrial Area in Watershed: 104.5 ha (258.2 acres)
    - Commercial/Industrial Land Use Target Areal WLA (TP): 0.048 kg/ha/yr (0.043 lb/acre/yr)

Estimated Loading from MassDOT

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

- MassDOT estimated 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 curing 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 440/5-800-011, "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 Whitney Pond is 1.1 acres of impervious area and 0.6 acres of pervious area. The TP loading is 2.0 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 0.043 lb/ac/yr and the total area of MassDOT property within the TMDL watershed directly draining to Whitney Pond (1.7 acres). The target TP WLA for MassDOT runoff is 0.07 lb/yr.

Assessment

MassDOT calculated its current TP loading rate (2.0 lb/yr) and its target TP WLA (0.07 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 Whitney Pond, this target reduction is 1.97 lb/yr, or 97%. 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).

During a site visit on October 21, 2013, no existing BMPs were identified in the DOT direct watershed to Parker 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	1.7	ac
Target Areal WLA	0.04	lb/ac/yr
Total Estimated Load	2.0	lb/yr
Target Load for MassDOT's Directly Contributing Property	0.07	lb/yr
MassDOT's Required Load Reduction	1.97	lb/yr

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 1.97 lb/yr, MassDOT will consider the implementation of additional BMPs.

Conclusions

MassDOT used the TMDL Method to assess Parker Pond (MA35056) for the impairments identified in MassDEP's final *Massachusetts Year 2012 Integrated List of Waters*. Results indicate that MassDOT should reduce its current TP loading rate by 1.97 lb/yr to meet the TMDL for TP. MassDOT evaluated its property within the directly contributing watershed to Parker Pond (MA35056) to identify existing BMPs and found that no BMPs exist to reduce the total phosphorus loading. This is summarized in Table 2 below.

Table 2. TP Load Reductions under Existing and Proposed Conditions

Current Estimated TP Load	2.0	lb/yr
Target Reduction in TP Load	1.97	lb/yr
TP Load Reduction provided by Existing BMPs	0	lb/yr
TP Load Remaining to Mitigate with Proposed BMPs	1.97	lb/yr

To meet the TMDL for aquatic plants (macrophytes), MassDOT should reduce its TP loading within the directly contributing watershed by 1.97 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 reductions 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 the load reduction, plans for construction of additional BMPs, and finalized assessments. Furthermore, MassDOT will also continue to implement non-structural BMPs that reduce the impacts of stormwater.

References

Massachusetts Department of Environmental Protection (MassDEP). (2013). Massachusetts Year 2012 Integrated List of Waters - Final Listing of the Condition of Massachusetts' Waters Pursuant to Sections 305(b), 314 and 303(d) of the Clean Water Act, CN:400.1. Retrieved from: http://www.mass.gov/dep/water/resources/12list2.pdf

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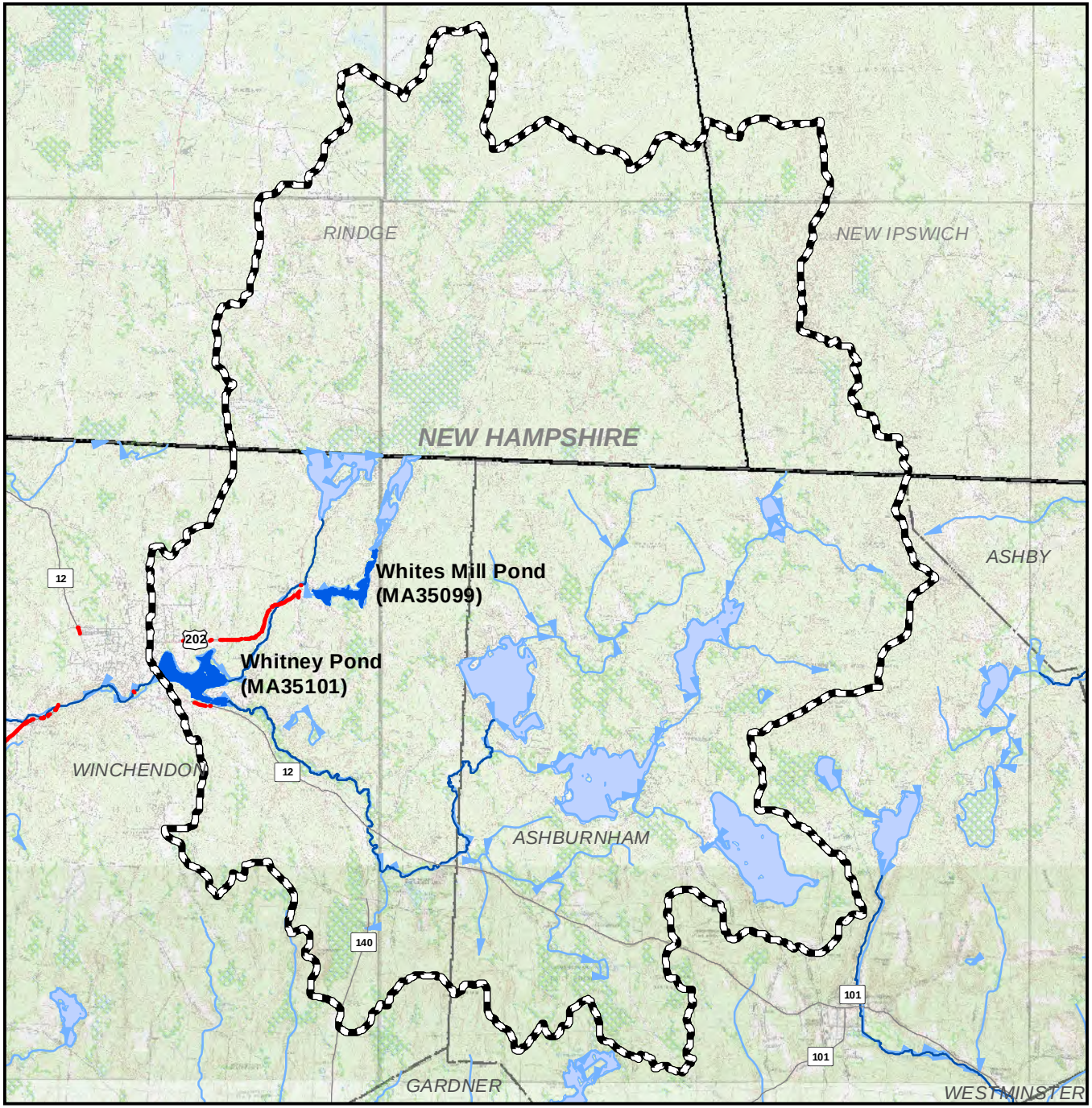
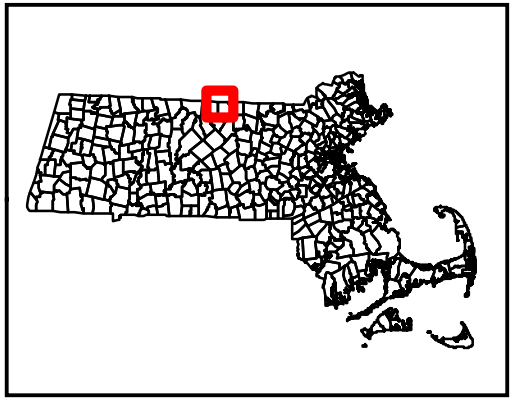




Whitney Pond (MA35101)
Impaired Water Bodies
Impaired Stream Segment
Non-Impaired Stream Segment
Total & Subwatershed
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 8,000 16,000

Feet

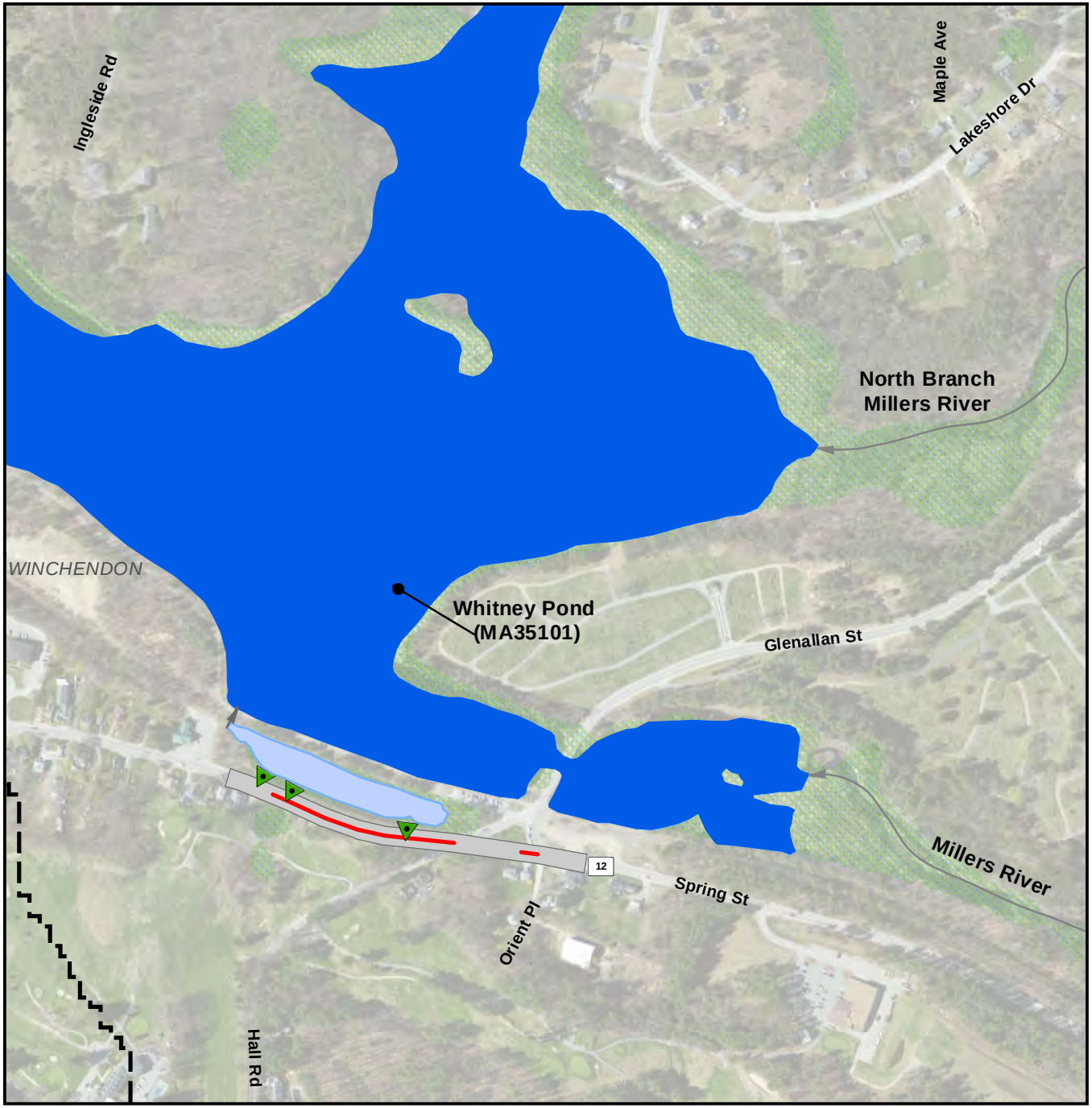
1 Inch = 8,000 Feet

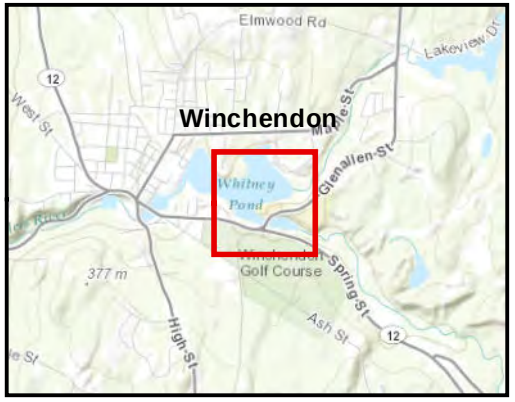
Figure 1

Whitney Pond
(MA35101)
Total & Subwatershed

November 2013

massDOT
Massachusetts Department of Transportation





MassDOT Outfall

Whitney Pond (35101)

MassDOT Contributing Watershed

Total & Subwatershed

NWI Wetland Areas

Non-Impaired Stream Segment

MassDOT Roads in Urban Areas

N

0 500 1,000

Feet

1 Inch = 500 Feet

Figure 2

Whitney Pond
(MA35101)
MassDOT Directly
Contributing Watershed

November 2013

massDOT
Massachusetts Department of Transportation

Impaired Waters Assessment for Dorchester Bay (MA70-03) – Progress Report

Impaired Water Body

Name: Dorchester Bay

Location: Boston, MA

Water Body ID: MA70-03

Impairments

Dorchester Bay (MA70-03) 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 Dorchester Bay impairment are listed as the following:

- Enterococcus
- fecal coliform
- other
- PCB in fish tissue
- total suspended solids (TSS)
- turbidity

MassDEP's *Boston Harbor 2004 – 2008 Water Quality Assessment Report* (MassDEP, 2010), identifies fish consumption, shellfishing, and primary contact impairments of Dorchester Bay. The fish consumption use is listed as impaired due to the current MA DPH fish consumption advisory due to elevated PCB in fish tissue resulting from sources including upstream sources, contaminated sediments, wet weather discharges (point source, stormwater, SSO or CSO), and discharges from biosolids storage, application or disposal. The entire segment of Dorchester Bay is restricted or prohibited to shellfishing and the primary contact recreation use is listed as impaired due to elevated enterococci bacteria associated with stormwater discharges from unspecified and municipal systems.

Dorchester Bay is also covered by a Draft Pathogen Total Maximum Daily Load (TMDL) for the Boston Harbor Watershed (excluding the Neponset River Sub-basin) (MassDEP, no date).

Relevant Water Quality Standards

Water Body Classification: Class SB

Applicable State Regulations:

- *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 (4)(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 (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 (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.

Site Description

Dorchester Bay is defined as the water body from the mouth of the Neponset River (MA73-04) (Boston/Quincy) to the line between Head Island and the north side of Thompson Island and the line between the south point of Thompson Island (Boston) and Chapel Rocks (Quincy). Dorchester Bay is located in the Boston Harbor watershed and is approximately 3.46 square miles in size.

The total and subwatershed to Dorchester Bay are the same and are highly urban. The subwatershed is approximately 1,540 acres and is shown in Figure 1. MassDOT's property directly contributing stormwater runoff to Dorchester Bay is comprised of approximately 1.3 miles of Interstate 93 (I-93) which is an 8-lane highway with an additional center HOV lane, Kosciuszko Circle, a portion of Columbia Rd, and portions of a bridge along Morrissey Boulevard. The entire MassDOT property directly contributing stormwater to Dorchester Bay is curbed with small piped systems along I-93 at the southern limit of the subwatershed and two large piped systems which discharge stormwater from I-93 and Kosciuszko Circle. Stormwater from I-93 north of the Dorchester Yacht Club is collected in catch basins and piped through a 36" pipe in the median until it discharges directly north of the Dorchester Yacht Club. Although it was not possible to identify stormwater collection systems along I-93 from Savin Hill Ave to the JFK/UMass MBTA train station because there was no information available in this area from Boston Water and Sewer Commission (BWSC) and MassDOT plans, desktop and aerial analysis show catch basins within this stretch of roadway, and it was conservatively estimated that stormwater from this portion of MassDOT property drains downstream to the discharge location at the Dorchester Yacht Club. Stormwater from Kosciuszko Circle is collected and piped to the Morrissey Boulevard Drainage Conduit (MBDC) which discharges through two 8'x9' rectangular conduits directly to Savin Hill Cove south of Bianculli Blvd. Approximately 23.1 acres of MassDOT impervious surfaces drain stormwater runoff directly to Dorchester Bay. MassDOT's directly contributing watershed is shown in Figure 2.

Major modifications to the stormwater systems draining to Dorchester Bay were made between 2006 and 2011 to improve water quality of the bay and surrounding waters. Massachusetts Water Resources Authority's (MWRA) North Dorchester Bay CSO Storage Tunnel Project (NDBST) was completed in 2011 and includes a 2.1 mile long, 17-ft diameter storage tunnel with 19 MGal of storage capacity, which stores stormwater and combined sewer overflow (CSO) water until it can be pumped to and treated at Deer Island. Additionally, the Morrissey Boulevard Drainage Conduit (MBDC) was completed in 2009. Along the northbound portion of Morrissey Boulevard, all stormwater is conveyed to the MBDC, and stormwater generated from storm events larger than the 1-year storm, which previously discharged through Outfall 087 (the Upper Basin), now discharges through the MBDC. Stormwater discharges from tributary systems to the MBDC are treated by several particle separators that were constructed on private storm drains which serve business along Morrissey Boulevard. (Massachusetts Water Resource Authority, 2011; Savin Hill Cove Water Quality Monitoring Program, 2013).

The NDBST collect the "first flush" of stormwater runoff which prevents pollutants from being discharged to Dorchester Bay. This stormwater construction project coupled with the MBDC provided the following improvements:

- All stormwater draining to Outfall 081 – 086 is intercepted and stored in the NDBST and treated at Deer Island for precipitation events up to and including the 5-year storm, and stormwater which previously discharged through Outfall 087 is stored and treated for events up to and including the 1-year storm;
- Outfall 087 was eliminated and stormwater from precipitation events larger than the 1-year storm is discharged through the MBDC to Savin Hill Cove;
- CSO discharges to North Dorchester Bay for all precipitation events up to and including the 25-year storm are intercepted and stored in the NDBST and treated at Deer Island rather

than discharging to North Dorchester Bay (previously occurred 16 times per year on average) (MWRA, 2010)

As a result of the stormwater improvements described above, stormwater which previously discharged to Dorchester Bay as part of a CSO system is captured and treated at Deer Island for precipitation events up to the 5-year storm (and up to the 1-year storm for stormwater previously draining to Outfall 087). MassDOT considers stormwater which drains to the NDBST to be indirect because the "first flush" is treated and never discharges to Dorchester Bay. Pollutant concentrations tend to be much higher at the beginning of a storm compared to the beginning or end of the event, because pollutants accumulate on impervious surfaces during dry weather and wash off quickly during the beginning of a storm. Thus, only stormwater from MassDOT property which drains through stormwater-only systems to Dorchester Bay and does not get treated at Deer Island is considered a direct discharge for this assessment.

Assessment under BMP 7U

None of the following impairments for Dorchester Bay 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:

- other
- total suspended solids (TSS)
- turbidity

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 impairments for Enterococcus and fecal coliform are assessed separately in the section titled Assessment of Pathogen Impairment 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 Dorchester Bay (MA70-03):

Table 1. Site Parameters for Dorchester Bay (MA70-03)

Type	Parameter	Quantity	Unit of Measure
Total and Subwatershed	Watershed Area	1,540	acres
Total and Subwatershed	Impervious Cover (IC) Area	880	acres
Total and Subwatershed	Percent Impervious	57.1	%
Total and Subwatershed	IC Area at 9% Goal	139	Acres
Total and Subwatershed	Target Reduction % in IC	84.2	%
Reductions Applied to DOT Direct Watershed	MassDOT's IC Area Directly Contributing to Impaired Segment	23.1	acres
Reductions Applied to DOT Direct Watershed	MassDOT's Target Reduction in Effective IC (84.2% of DOT Directly Contributing IC)	19.5	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 84.2%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 19.5 acres.

Existing BMPs

There are no existing BMPs in the Dorchester Bay (MA70-03) directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to Dorchester Bay.

Mitigation Plan

There are no existing structural BMPs in place to mitigate the effects of MassDOT impervious surfaces that directly discharge to Dorchester Bay. Therefore, MassDOT considered the implementation of additional BMPs to reach the target reduction of 19.5 acres.

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 are assessed 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, and has a pet waste management program underway to address this source where necessary.
- 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

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.

MassDOT anticipates the issuance of an individual stormwater permit from U.S. EPA which will outline details of a required Illicit Detection.

Conclusions

MassDOT used the IC Method to assess Dorchester Bay (MA70-03) 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 watershed by 19.5 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Dorchester Bay 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

Type of Reduction	Quantity	Unit of Measure
IC in Directly Contributing Watershed	23.1	acres
Target Reduction in Effective IC	19.5	acres
IC Effectively Reduced by Existing BMPs	0.0	acres
IC Remaining to Mitigate with Proposed BMPs	19.5	acres

MassDOT should reduce its effective IC within the directly contributing watershed by an additional 19.5 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 Enterococcus and 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 continue to implement non-structural BMPs that reduce the impacts of stormwater.

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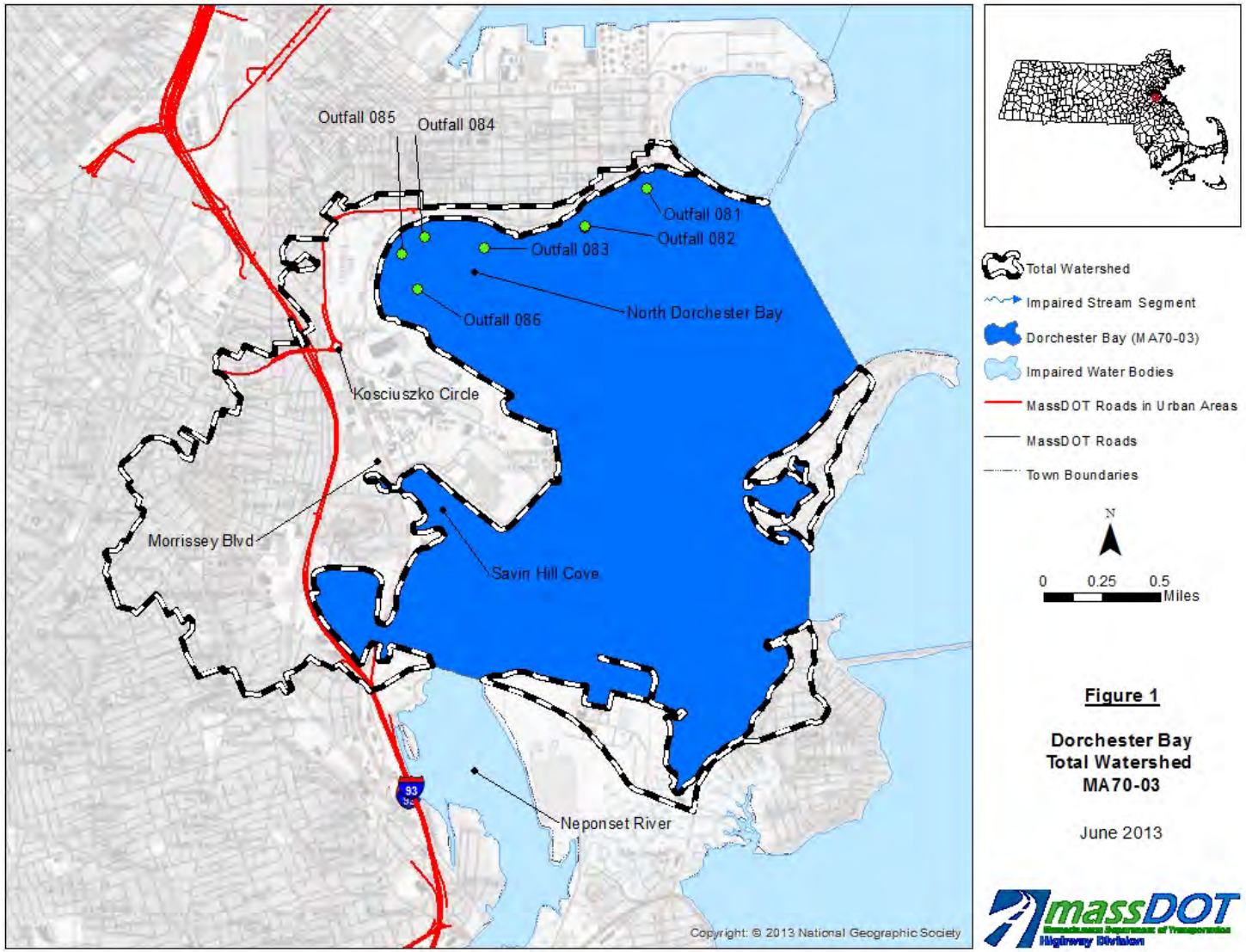

Figure 1

Dorchester Bay
Total Watershed
MA70-03

June 2013

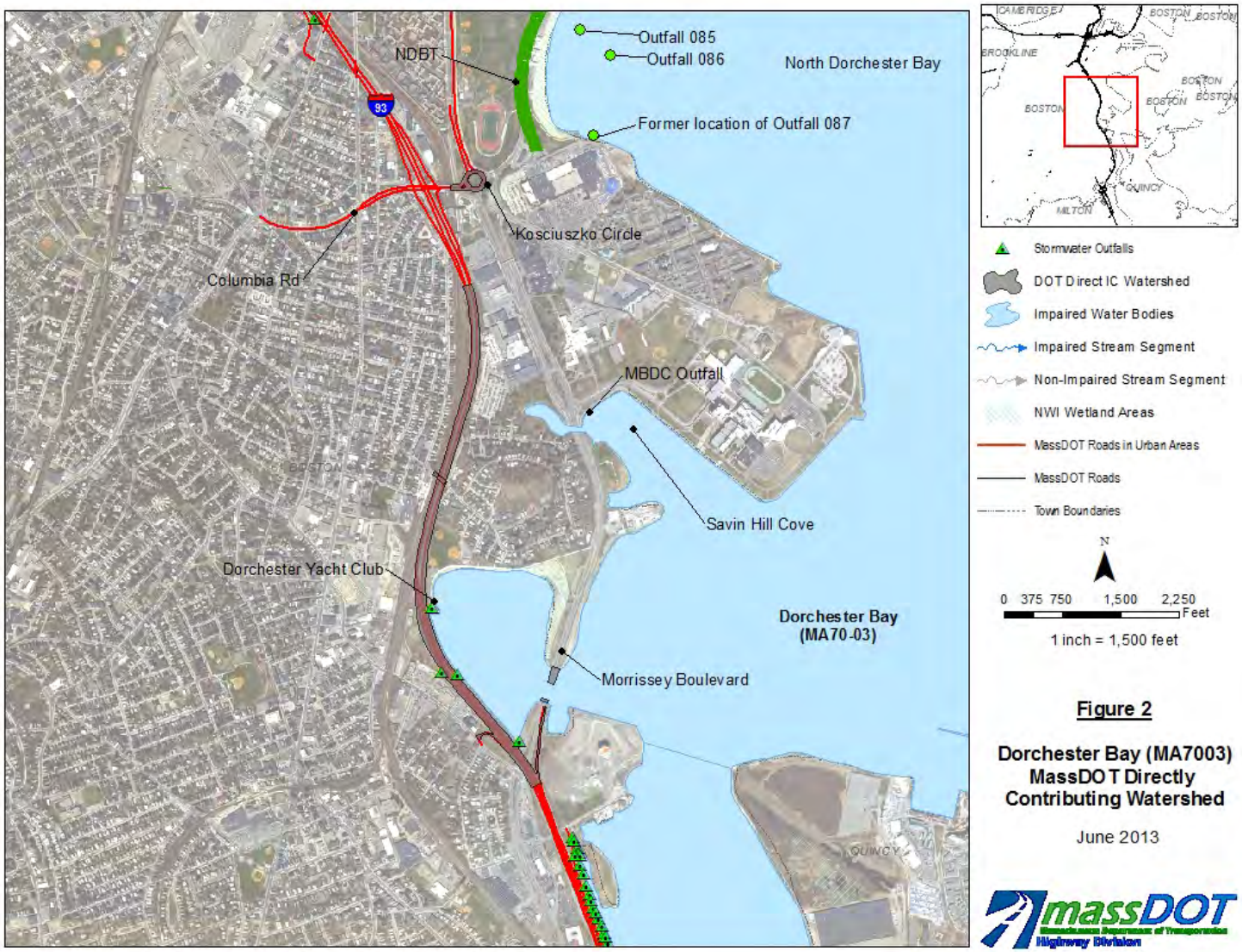

Figure 2

Dorchester Bay (MA7003) MassDOT Directly Contributing Watershed

June 2013

Impaired Waters Assessment for Malden River (MA71-05) – Progress Report

Impaired Water Body

Name: Malden River

Location: Malden, Medford and Everett, MA

Water Body ID: MA71-05

Impairments

Malden River (MA71-05) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). Malden River is impaired for the following:

- (debris/floatables/trash*)
- Chlordane
- DDT
- Dissolved oxygen saturation
- Escherichia coli
- Fecal coliform
- Foam/flocs/scum/oil slicks
- Oxygen, dissolved
- PCB in fish tissue
- pH, high
- Phosphorus (total)
- Secchi disk transparency
- Sediment bioassays – chronic toxicity freshwater
- Taste and odor
- Total suspended solids (TSS)

According to MassDEP's *Mystic River Watershed 2004-2008 Water Quality Assessment Report* (MassDEP, 2010), a 2.3 mile reach of the Malden River (MA71-05) is impaired for the following uses: aquatic life, fish consumption, primary contact, secondary contact and aesthetics.

There are no National Pollutant Discharge Elimination System (NPDES) permits to discharge to Malden River (MassDEP, 2010). The Malden River (MA71-05) is covered by the *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, Warm Water Fishery

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 CMP 4.05 (3)(b) 7 Oil and Grease.* These waters shall be free from oil and grease, petrochemicals and other volatile or synthetic organic pollutants.
- *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)(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.* 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)(a) 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 Malden River (MA71-05) headwaters originate south of Exchange Street in Malden and travel 2.3 miles to its confluence with the Mystic River (MA71-02) along the boundary of Medford and Everett. The total Malden River watershed area is 11 square miles (7,041 acres), in which the impaired segment's (MA71-05) subwatershed area is 4.45 square miles (2,845 acres). The total watershed is shown in Figure1 and the subwatershed is shown in Figure 2. The impaired water bodies Spot Pond (MA71039) and Ell Pond (MA71014) are located within the total watershed, but not in the subwatershed.

MassDOT's property directly contributing stormwater runoff to the Malden River (MA71-05) is comprised of a bridge on the Revere Beach Parkway (Route 16) located to the west of the Malden River (MA71-05), as shown on Figure 3. Stormwater draining to the east of the bridge is collected by a series of catch basins and discharges to an approximate outfall location shown on Figure 3. The outfall location was not confirmed in the field due to limited access, but it is shown on the

design plans from 1955. Stormwater that drains to the west side of the bridge is collected by catch basins and discharged at an end wall located adjacent to the railroad tracks that the bridge spans. Due to the uncertainty of the final destination of the stormwater from this end wall, it was assumed that the entire bridge directly conveys runoff to the Malden River (MA71-05).

The other MassDOT roads in urban areas located within the subwatershed (shown on Figure 2), were determined to not directly discharge stormwater into the Malden River (MA71-05). Stormwater from the Fellsway (Route 28) Bridges over the railroad tracks in Medford was collected via catch basins to the north and south of the bridge. These catch basins appear to be connected to a municipal storm sewer system and no outfalls or stormwater conveyance features were observed to the east side of the bridge, which would have taken stormwater flow towards the Malden River (MA71-05).

Similar situations were observed at the Tileston Street Bridge and Route 16 / Route 99 rotary bridges in Everett. From the field visit and the review of the drainage plans, it appeared that stormwater was conveyed into a municipal storm sewer system or conveyed away from the Malden River (MA71-05).

Highland Avenue and Middlesex Avenue in Medford (shown on Figure 2) convey stormwater toward an outfall near a railroad crossing. From the outfall, stormwater travels along a swale on the southern side of the railroad tracks, then enters a headwall adjacent to the car wash property and crosses the railroad tracks towards a commercial property. The headwall contains a sign with "Medford Stormwater Outfall OF-05700" printed on it. From here, the path of the stormwater was unable to be confirmed via the field visit. However, a MassDOT maintenance crew confirmed the stormwater from Highland Avenue and Middlesex Avenue discharges to a non-impaired stream segment prior to the Malden River (MA71-05) via this outfall. The MassDOT maintenance crew was cleaning catch basins along Middlesex Avenue the day of our site visit (October 24, 2013).

Along the Revere Beach Parkway (Route 16) in Medford and Everett, there are a number of MassDOT owned bridges that convey stormwater to a non-impaired stream segment prior to the Malden River (MA71-05), as shown on Figure 3. The two bridges are E-12-2, which carries two lanes of traffic over railroad tracks, and E-12-5, which carries three lanes of traffic in both the eastbound and westbound directions. Stormwater from the two bridges to the east of Malden River in Everett eventually drain to a non-impaired stream segment, on the southern side of Route 16, which eventually outlets to Malden River (MA71-05). The entire path of the stormwater from these bridges was unable to be confirmed via the field visit and is primarily based on information shown on the design plans of the *Revere Beach Parkway at Main Street and Broadway* (File No. 4363).

Assessment under BMP 7U

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 saturation
- Foam/flocs/scum/oil slicks

- Oxygen, dissolved
- pH, high
- Phosphorus (total)
- Secchi disk transparency
- Sediment bioassays – chronic toxicity freshwater
- Taste and odor
- Total suspended solids (TSS)

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 *Nationwide Urban Runoff Program* (NURP) conducted by the EPA found that DDT was detected in less than 1% of 121 samples collected and that it "should be considered to pose a minimal threat to the quality of surface waters from runoff contamination" (EPA, 1983). Therefore, MassDOT concluded that storm water runoff from its roadways does not contribute to the impairment of DDT.

According to the final *Massachusetts Year 2012 Integrated List of Waters*, non-native aquatic plants and Eurasian Water Milfoil, chlordane, Myriophyllum spicatum and debris/floatables/trash 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 impairments for Escherichia Coli and Fecal Coliform are assessed separately in the section titled Assessment of Pathogen Impairment 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 Malden River (MA71-05):

Table 1. Site Parameters for Malden River (MA71-05)

Type	Parameter	Quantity	Unit of Measure
Total Watershed	Watershed Area	7,041	acres
Total Watershed	Impervious Cover (IC) Area	2,807	acres
Total Watershed	Percent Impervious	39.9	%
Subwatershed	Subwatershed Area	2,845	acres
Subwatershed	Impervious Cover (IC) Area	1,566	acres
Subwatershed	Percent Impervious	55.0	%
Subwatershed	IC Area at 9% Goal	256	acres
Subwatershed	Target Reduction% in IC	83.7	%
Reductions Applied	MassDOT's IC Area Directly Contributing to Impaired Segment	0.4*	acres
Reductions Applied	MassDOT's Target Reduction in Effective IC (83.7% of DOT Directly Contributing IC)	0.3*	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 83.7%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 0.3 acres.

Existing BMPs

Based on the site visit, there are no existing BMPs in the Malden River (MA71-05) directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to Malden River (MA71-05).

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 0.3 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 are assessed 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, and has a pet waste management program underway to address this source where necessary.
- 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. 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 Malden 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 0.3 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Malden River (MA71-05) 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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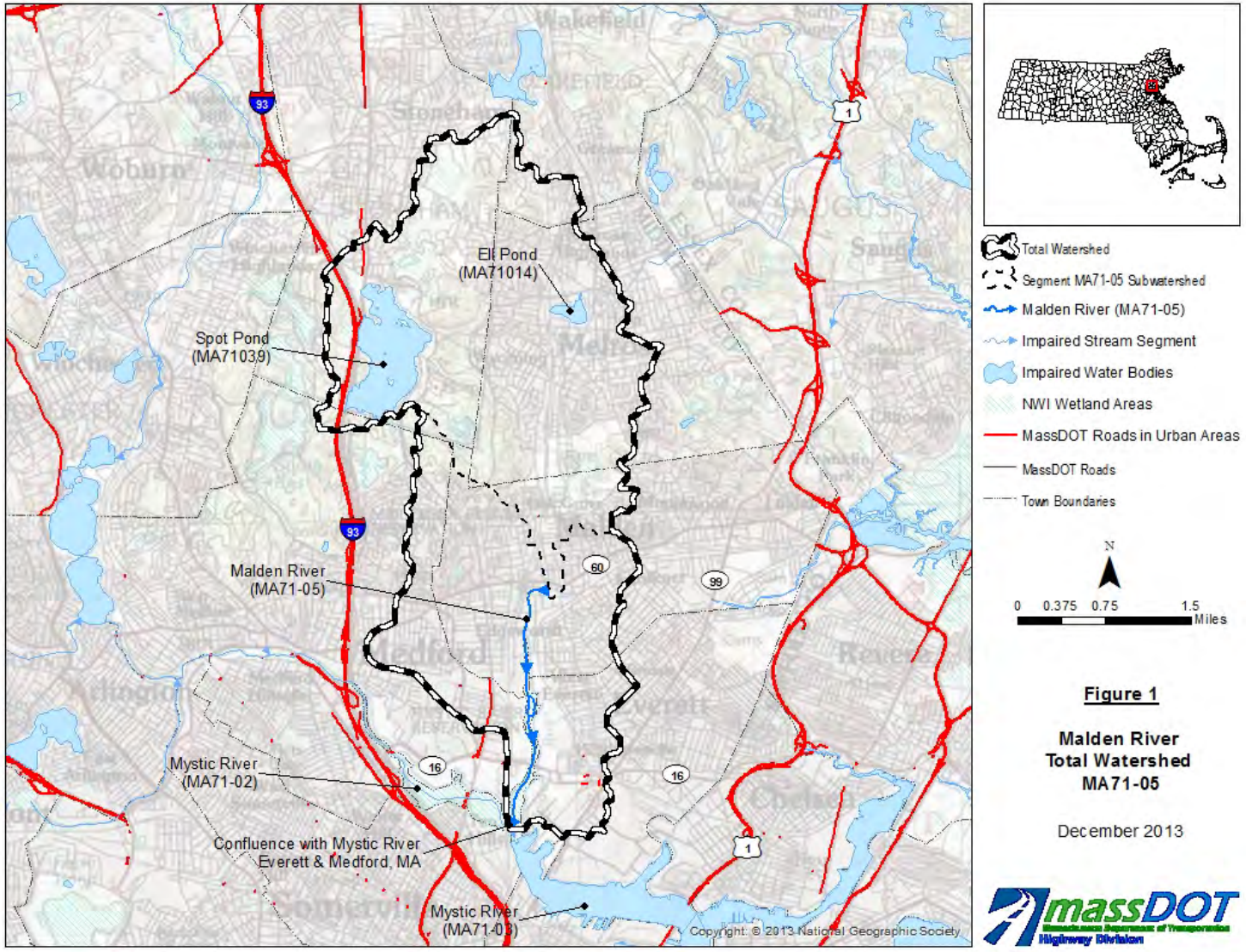

Figure 1

Malden River
Total Watershed
MA71-05

December 2013

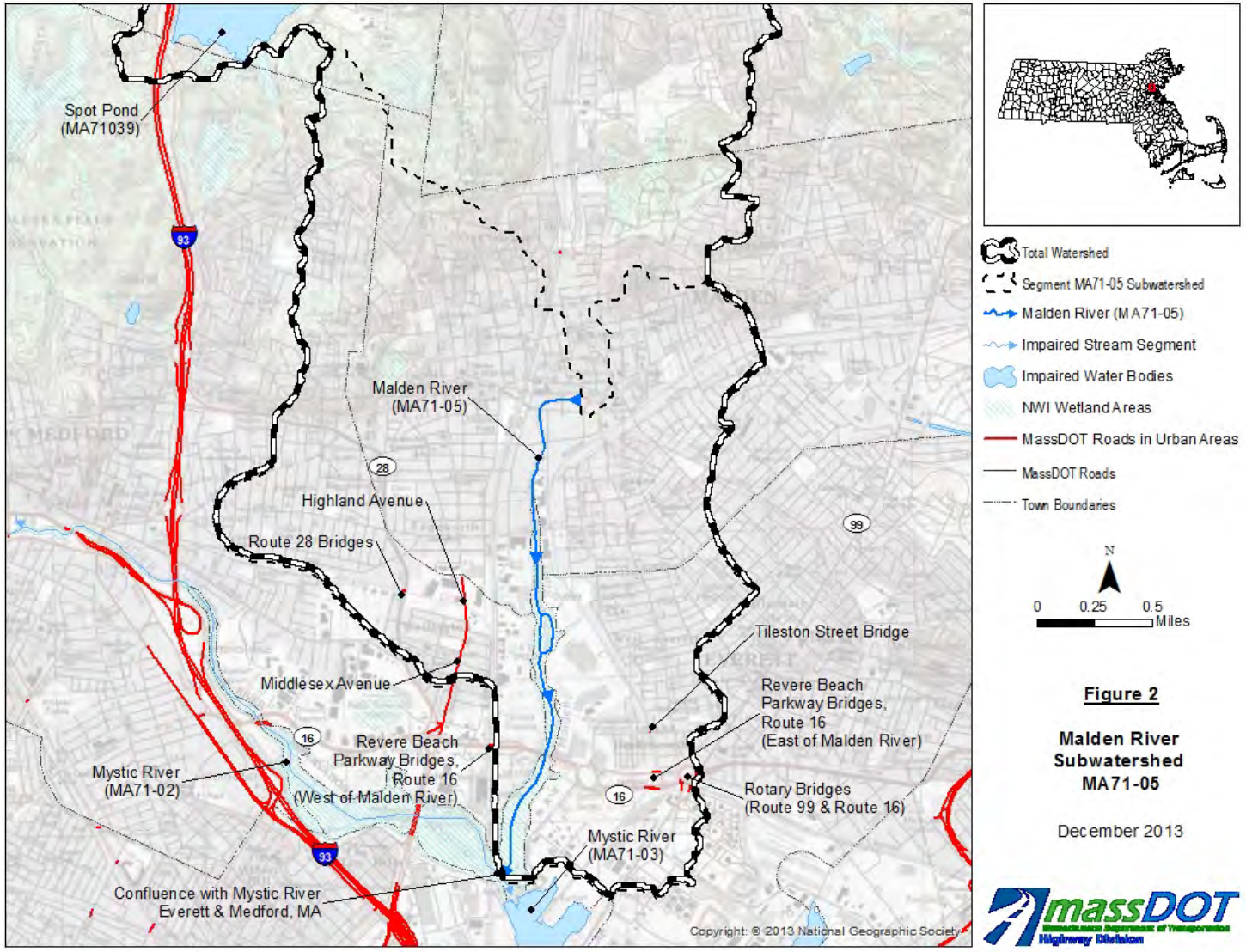

Figure 2

Malden River Subwatershed MA71-05

December 2013

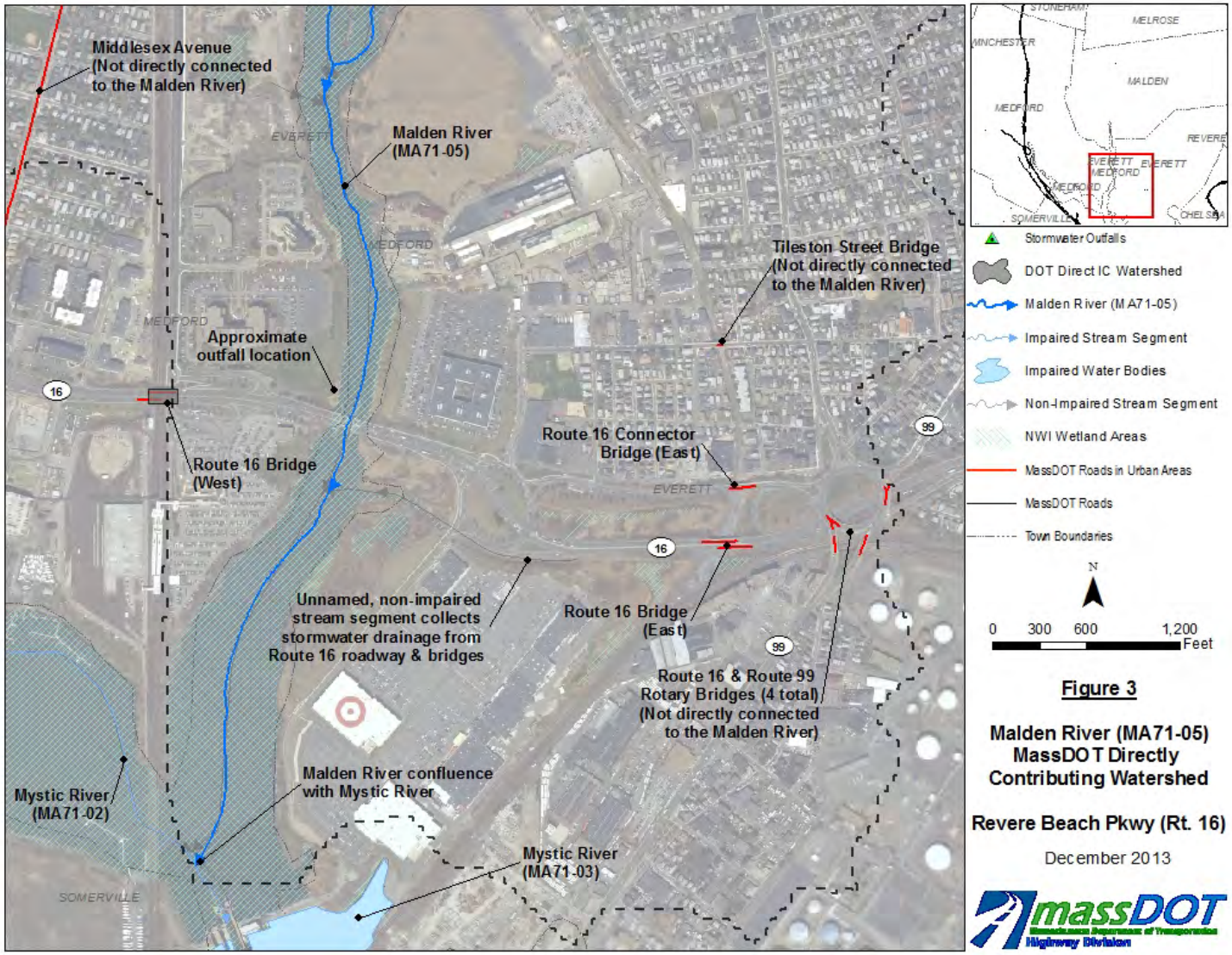

Figure 3

Malden River (MA71-05)
MassDOT Directly Contributing Watershed

Revere Beach Pkwy (Rt. 16)

December 2013

Impaired Waters Assessment for Neponset River (MA73-03) – Progress Report

Impaired Water body

Name: Neponset River

Location: Milton and Boston, MA

Water Body ID: MA73-03

Impairments

Neponset River (MA73-03) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). Neponset River is impaired for the following:

- (debris/floatables/trash*)
- DDT
- Escherichia coli
- Enterococcus
- fecal coliform
- other
- dissolved oxygen
- Foam/Flocs/Scum/Oil Slicks
- PCB in fish tissue
- Polychlorinated biphenyls

According to MassDEP's *Neponset River Watershed 2004 Water Quality Assessment Report* (MassDEP, 2010), Segment MA73-03 is a Class B\WWF water body and is included in the *final Total Maximum Daily Loads of Bacteria for Neponset River Basin* (MassDEP, 2002).

Relevant Water Quality Standards

Water Body Classification: Class B\WWF

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)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. 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 (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 (4) (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 Neponset River begins at the outlet of the Neponset Reservoir in Foxborough, MA and flows northeast for approximately 29 miles before discharging to Dorchester Bay (MA70-03). The Neponset River is broken up into four segments on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). This assessment only includes segment MA73-03.

Segment MA73-03 is 3.6 miles and begins at the confluence with Mother Brook and flows to Milton Lower Falls Dam. Refer to Figure 1 and Figure 2 for the total watershed and subwatershed to Segment MA73-03, respectively. MassDOT's property directly contributing stormwater runoff to Segment MA73-03 is comprised of portions of the following roadways in Boston, and Milton:

- Blue Hill Avenue
- Gallivan Boulevard/Morton Street
- Mattapan Bridge
- Cummins Highway
- Babson Street Bridge
- River Street Bridge
- Fairmount Avenue Bridge

Stormwater from Blue Hill Avenue flows from a high point between Concord Ave and Aberdeen Road to an outfall into the Neponset River which is located near the Mattapan Bridge.

Stormwater from sections of Gallivan Boulevard and Morton Street flows into the municipal stormwater system and discharges to Segment MA73-03 through an outfall located under the Mattapan Bridge, which is owned by the Boston Water and Sewer Company (BWSC).

Stormwater from sections of Mattapan Bridge flow from a high point to catch basins which flow to an outfall located near the Mattapan Bridge.

From a highpoint in the centerline in the bridge, stormwater from Cummins Highway Bridge flows to a catch basin which is directed to an outfall in the Neponset River. All of the runoff from Babson Street Bridge flows directly to an outfall in the Neponset River.

About half a mile north of the Mattapan Bridge, stormwater from sections of another bridge on Blue Hill Ave flow from the highpoint in the center of the bridge to a catch basin which travels to a large outfall under the Mattapan Bridge.

Stormwater from River Street Bridge flows adjacent to a Combined Sewer Overflow which discharges to an outfall in the Neponset River, to the West of the Mattapan Bridge.

Fairmount Avenue Bridge runs directly over the Neponset River, and runoff from the bridge flows to outfalls located near the bridge.

Assessment under BMP 7U

Of the impairments listed for Segment MA73-03 of the Neponset River, three are potentially linked to highway runoff and have not been addressed by a TMDL. MassDOT assessed these

impairments using the approach outlined 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 the completion of a TMDL. This approach is fully described in MassDOT's "Description of MassDOT's Application of Impervious Cover Method in BMP 7U" (2011). It uses impervious cover (IC) as a surrogate to measure the potential impacts of stormwater and associated pollutants on a receiving water body. For Segment MA73-03, MassDOT used the Impervious Cover Method to assess the following impairment:

- dissolved oxygen
- foam/flocs/scum/oil Slicks
- other

According to MassDEP's final Massachusetts Year 2012 Integrated List of Waters, the impairment for (debris/floatables/trash*) is considered a non-pollutant and is unrelated to stormwater in general. Therefore, MassDOT has determined that further assessment of this impairment for Segment MA73-03 is not required under BMP 7U (MassDEP, 2013).

MassDOT has concluded that the impairment for PCB in fish tissue, DDT, and Polychlorinated biphenyls are also unrelated to stormwater runoff. The Nationwide Urban Runoff Program (NURP) conducted by the EPA found that PCB, DDT and Polychlorinated biphenyls were 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, DDT and Polychlorinated biphenyls.

The impairments for Enterococcus, fecal coliform, and Escherichia coli, have been addressed by a TMDL and 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 Neponset River (MA73-03):

Table 1. Site Parameters for Neponset River (MA73-03)

Type	Parameter	Quantity	Unit of Measure
Total Watershed	Watershed Area	69,458	acres
Total Watershed	Impervious Cover (IC) Area	13,176	acres
Total Watershed	Percent Impervious	19.0	%
Subwatershed	Subwatershed Area	2,250	acres
Subwatershed	Impervious Cover (IC) Area	1,064	acres
Subwatershed	Percent Impervious	47.3*	%
Subwatershed	IC Area at 9% Goal	203	acres
Subwatershed	Target Reduction% in IC	80.9	%
Reductions Applied	MassDOT's IC Area Directly Contributing to Impaired Segment	7.0	acres
Reductions Applied	MassDOT's Target Reduction in Effective IC (80.9% of DOT Directly Contributing IC)	5.7	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 80.9%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 5.7 acres.

Existing BMPs

Based on the site visit, there are no existing BMPs in the Neponset River (MA73-03) directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to Neponset River(MA73-03).

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 5.7 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 are assessed 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, and has a pet waste management program underway to address this source where necessary.

- 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.

Unlike other TMDLs that establish pollutant load allocations based on mass per time, many bacteria and pathogen TMDLs in Massachusetts establish bacterial TMDLs that are concentration based and equivalent to the MassDEP water quality standard for the receiving water body. This requirement therefore requires that at the point of discharge to the receiving water, all sources include bacteria concentrations that are equal or less than the MassDEP water quality standard for the receiving water body.

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

In addition to the generic recommendations provided in the draft MS4 permits for Massachusetts, the Neponset River TMDL report (pages 38-39) recommends the following specific BMPs to address elevated fecal coliform levels in the watershed:

- Identification and elimination of illicit sources
- Increased frequency of street sweeping and catch basin cleaning
- Public education programs
- Adoption of pet waste pick up laws
- Diversion of runoff to pervious areas for infiltration where possible

The TMDL report also indicates that structural BMPs may be appropriate to address runoff from impervious areas in instances where fecal coliform concentrations cannot be reduced by other means.

The following BMPs are specifically identified as being ongoing and/or planned in order to meet the bacteria TMDL for the Neponset River:

- Watershed resident education
- Additional monitoring

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

MassDOT believes that existing efforts are consistent with the current and draft MS4 permit requirements and TMDL recommendations in regard to pathogens. MassDOT has documented the locations of its stormwater outfalls. In addition, as part of its pet waste management program, MassDOT has determined that no MassDOT rest stops are located within the sub-watershed of this water body. At rest stops that have been identified as being within sub-watersheds of water bodies impaired for pathogens, MassDOT will be installing signs informing the public of the need to remove pet waste in order to minimize contributions of pathogens to the impaired water body, and pet waste removal bags and disposal cans will be provided.

Although the TMDL report also identifies that depending on the success of non-structural BMPs structural BMPs may become appropriate to address runoff from impervious areas, MassDOT feels that it is not a beneficial approach to implement these BMPs in advance of other ongoing BMP efforts identified in the watershed, given the documented variability of pathogen concentrations in highway runoff, and the low probability of achieving substantial gains towards meeting the TMDL with solely implementing IC reductions and controls.

Furthermore, MassDOT has an ongoing inspection and monitoring program aimed at identifying and addressing illicit discharges to MassDOT's stormwater management system. Any illicit discharges to MassDOT's system could contribute pathogens to impaired waters, however, MassDOT's existing Illicit Discharge Detection and Elimination (IDDE) program is aimed at identifying and addressing these contributions. District maintenance staff is trained to conduct regular inspections of MassDOT infrastructure and note any signs of potential illicit discharges, such as dry weather flow and notable odors or sheens. Similarly, resident engineers overseeing construction projects also receive training to note any suspicious connections or flows, and report these for follow-up investigation and action as appropriate. MassDOT will continue to implement this Illicit Discharge Detection and Elimination (IDDE) training, and District staff will continue to report any suspicious flows requiring further investigation. MassDOT investigates any suspicious flows noted, and will work with owners of confirmed illicit discharges to remove these flows, and thereby minimize the possibility of pathogen contributions to receiving waters. At present, there are no suspected or known illicit discharges, or unauthorized drainage tie-ins, within the sub-watershed of this water body that could be contributing pathogens to the impaired water body.

Conclusions

MassDOT used the IC Method to assess Neponset 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 5.7 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Neponset River (MA73-03) to identify existing BMPs and found that there were no existing BMPs to contribute to the target reduction in effective IC. This information is summarized in Table 2 below.

Table 2. Effective IC Reductions under Existing & Proposed Conditions

Type of Reduction	Quantity	Unit of Measure
IC in Directly Contributing Watershed	7.0	acres
Target Reduction in Effective IC	5.7	acres
IC Effectively Reduced by Existing BMPs	0.0	acres
IC Remaining to Mitigate with Proposed BMPs	5.7	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 MA73-03, 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, and the Final Bacteria TMDL for this impaired water body segment, that the BMPs outlined in MassDOT's stormwater management plan 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. As stated previously, pathogen loadings are highly variable and although there is potential for stormwater runoff from DOT roadways to be a contributing source it is unlikely to be warrant action relative to other sources of pathogens in the watershed.

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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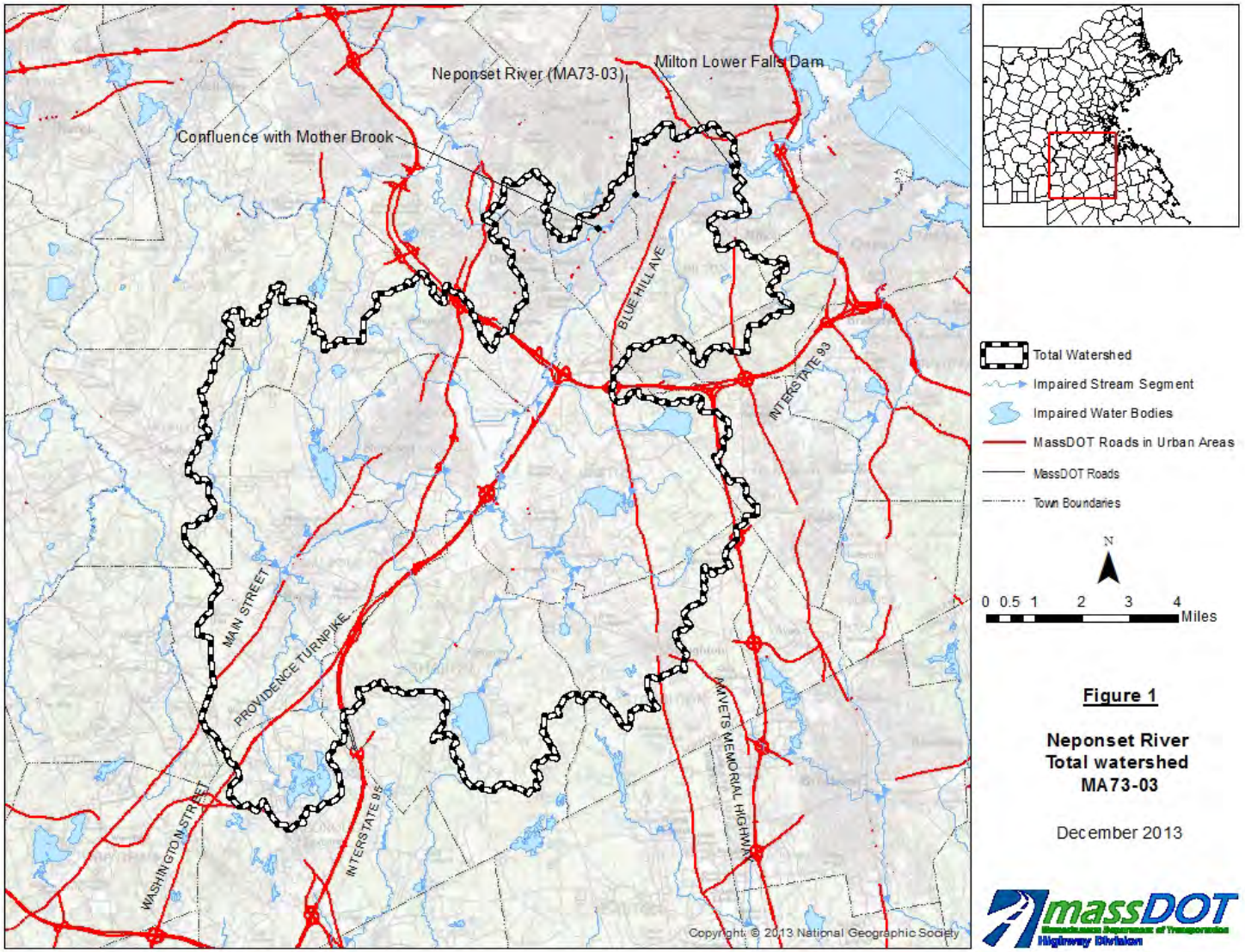

Figure 1

Neponset River
Total watershed
MA73-03

December 2013

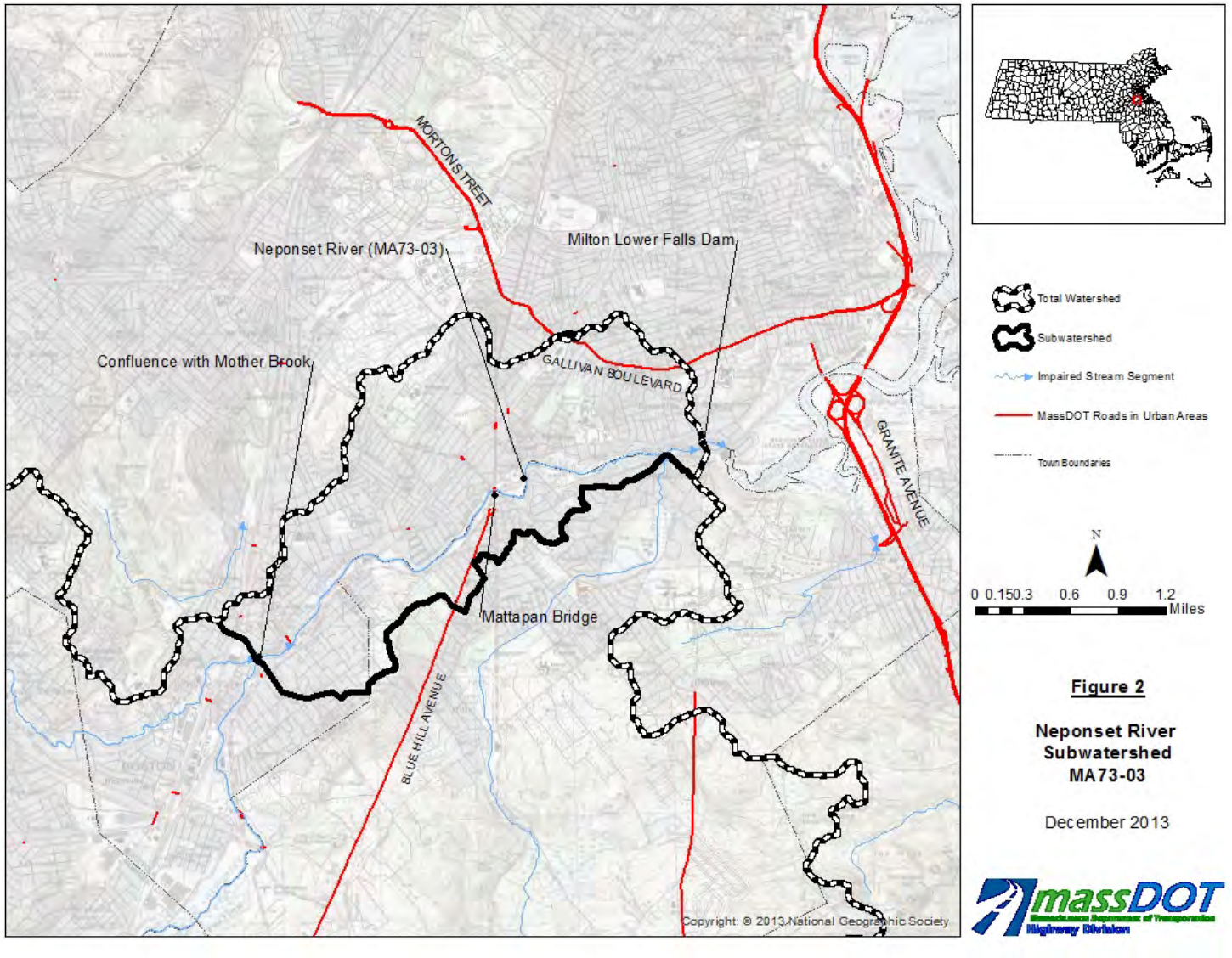

Figure 2

Neponset River Subwatershed MA73-03

December 2013

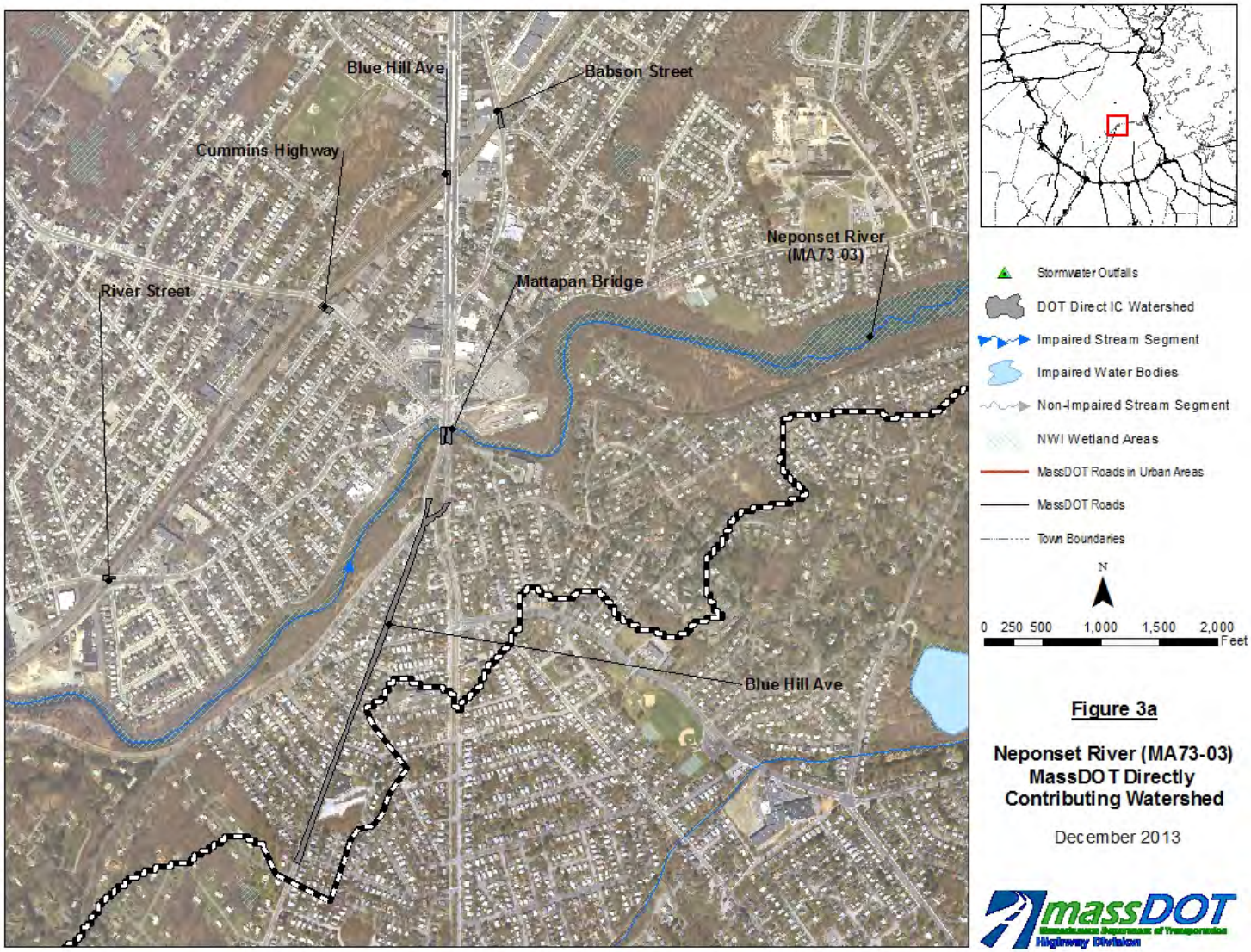

Figure 3a

Neponset River (MA73-03)
MassDOT Directly Contributing Watershed

December 2013

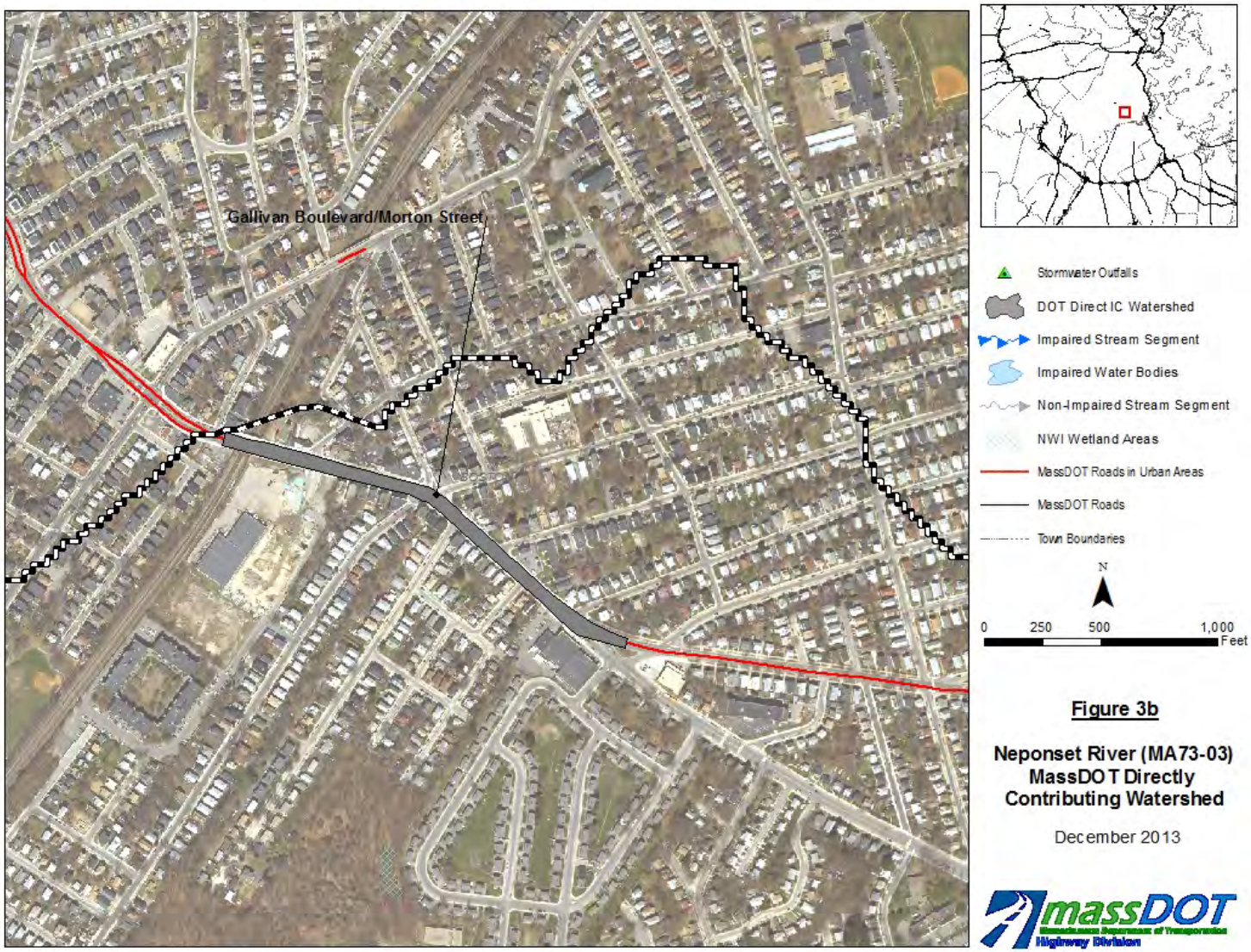

Figure 3b

Neponset River (MA73-03)
MassDOT Directly Contributing Watershed

December 2013

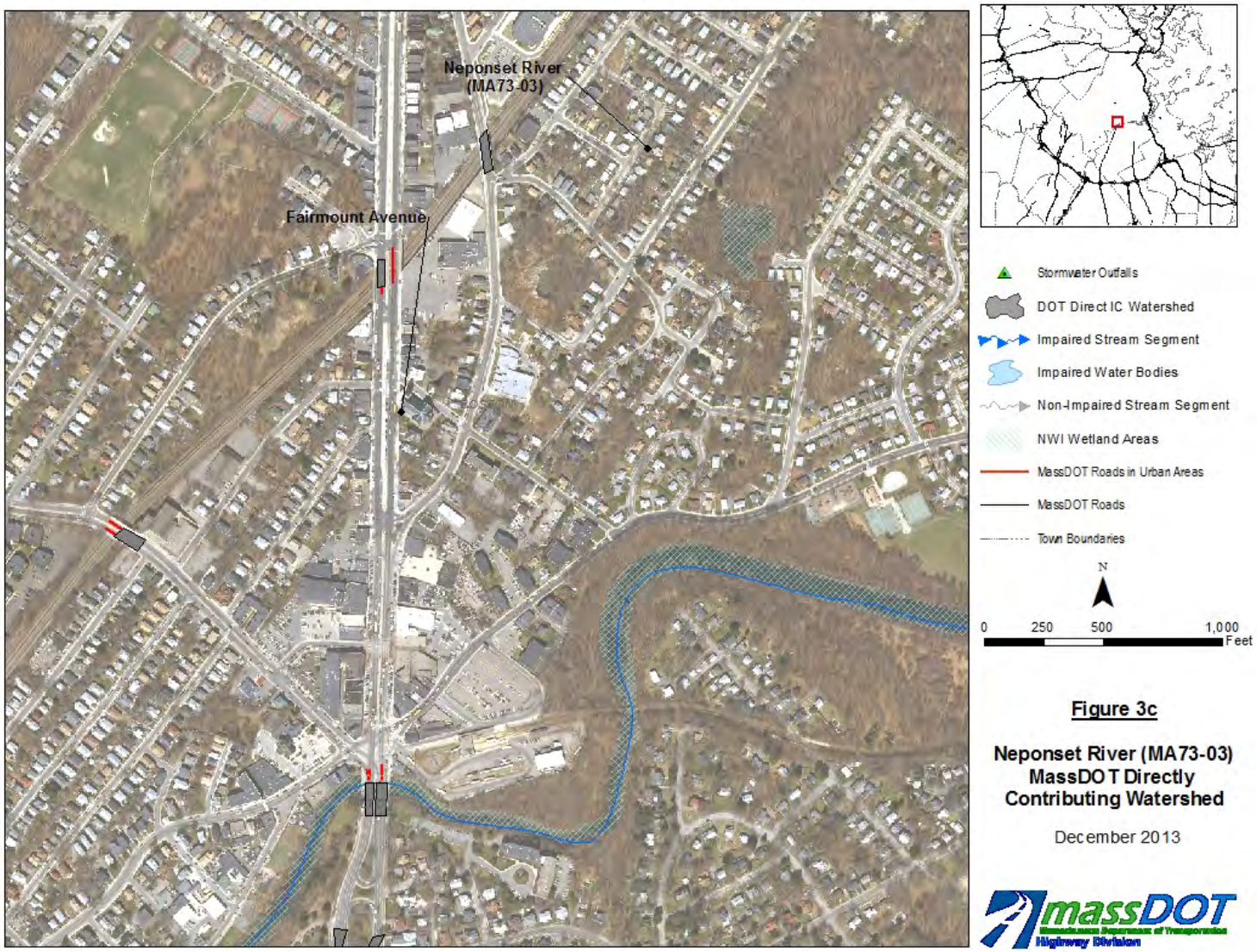

Figure 3c

Neponset River (MA73-03)
MassDOT Directly Contributing Watershed

December 2013

Impaired Waters Assessment for Neponset River (MA73-04) – Progress Report

Impaired Waterbody

Name: Neponset River

Location: Milton, Quincy, Boston, MA

Water Body ID: MA73-04

Impairments

Segment MA73-04 of the Neponset River is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). It is impaired for the following:

- (debris/floatables/trash*)
- Enterococcus [2592]
- fecal coliform [2592]
- other
- dissolved oxygen
- PCB in fish tissue
- turbidity

According to MassDEP's *Neponset River Watershed 2004 Water Quality Assessment Report* (MassDEP, 2010), Segment MA73-04 is a Class SB water body and is included in the final *Total Maximum Daily Loads of Bacteria for Neponset River Basin* (MassDEP, 2002).

Relevant Water Quality Standards

Water Body Classification: Class SB

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) 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; and
  - c. consistent with Massachusetts Department of Public Health regulations for bathing beaches, the single sample maximum values in the primary contact recreation bacteria criteria in 314 CMR 4.05(4)(b)4.b. also are for use in the context of notification and closure decisions.

- *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 (4) (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) (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) (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 Neponset River begins at the outlet of the Neponset Reservoir in Foxborough, MA and flows northeast for approximately 29 miles before discharging to Dorchester Bay (MA70-03). The Neponset River is broken up into four segments on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). This assessment includes only the most downstream segment, MA73-04.

Segment MA73-04 begins at the Baker Dam, which is located within the Dorchester/Milton Lower Mills Industrial Complex, and flows north/northeast into Dorchester Bay (MA70-03). Refer to Figure 1 and Figure 2 for the total watershed and subwatershed to Segment MA73-04, respectively. MassDOT's property contributing direct stormwater runoff to Segment MA73-04 is comprised of portions of the following roadways in Boston, Milton, and Quincy:

- Newport Avenue/Squantam Street Ramp
- Gallivan Boulevard (Rt. 203/3A)
- Granite Avenue
- Hancock Street
- I-93/Southeast Expressway

Stormwater from the Newport Avenue/Squantam Street Ramp and Hancock Street in Quincy appears to flow into the municipal stormwater system. Due to the local topography and proximity to the Neponset River, it is assumed that the municipal system discharges to the Neponset River and therefore these areas are considered direct discharges.

Stormwater from Gallivan Boulevard (Rt. 203/3A) in Boston flows into the municipal stormwater system and discharges to Segment MA73-04 through outfall 10LSDO094, which is owned by the Boston Water and Sewer Company (BWSC).

Stormwater from Granite Avenue in Boston also flows into the municipal stormwater system and discharges to Segment MA73-04 through outfall 9LSDO095, which is owned by the BWSC. Stormwater from Granite Avenue in Milton flows into several small collection systems that discharge to wetlands directly connected to Segment MA73-04.

Stormwater from I-93/Southeast Expressway and its entry/exit ramps is collected by small, localized collection systems that discharge directly to Segment MA73-04 and adjacent wetlands. These wetlands are hydraulically well-connected to Segment MA73-04 and periodically become submerged due to tidal fluctuations. For these reasons, discharges to these wetlands are considered direct. Several of the collection systems along I-93 in Boston are tied into the municipal stormwater system and discharge to Segment MA73-04 via non-MassDOT outfalls. Refer to Figure 3 for the locations of MassDOT's directly contributing impervious cover within the subwatershed to Segment MA73-04 of the Neponset River.

Assessment under BMP 7U

Of the impairments listed for Segment MA73-04 of the Neponset River, three are potentially linked to highway runoff and have not been addressed by a TMDL. MassDOT assessed these impairments using the approach outlined 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 the completion of a TMDL. This approach is fully described in MassDOT's "Description of MassDOT's Application of Impervious Cover Method in BMP 7U" (2011). It uses impervious cover (IC) as a surrogate to measure the potential impacts of stormwater and associated pollutants on a receiving water body. For Segment MA73-04, MassDOT used the Impervious Cover Method to assess the following three impairments:

- other
- dissolved oxygen
- turbidity

According to MassDEP's final *Massachusetts Year 2012 Integrated List of Waters*, the impairment for (debris/floatables/trash*) is considered a non-pollutant and is unrelated to stormwater in general. Therefore, MassDOT has determined that further assessment of this impairment for Segment MA73-04 is not required under BMP 7U (MassDEP, 2013).

MassDOT has concluded that the impairment for PCB in fish tissue is also 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 impairments for Enterococcus [2592] and fecal coliform [2592] have been addressed by a TMDL and 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. For cases where the USGS Data Series watersheds did not correctly 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. Due to the urban nature of the subwatershed to Segment MA73-04, the subwatershed delineation was also revised based on BWSC's existing stormwater infrastructure GIS database. 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 MA73-04 of the Neponset River:

Table 1. Site Parameters for Neponset River (MA73-04)

Type	Parameter	Quantity	Unit of Measure
Total watershed	Watershed Area	74,543	acres
Total watershed	Impervious Cover (IC) Area	15,596	acres
Total watershed	Percent Impervious	20.9	%
Subwatershed	Watershed Area	5,222	acres
Subwatershed	Impervious Cover (IC) Area	2,490	acres
Subwatershed	Percent Impervious	47.7	%
Subwatershed	IC Area at 9% Goal	470	Acres
Subwatershed	Target Reduction % in IC	81.1	%
Reductions Applied to DOT Direct Watershed	MassDOT's IC Area Directly Contributing to Impaired Segment	65.2	acres
Reductions Applied to DOT Direct Watershed	MassDOT's Target Reduction in Effective IC (81.1% of DOT Directly Contributing IC)	52.9	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 81.1%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 52.9 acres.

Existing BMPs

Based on the site visit, there are no existing BMPs within MassDOT's directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to Segment MA73-04 of the Neponset River.

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 52.9 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:

- 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

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.

MassDOT anticipates the issuance of an individual stormwater permit from U.S. EPA which will outline details of a required Illicit Detection.

Conclusions

MassDOT used the IC Method to assess Segment MA73-04 of the Neponset 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 52.9 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Segment MA73-04 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

Type of Reduction	Quantity	Unit of Measure
IC in Directly Contributing Watershed	65.2	acres
Target Reduction in Effective IC	52.9	acres
IC Effectively Reduced by Existing BMPs	0.0	acres
IC Remaining to Mitigate with Proposed BMPs	52.9	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 MA73-04, 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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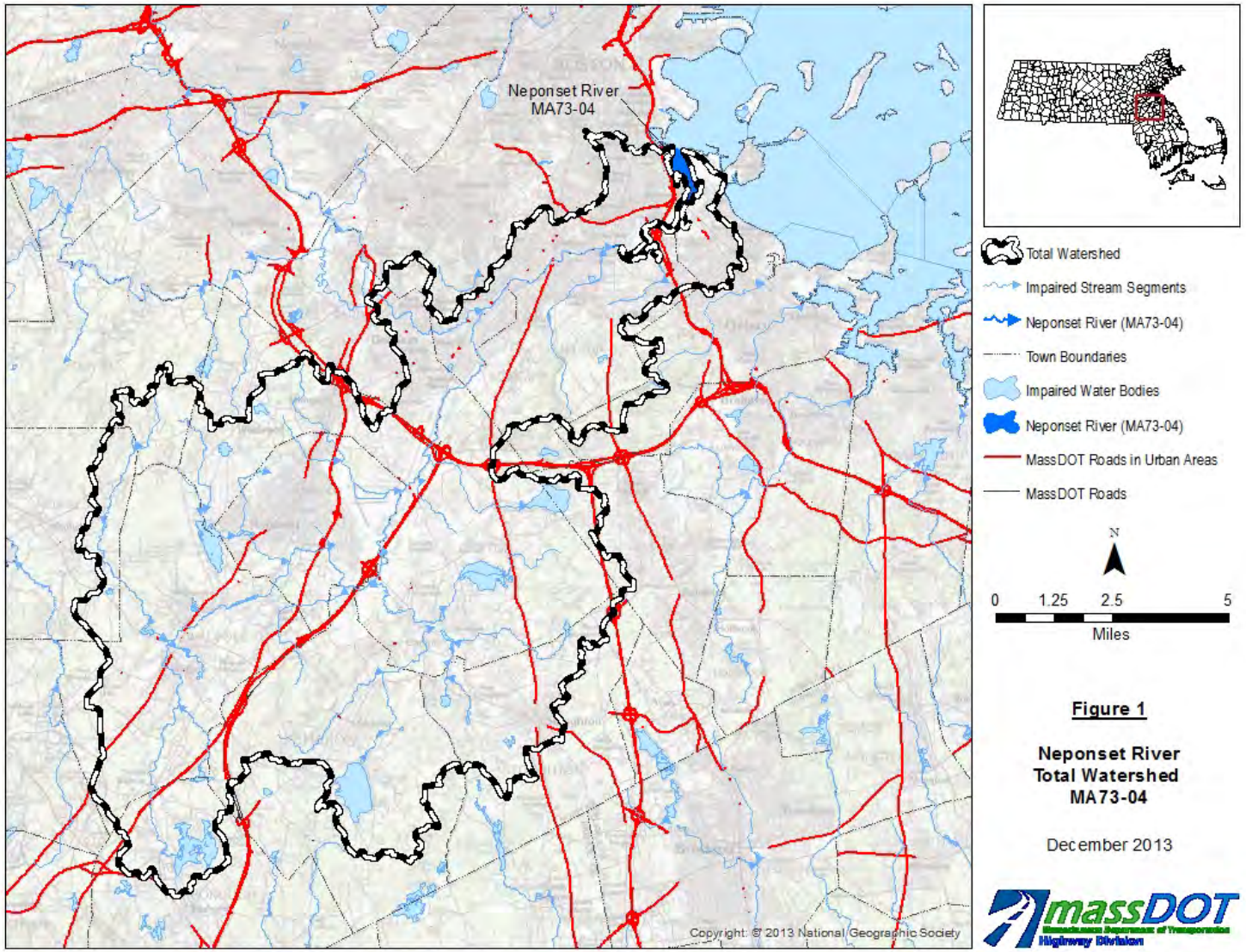

Figure 1

Neponset River
Total Watershed
MA73-04

December 2013

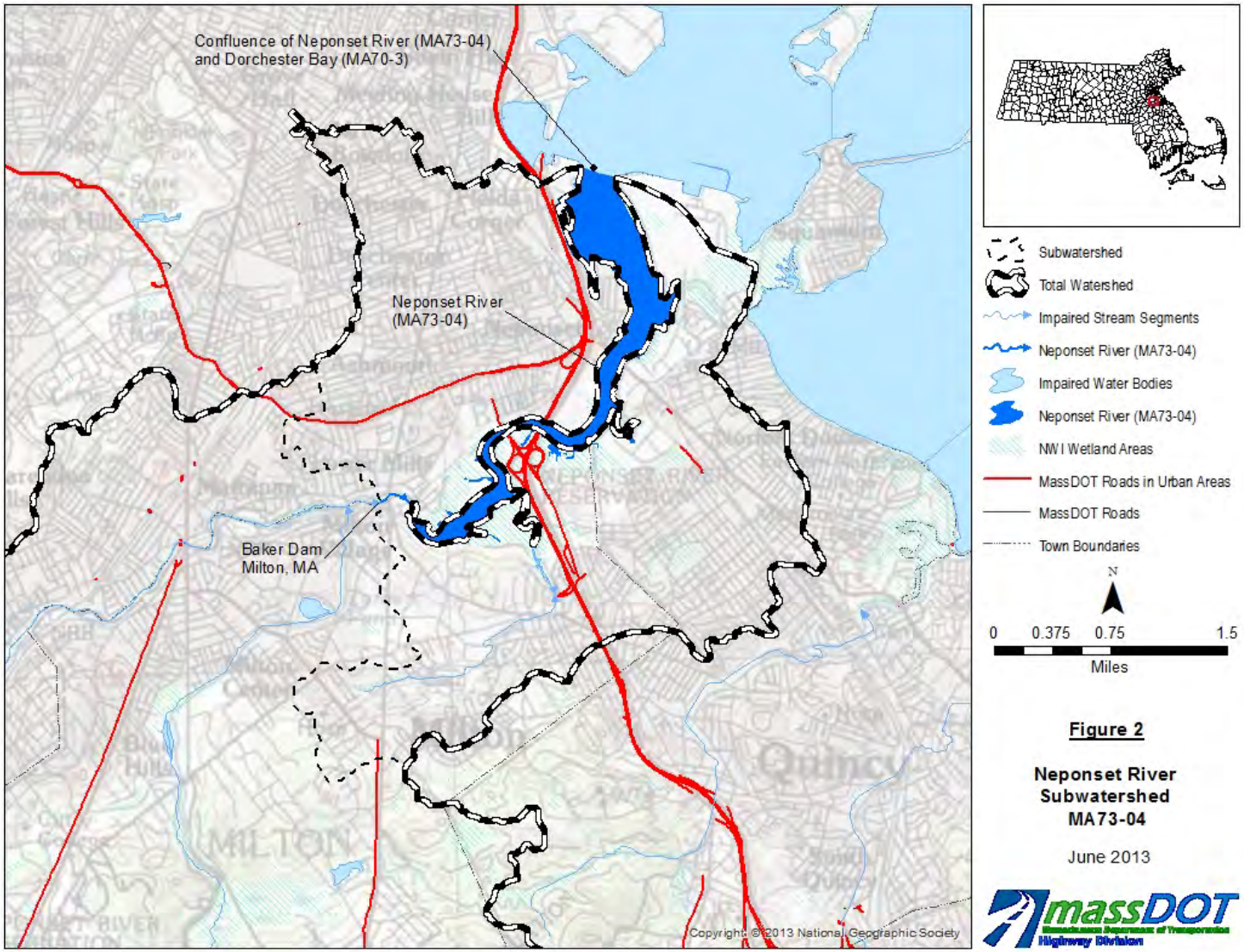

Figure 2

Neponset River Subwatershed MA73-04

June 2013

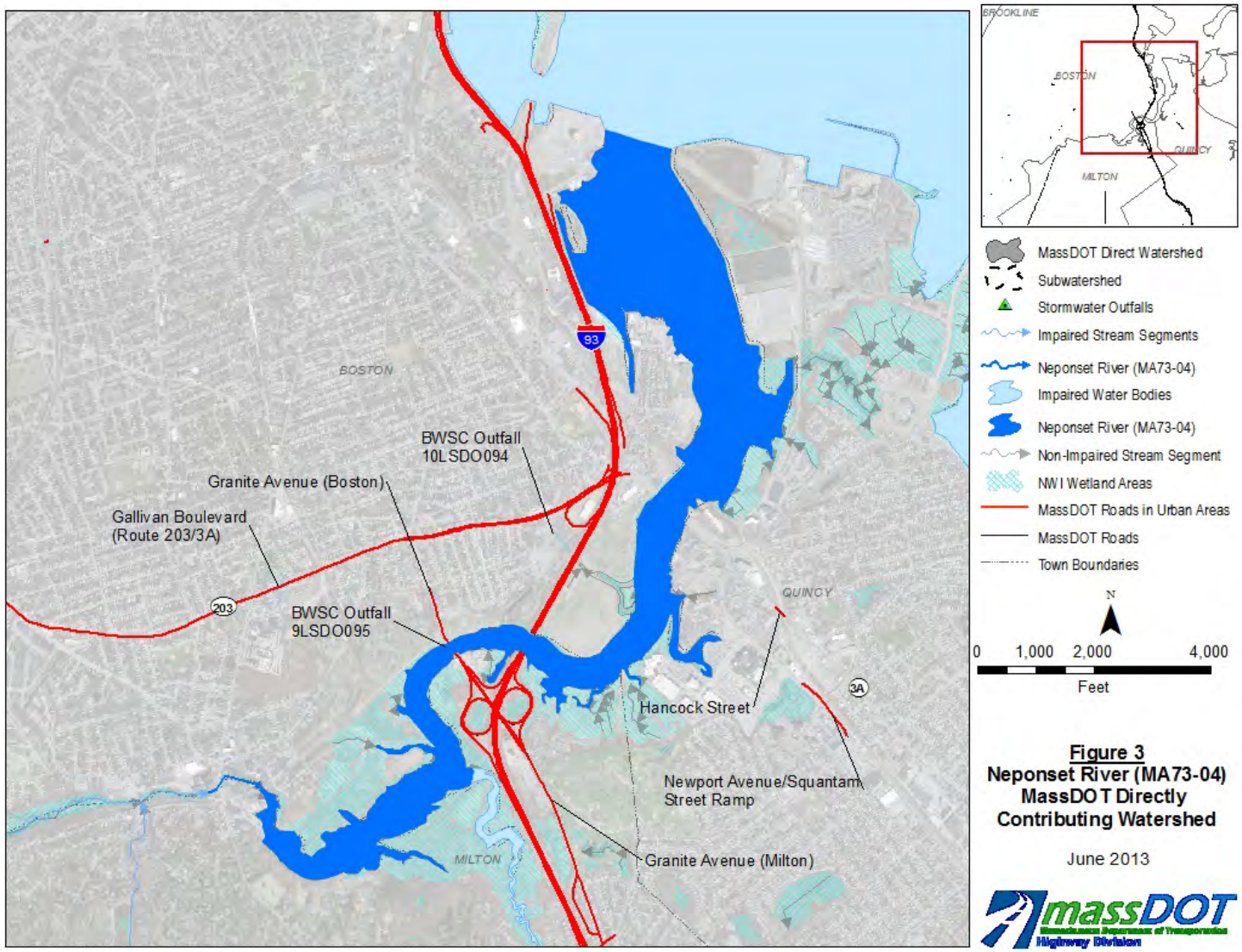

Figure 3
Neponset River (MA73-04)
MassDOT Directly Contributing Watershed

June 2013

Impaired Waters Assessment for Pequid Brook (MA73-22) – Progress Report

Impaired Waterbody

Name: Pequid Brook

Location: Canton, MA

Water Body ID: MA73-22

Impairments

Pequid Brook (MA73-22) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). Pequid Brook is impaired for the following:

- Oxygen, Dissolved

According to MassDEP's *Neponset River Watershed 2004 Water Quality Assessment Report* (MassDEP, 2010), a 2.8 mile reach of Pequid Brook (excluding approximately 1.3 miles through Reservoir Pond), which flows from York Street in Canton to the inlet of Forge Pond also in Canton, is impaired for dissolved oxygen and the possible sources are unknown.

Relevant Water Quality Standards

Water Body Classification: Class B, Warm Water Fishery

Applicable State Regulations:

- 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.

Site Description

Pequid Brook (MA73-22) originates at York Street in Canton and flows approximately 1.9 miles to the inlet of Reservoir Pond. The Brook continues at the outlet of Reservoir Pond and flows through Canton for 0.9 miles to the inlet of Forge Pond where the segment of Pequid Brook terminates.

The total watershed is shown in Figure1 and the subwatershed is shown in Figure 2. MassDOT's property directly contributing stormwater runoff to Pequid Brook (MA13-22) is comprised of Route 138 (Turnpike Street) in Canton (Figure 3).

Stormwater features along Route 138 (Turnpike Street) northbound and southbound are the primary conveyers of stormwater from this roadway to Pequid Brook (MA73-22). Field observations confirmed that drainage from Route 138 north and south of Pequid Brook flows into the system that discharges to the Brook.

Assessment under BMP 7U

The dissolved oxygen impairment listed for Pequid Brook 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:

- dissolved oxygen

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 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 Pequid Brook (MA73-22):

Table 1. Site Parameters for Pequid Brook (MA73-22)

Type	Parameter	Quantity	Unit of Measure
Total Watershed	Watershed Area	60,736	acres
Total Watershed	Impervious Cover (IC) Area	10,851	acres
Total Watershed	Percent Impervious	17.9*	%
Subwatershed	Subwatershed Area	4,177	acres
Subwatershed	Impervious Cover (IC) Area	661	acres
Subwatershed	Percent Impervious	15.8*	%
Subwatershed	IC Area at 9% Goal	378	acres
Subwatershed	Target Reduction % in IC	43.1	%
Reductions Applied	MassDOT's IC Area Directly Contributing to Impaired Segment	2.1	acres
Reductions Applied	MassDOT's Target Reduction in Effective IC (43.1% of DOT Directly Contributing IC)	0.9*	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 43.1%. 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

Based on the site visit, there are no existing BMPs in the Pequid Brook (MA73-22) directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to Pequid Brook (MA73-22).

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 Pequid 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 0.9 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Pequid Brook (MA73-22) 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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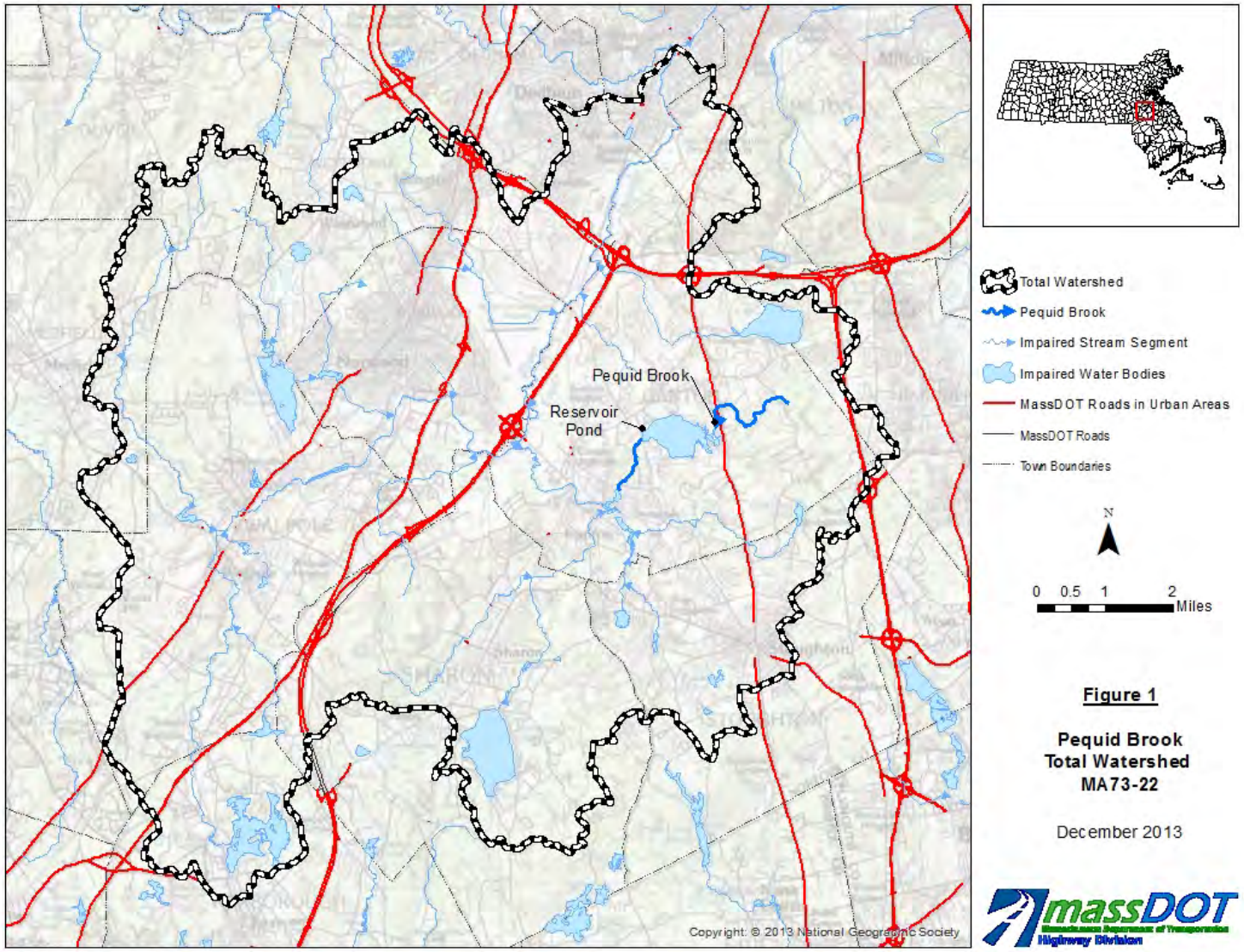

Figure 1

Pequid Brook
Total Watershed
MA73-22

December 2013

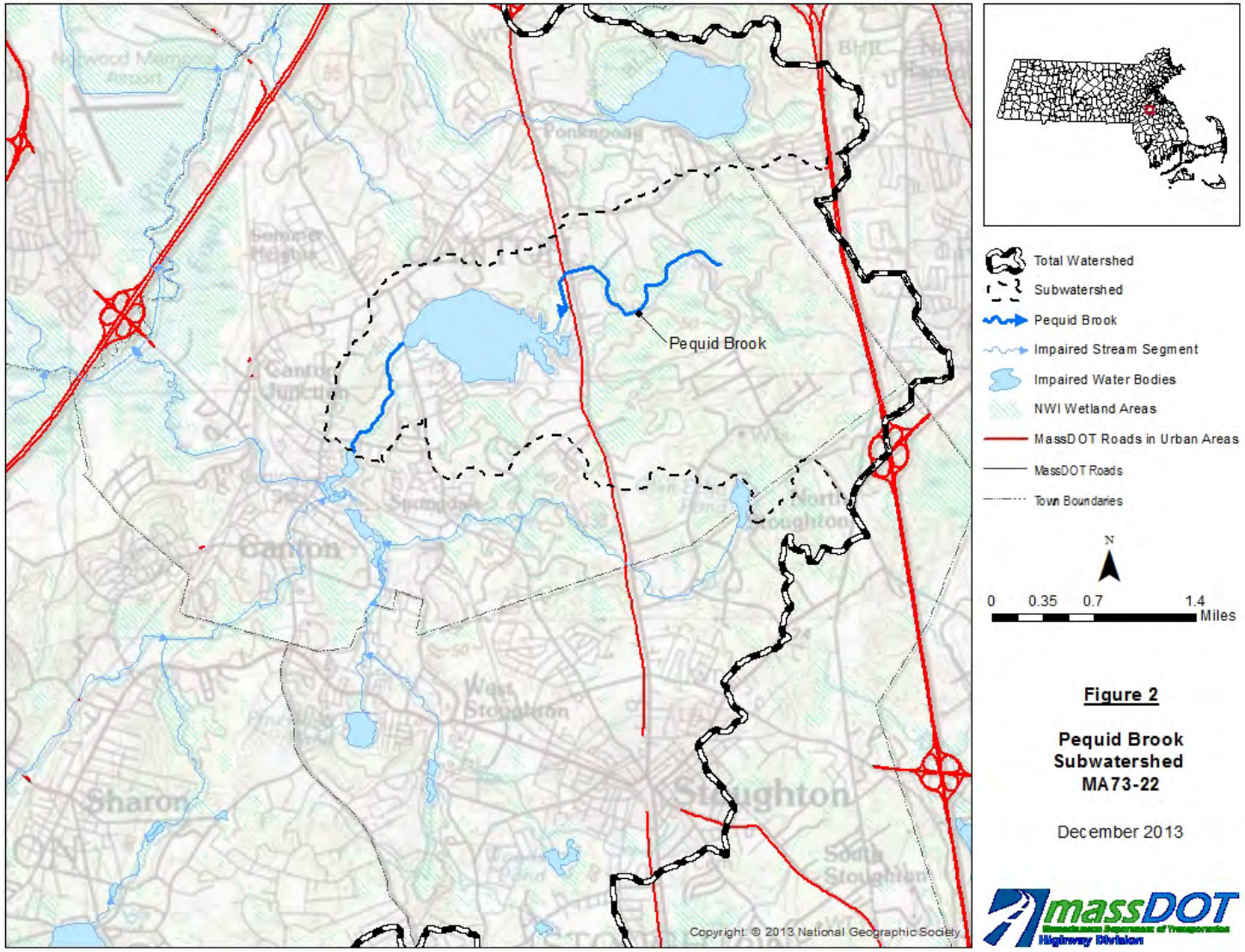

Figure 2

Pequid Brook Subwatershed MA73-22

December 2013

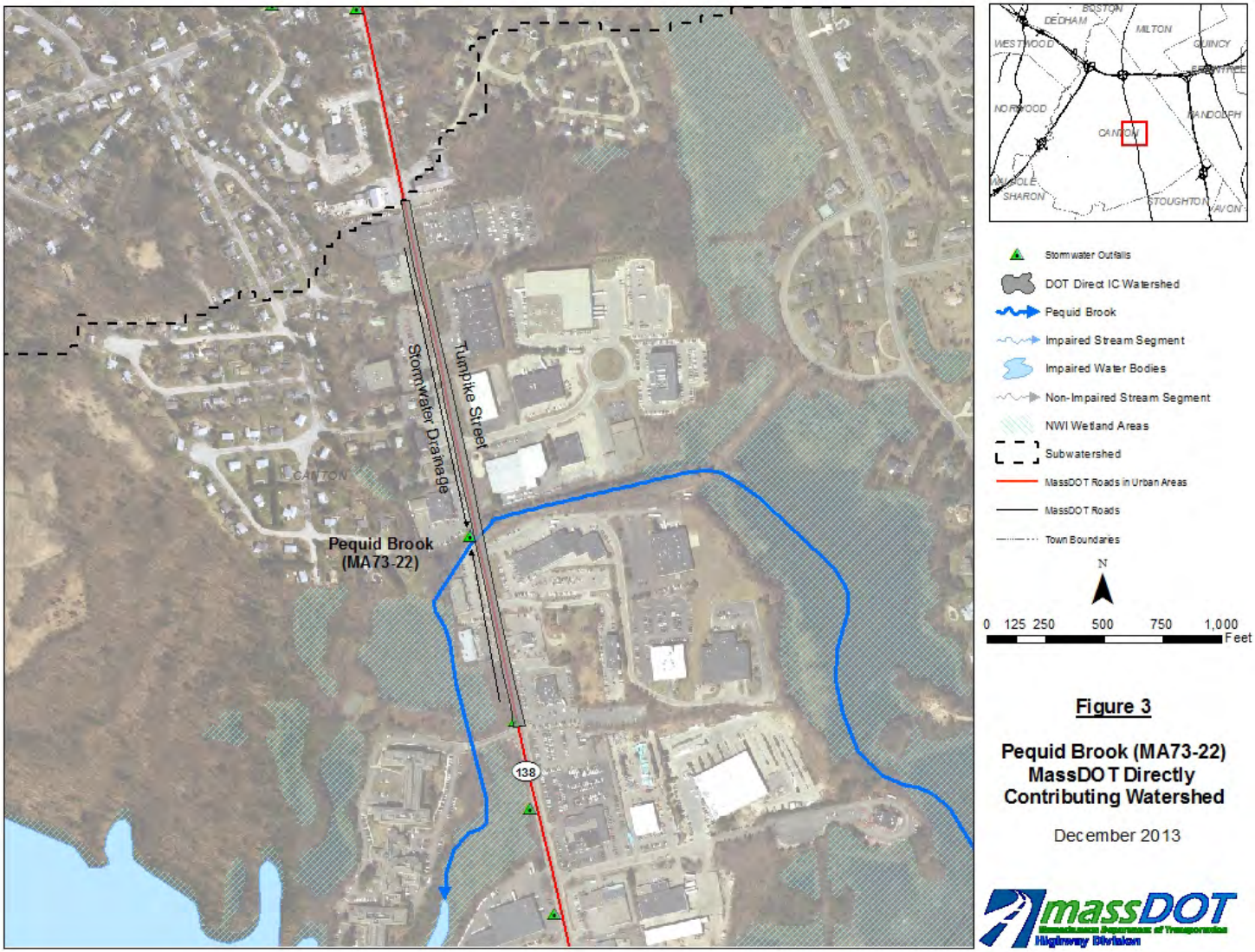

Figure 3

Pequid Brook (MA73-22) MassDOT Directly Contributing Watershed

December 2013

Impaired Waters Assessment for Weir River (MA74-02) and Foundry Pond (MA74011) – Progress Report

Impaired Water Body

Name: Weir River and Foundry Pond

Location: Hingham, MA

Water Body ID: MA74-02 and MA74011

Impairments

Weir River (MA74-02) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). Weir River is impaired for the following:

- Fecal Coliform
- Sedimentation/Siltation
- (Low flow alterations)
- Nutrient/Eutrophication Biological Indicators

Based on the 2012 Integrated List of Waters, Foundry Pond (formerly referred to as MA74011) is now incorporated into the segment identified as Weir River (MA74-02). Therefore, these water bodies are combined within this assessment. In addition, the 2012 List of Integrated Waters identifies the low-flow alterations impairment as not requiring a TMDL as it is considered a non-pollutant related stress.

According to MassDEP's *Weymouth and Weir River Basin 2004 Water Quality Assessment Report* (MassDEP, 2010), a 2.7 mile reach of the Weir River, which flows from its headwaters at the confluence of Crooked Meadow River and Fulling Mill Brook in Hingham to the Foundry Pond outlet, is impaired for low flow alterations. GZA estimated stream depletion due to water withdrawal in the Weir River. Given the fact that net outflows from the basin exceed the August median flow at the outflow to the ocean the Weir river basin has been identified as highly stressed by the Water Resources Commission. The segment was not assessed for Fish Consumption, Primary and Secondary contact and aesthetics due to insufficient data (MassDEP 2010) .

Weir River/Foundry Pond is also covered by a Draft Pathogen Total Maximum Daily Load (TMDL) for the Boston Harbor Watershed (excluding the Neponset River Sub-basin) (MassDEP, no date).

Relevant Water Quality Standards

Water Body Classification: Class B, Outstanding Resource Water

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) 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.
- 14CMR 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 Weymouth and Weir River Basin is located in the southeast region of the Boston Harbor Watershed and is comprised of five systems: Furnace Brook, Town River, Weymouth Fore River, Weymouth Back River and Weir River. The Weir River Segment MA74-02, which is the subject of this assessment, is

formed at the confluence of Crooked Meadow River and Fulling Mill Brook, and flows 2.7 miles to the Foundry Pond outlet, Hingham (through former pond segment Foundry Pond MA74011). The Weir River Segment MA74-11 is also classified as impaired and continues an additional 0.8 miles from Foundry Pond to the mouth at Words End, Hingham.

The Weir River Area of Critical Environmental Concern (ACEC) in Cohasset, Hingham and Hull was designated as an ACEC on December 11th, 1986 and includes approximately 950 acres. The area supports over 100 species of migratory and resident bird species and an abundance of shellfish and finfish.

MassDOT's property directly contributing stormwater runoff to the Weir River (MA74-02) is comprised of portions of Route 3A, Chief Justice Cushing Highway (See Figure 3). The total watershed is shown in Figure1 and the subwatershed is shown in Figure 2.

Drainage ditches paralleling Route 3A east of the Weir River are the primary conveyers of stormwater from this roadway to the Weir River (MA74-02). On the portion of Route 3A west of the Weir River directly contributing stormwater, drainage ditches convey water to a small brook on the northern side of Route 3A that immediately conveys stormwater into the Weir River. MassDOT Plan RP338 supports the field observation that drainage from Route 3A discharges to these ditches which flow to the Weir River.

Assessment under BMP 7U

None of the impairments for Weir River 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
- Nutrient/Eutrophication Biological Indicators

As described below the impairment for pathogens is assessed separately.

According to the final *Massachusetts Year 2012 Integrated List of Waters*, low flow alterations is 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 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 Weir River (MA74-02):

Table 1. Site Parameters for Weir River (MA74-02)

Type	Parameter	Quantity	Unit of Measure
Total Watershed	Watershed Area	9,650	acres
Total Watershed	Impervious Cover (IC) Area	1,960	acres
Total Watershed	Percent Impervious	20.4*	%
Subwatershed	Subwatershed Area	1,870	acres
Subwatershed	Impervious Cover (IC) Area	300	acres

Type	Parameter	Quantity	Unit of Measure
Subwatershed	Percent Impervious	15.8*	%
Subwatershed	IC Area at 9% Goal	168	acres
Subwatershed	Target Reduction% in IC	43.1	%
Reductions Applied	MassDOT's IC Area Directly Contributing to Impaired Segment	2.59	acres
Reductions Applied	MassDOT's Target Reduction in Effective IC (43.1% of DOT Directly Contributing IC)	1.1	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 43.1%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 1.1 acres.

Existing BMPs

Based on the site visit, there are no existing BMPs in the Weir River (MA74-02) directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to Weir River (MA74-02).

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 1.1 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 are assessed 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, and has a pet waste management program underway to address this source where necessary.
- 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.

Conclusions

MassDOT used the IC Method to assess Weir 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 1.1 acres to achieve the targeted reduction in

effective IC. MassDOT evaluated its property within the directly contributing watershed to Weir River (MA74-02) 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 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 Enterococcus and 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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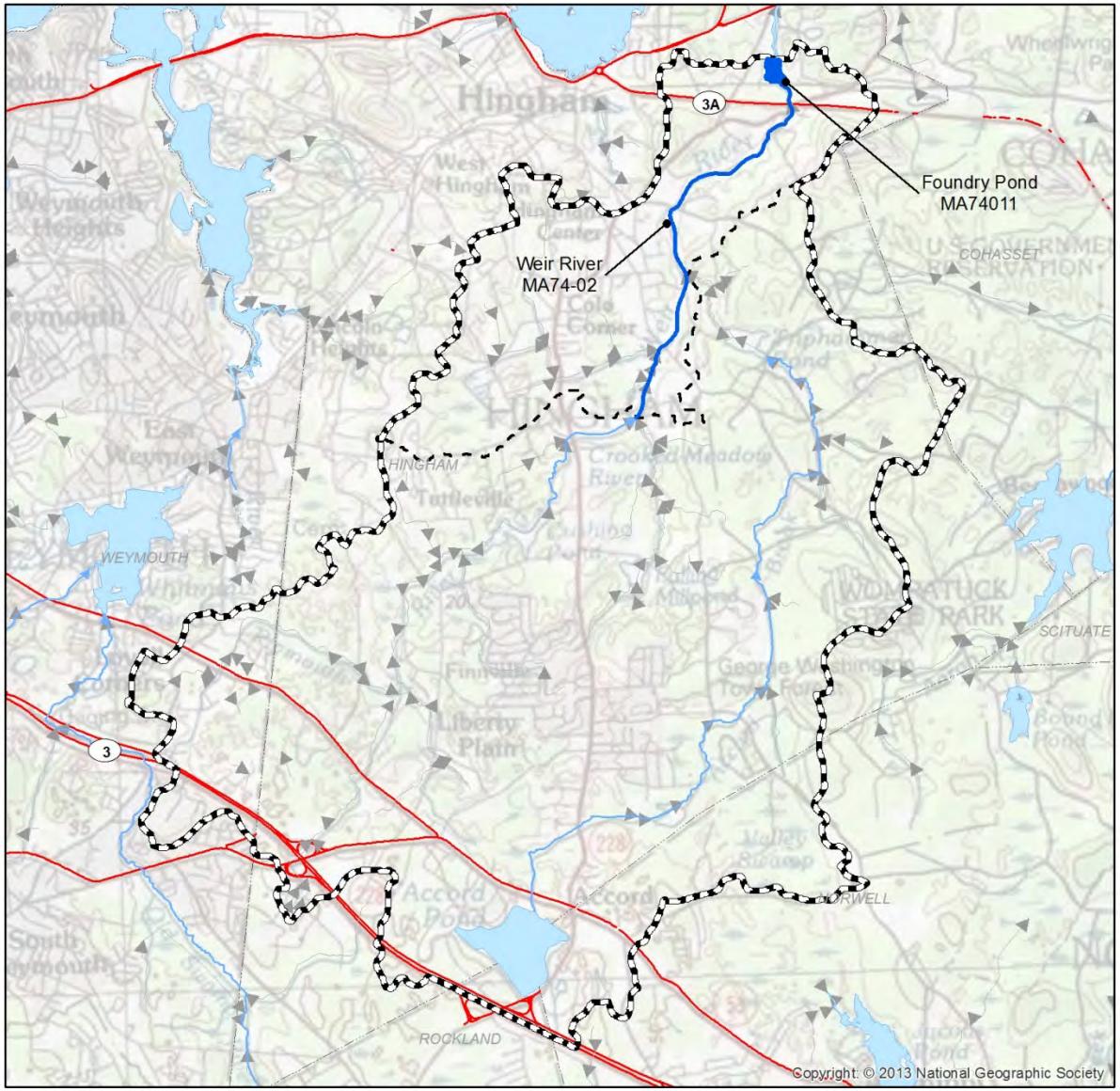

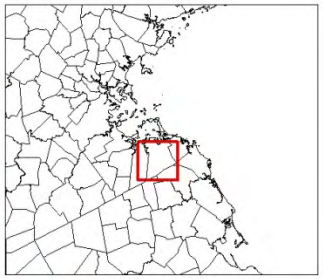

Foundry Pond
Weir River
Totalwatershed
Subwatershed
Impaired Stream Segment
Impaired Water Bodies
Non-Impaired Stream Segment
MassDOT Roads in Urban Areas
Town Boundaries

N

0 0.2 0.4 0.8 1.2
Miles

Figure 1

Weir River & Foundry Pond Total Watershed MA74-02 & MA74011

December 2013

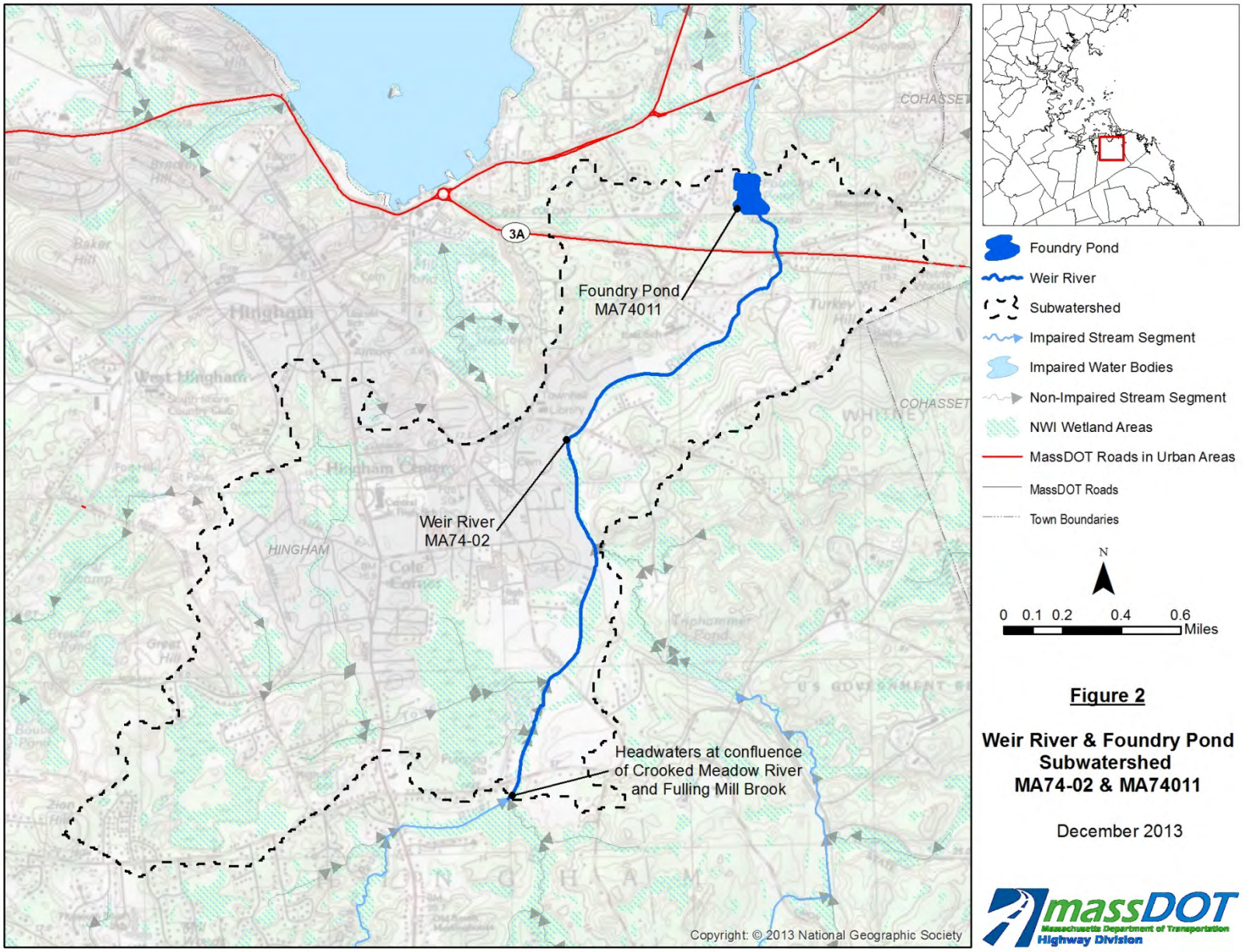

Figure 2

Weir River & Foundry Pond Subwatershed MA74-02 & MA74011

December 2013

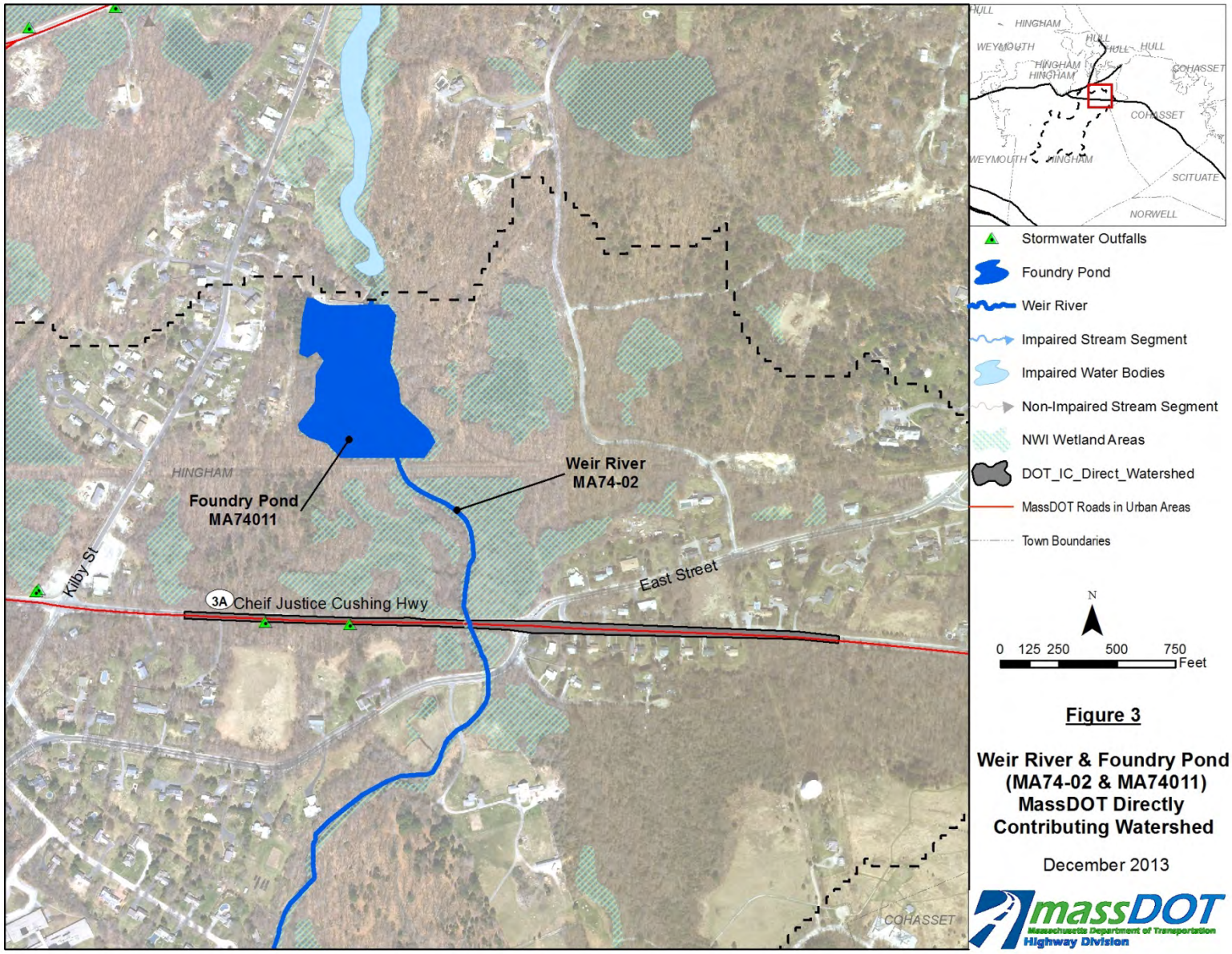

Figure 3

Weir River & Foundry Pond (MA74-02 & MA74011) MassDOT Directly Contributing Watershed

December 2013

Impaired Waters Assessment for Accord Brook (MA74-16) – Progress Report

Impaired Water Body

Name: Accord Brook

Location: Hingham, MA

Water Body ID: MA74-16

Impairments

Accord Brook (MA74-16) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). Accord Brook is impaired for the following:

- aquatic macroinvertebrate bioassesments

Relevant Water Quality Standards

Water Body Classification: Class A, Public Water Supply, Outstanding Resource Water

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 (3)(a) 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)(a) 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)(a) 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 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 1.5°F (0.8°C); and
  - 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)(a) 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

The Weymouth and Weir River Basin is located in the southeast region of the Boston Harbor Watershed and is comprised of five systems: Furnace Brook, Town River, Weymouth Fore River, Weymouth Back River and Weir River. The Weir River System is the easternmost of the five rivers. The system is comprised of the Plymouth, Crooked Meadow, and Weir Rivers. Tributaries to these rivers include Accord, Norroway, and Tumbling Brooks and the Eel River. Two segments of the Accord Brook have been designated as impaired. Segment MA74-16, which is the subject of this assessment, runs 3.2 miles from the outlet of Accord Pond in Hingham to a water supply intake south of South Pleasant Street in Hingham. Accord Brook Segment MA74-17 continues 1.8 miles from South Pleasant Street in Hingham to Triphammer Pond in Hingham.

The Weir River Area of Critical Environmental Concern (ACEC) in Cohasset, Hingham and Hull was designated as an ACEC on December 11th, 1986 and includes approximately 950 acres. The area supports over 100 species of migratory and resident bird species and an abundance of shellfish and finfish.

MassDOT's property directly contributing stormwater runoff to the Accord Brook (MA74-16) is comprised of portions of Route 53 (Whiting/Washington Street) in Hingham and Norwell. The total watershed and subwatershed are shown in Figure 1.

Stormwater from the section of Route 53 east of Accord Brook, extending to the high point just past the intersection of High Street and Route 53 (see Figure 2) is directly conveyed to Accord Brook. The majority of catch basins on both sides of Route 53 were filled with leafs, limiting the ability to confirm pipe locations in the field. However, enough information was gathered to strongly suggest that all stormwater from this section is conveyed directly to Accord Brook via various sized concrete pipes as shown on MassDOT plan set 114880, and MassDOT plan set RP548.

The section of Route 53 west of Accord Brook extending to the high point near Farm Hills Lane in Hingham is also considered as directly discharging to Accord Brook. This section of Route 53 is significantly less built up than other areas, with few catch basins and no major stormwater pipes. Information provided by MassDOT plan set RP548 shows that isolated catch basins convey water to the north side of Route 53; only some of these pipes could be confirmed in the field, as most catch basins were filled with leafs. From the information gathered it is assumed that only a small section of Route 53 west of Accord Brook directly drains to Accord Brook (see Figure 2). Route 53 from the high-point at Farm Hills Lane west to the intersection of Route 53 and Derby Street, is within the Accord Brook subwatershed. However this impervious area does not directly contribute to Accord Brook.

Assessment under BMP 7U

Of the impairments listed for Segment MA74B-16 of Accord Brook, one is potentially linked to stormwater runoff and has 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:

- aquatic macroinvertebrate bioassessments

The following sections describe the methodology used by MassDOT to assess the impairment 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 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 Accord Brook (MA74-16):

Table 1. Site Parameters for Accord Brook (MA74-16)

Type	Parameter	Quantity	Unit of Measure
Total Watershed	Watershed Area	2,485	acres
Total Watershed	Impervious Cover (IC) Area	330	acres
Total Watershed	Percent Impervious	13.3*	%
Subwatershed	Subwatershed Area	1,878	acres
Subwatershed	Impervious Cover (IC) Area	196	acres
Subwatershed	Percent Impervious	10.4*	%
Subwatershed	IC Area at 9% Goal	169	acres
Subwatershed	Target Reduction% in IC	13.8	%
Reductions Applied	MassDOT's IC Area Directly Contributing to Impaired Segment	4.67	acres
Reductions Applied	MassDOT's Target Reduction in Effective IC (13.8% of DOT Directly Contributing IC)	0.64	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 13.8%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 0.64 acres.

Existing BMPs

Based on the site visit, there are no existing BMPs in the Accord Brook (MA74-16) directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to Accord Brook (MA74-16).

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 0.64 acres, MassDOT will consider the implementation of additional BMPs.

Conclusions

MassDOT used the IC Method to assess Accord 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 0.64 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Accord Brook (MA74-16) 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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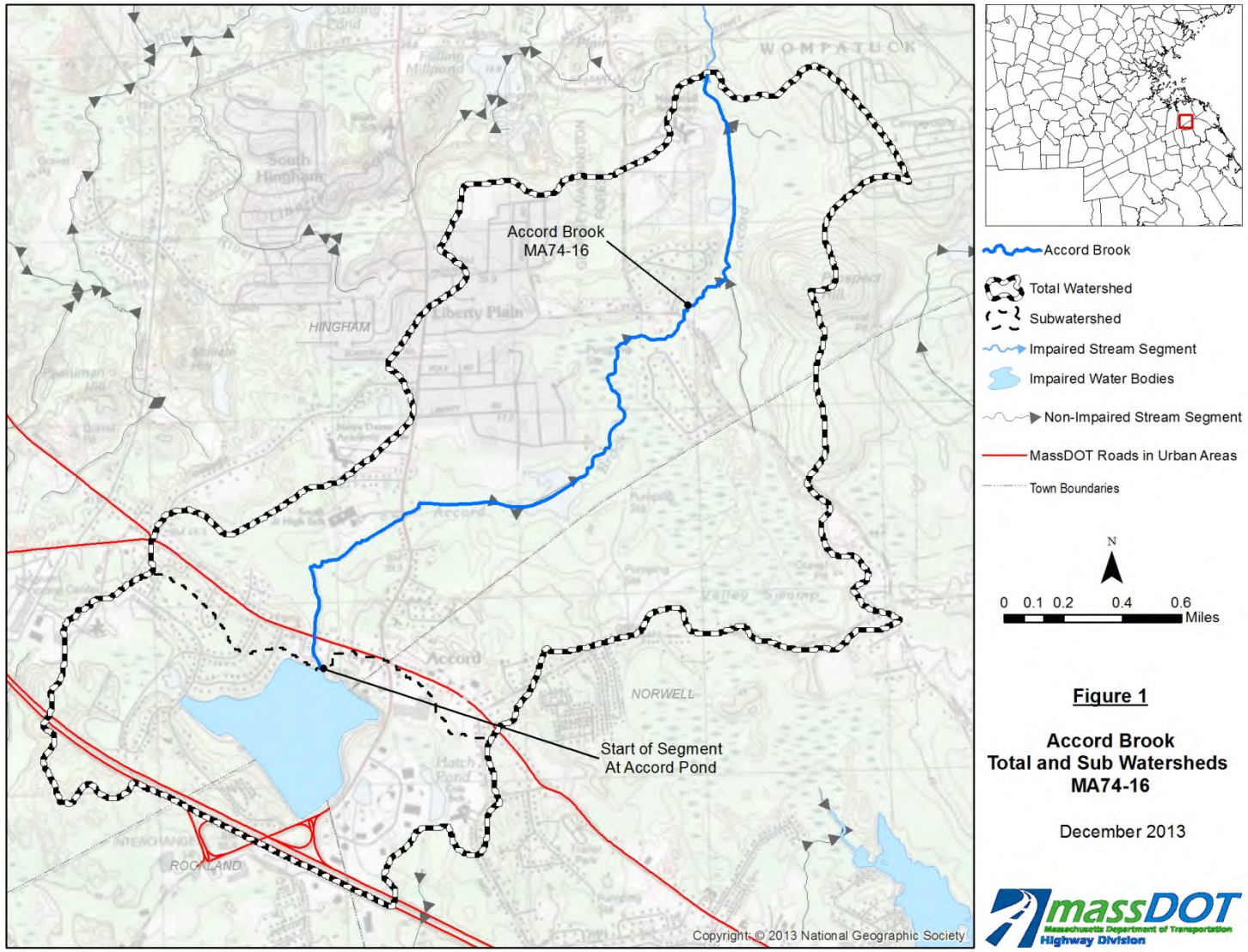

Figure 1

Accord Brook
Total and Sub Watersheds
MA74-16

December 2013

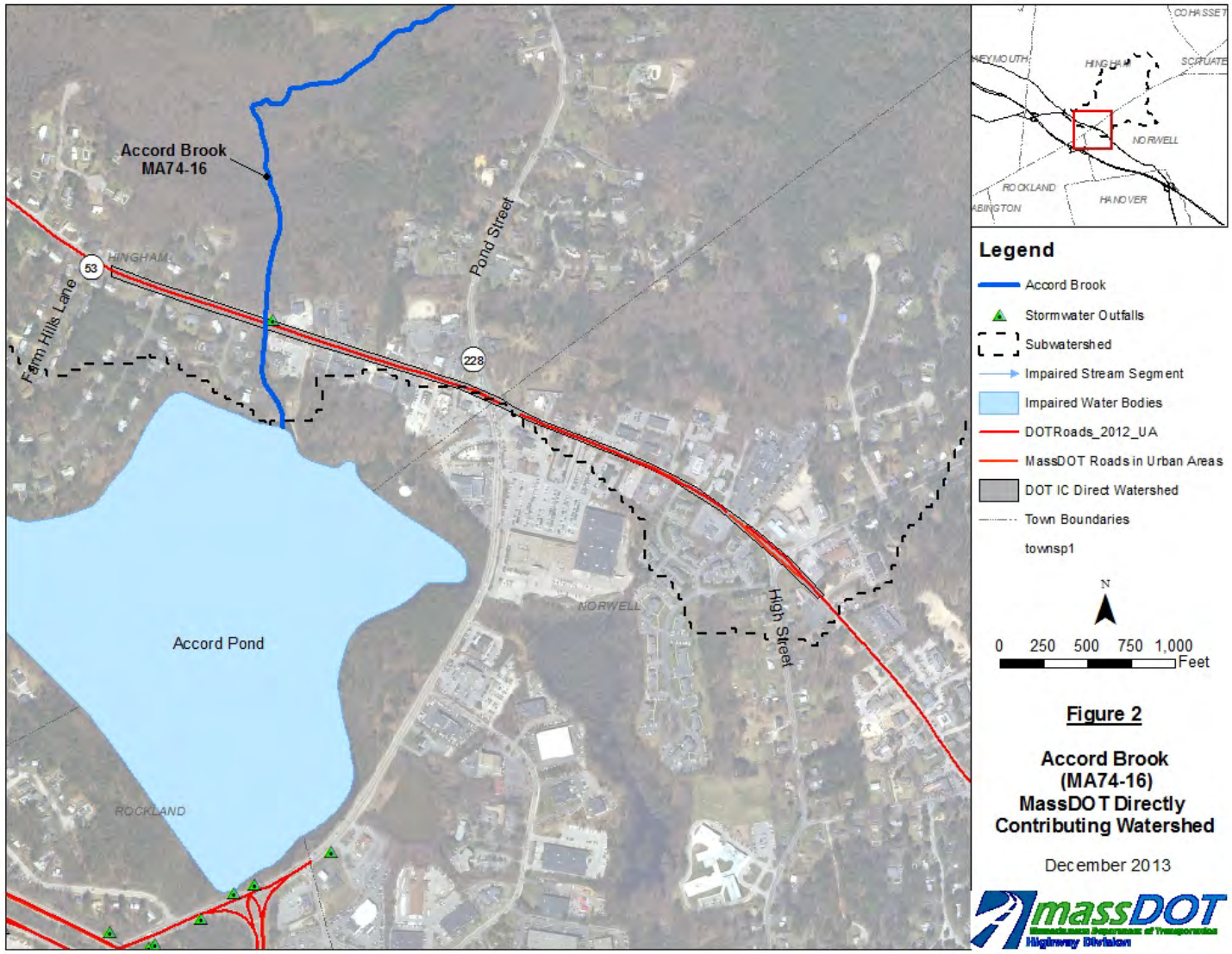

Figure 2

Accord Brook (MA74-16) MassDOT Directly Contributing Watershed

December 2013

Impaired Waters Assessment for Merrimack River (MA84A-02) – Progress Report

Impaired Water Body

Name: Merrimack River

Location: Lowell, MA

Water Body ID: MA84A-02

Impairments

Merrimack River (MA84A-02) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). Merrimack River (MA84A-02) is impaired for the following:

- (low flow alterations*)
- *Escherichia coli*
- mercury in fish tissue
- phosphorus (total)

According to MassDEP's *Merrimack River Watershed 2004 Water Quality Assessment Report* (MassDEP, 2010), the primary contact recreational use is impaired within segment MA84A-02 of the Merrimack River due to *Escherichia coli* from wet weather discharges (point source and a combination of stormwater, SSO or CSO) and unknown sources.

According to MassDEP's *Merrimack River Watershed 2004 Water Quality Assessment Report* (MassDEP, 2010), the following facilities have National Pollutant Discharge Elimination Permits (NPDES) to discharge to Merrimack River (MA84A-02): Boott Hydropower, Inc. (NPDES permit numbers: MAG250950 and MAG250163) and Lowell Regional Wastewater Utilities (MA0100633). Boott Hydropower, Inc. is authorized (permit MAG250950) to discharge 0.006 MGD of noncontact cooling water from the John Street Power Station to the Merrimack River and 0.6 MGD of noncontact cooling water from Eldred L. Field Hydroelectric Project on Pawtucket Street in Lowell to the Merrimack River (permit MAG250163). Lowell Regional Wastewater Utilities is authorized to discharge from the following CSOs to Merrimack River (MA84A-02): Outfall #002 (Walker Street), Outfall #008 (West Street), Outfall #011 (Read Street), Outfall #012 (First Street), Outfall 027 Tilden Street, Outfall #030(1) (Barasford Street) and Outfall #030(2) (Merrimack River).

A draft Pathogen TMDL has been prepared 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) 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

Segment MA84A-02 of the Merrimack River begins at the Pawtucket Dam in Lowell, MA and continues northeast to the north of and adjacent to the Northern Canal approximately one mile to the confluence with Beaver Brook, continues southeast approximately 0.6 miles to the confluence with Lawrence Canal, continues southeast approximately 0.3 miles to the confluence with Eastern Canal, continues approximately 0.3 miles to the confluence with the Concord River and continues approximately one mile to the southeast then northeast to the Lowell Regional Wastewater Utilities outfall at Duck Island in Lowell.

According to MassDEP's *Merrimack River Watershed 2004 Water Quality Assessment Report* (MassDEP, 2010), Merrimack River (MA84A-02) is classified as a water body with designations: Class B, TWS, WWF, and CSO. Merrimack River (MA84A-02) is classified as impaired due to (low flow alterations*), *Escherichia coli*, mercury in fish tissue, and phosphorus (total) according to the *Merrimack River Watershed 2004 Water Quality Assessment Report* (MassDEP, 2010). The total length of Merrimack River (MA84A-02) is approximately 3.2 miles; refer to Figure 1 for the subwatershed of Merrimack River (MA84A-02).

MassDOT's property directly contributing stormwater runoff to the Merrimack River is comprised of (but not limited to) portions of Varnum Avenue, the Veterans of Foreign Wars (VFW) Highway, Bridge Street, the Hunts Falls Rotary and Nesmith Street (Route 38). Refer to Figures 2a through 2c for the location of these roadways within the subwatershed to segment MA84A-02 of Merrimack River. An overview and details of the direct drainage watersheds and outfalls are presented in greater detail below.

The following MassDOT owned properties are located within the subwatershed of Merrimack River (MA84A-02) (within the City of Lowell unless indicated otherwise below) but do not directly contribute to Merrimack River (MA84A-02) (see Figure 1 for the locations of these roadways): the area upstream of the Pawtucket Dam, including a portion of Varnum Avenue, Pawtucket Boulevard, Princeton Boulevard in Lowell and Princeton Street in Chelmsford, and Rourke Bridge; south of Merrimack River (MA84A-02) in the vicinity of Lowell Canals (MA84A-29), including Wilder Street, Walker Street, School Street, and the Middlesex Street/Thorndike Street intersection; and north of Merrimack River (MA84A-02) including Willard Street and Broadway Road in Dracut.

As shown on Figure 2a, runoff is collected by catch basins and discharges via outfalls along Varnum Avenue downstream of the Pawtucket Dam and along the VFW Highway. Runoff from Varnum Avenue upstream of the Pawtucket Dam does not appear to directly discharge to Segment MA84A-02 of the Merrimack River; runoff upstream of the Pawtucket Dam likely discharges to segment MA84A-01 of the Merrimack River. Runoff from the bridge over Beaver Brook discharges directly to segment MA84A-02 of the Merrimack River via a bridge scupper. Runoff from some portions of the VFW Highway does not appear to directly discharge to segment MA84A-02 of the Merrimack River, as shown in Figure 2a; runoff is collected by catch basins that are connected to the municipal combined sewer system.

Runoff from the Bridge Street bridge over segment MA84A-02 of the Merrimack River drains to the river via scuppers along the bridge (Figure 2b). In addition, runoff from a portion of Bridge Street south of segment MA84A-02 of the Merrimack River is collected by catch basins and discharges via an outfall to segment MA84A-02 of the Merrimack River. Runoff from the southernmost portion of the MassDOT owned portion of Bridge Street does not directly discharge to segment MA84A-02 of the Merrimack River (as shown on Figure 2b); runoff from this portion of Bridge Street discharges to Lowell Canals (MA84A-29). Runoff from the VFW Highway in this area does not appear to directly

discharge to segment MA84A-02 of the Merrimack River, as shown in Figure 2b; runoff is collected by catch basins that are connected to the municipal combined sewer system and do not appear to directly discharge to the river.

Runoff from the Nesmith Street bridge over segment MA84A-02 of the Merrimack River drains to the river via scuppers along the bridge (Figure 2b). In addition, runoff from a portion of the Hunts Falls Rotary is collected by catch basins and discharges to Merrimack River (MA84A-02). Runoff from some the northern portion of the Hunts Falls Rotary does not appear to directly discharge to Merrimack River (MA84A-02), as shown in Figure 2b; runoff is collected by catch basins that discharge outside of the rotary and do not directly flow to the river.

As shown on Figure 2c, runoff is collected by catch basins and discharges via outfalls along the VFW Highway. (Figure 2c). Runoff from the VFW Highway to the west of the DOT direct watershed shown in Figure 2c is collected by catch basins that are connected to the municipal combined sewer system and do not appear to directly discharge to the river.

Assessment under BMP 7U

None of the impairments for Merrimack River (MA84A-02) 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 (total)

According to the final *Massachusetts Year 2012 Integrated List of Waters*, low flow alterations is 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.

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.

The impairment for *E. coli* has been addressed by the *Draft Pathogen TMDL for the Merrimack River Watershed* (MassDEP, no date). MassDOT has assessed its contribution to this impairment and compliance with the corresponding TMDL separately in the section titled "Assessment of Pathogen Impairment 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 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 MA84A-02 of Merrimack River:

Table 1. Site Parameters for Merrimack River (MA84A-02)

Type*	Parameter	Quantity	Unit of Measure
Subwatershed	Subwatershed Area	9,273	acres
Subwatershed	Impervious Cover (IC) Area	2,721	acres
Subwatershed	Percent Impervious	29.3**	%
Subwatershed	IC Area at 9% Goal	835	acres
Subwatershed	Target Reduction% in IC	69.3**	%
Reductions Applied	MassDOT's IC Area Directly Contributing to Impaired Segment	14.6**	acres
Reductions Applied	MassDOT's Target Reduction in Effective IC (69.3% of DOT Directly Contributing IC)	10.1**	acres

*The majority of the total watershed is located in New Hampshire; therefore, IC calculations for the total watershed were not applicable for DOT property.
**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 69.3%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 10.1 acres.

Existing BMPs

Based on the site visit, there are no existing BMPs in the Merrimack River (MA84A-02) directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to Merrimack River (MA84A-02).

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 10.1 acres, MassDOT will consider the implementation of additional BMPs.

Flat grassy areas along both sides of the VFW Highway within the Hunts Falls Rotary have the potential to be used for BMPs, as displayed in **Photos 1** and **2**. The photos show well vegetated areas along both sides of the roadway.

Photo 1. Vegetated area to the north of the VFW Highway within the Hunts Falls Rotary

Photo 2. Vegetated areas to the north and south of the VFW Highway within the Hunts Falls Rotary

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 are assessed 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, and has a pet waste management program underway to address this source where necessary.
- 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 2c-1: Drainage Connection Policy
- BMP 2c-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 Merrimack River (MA84A-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 10.1 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Merrimack River (MA84A-02) to identify existing BMPs and found that no BMPs exist to reduce 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 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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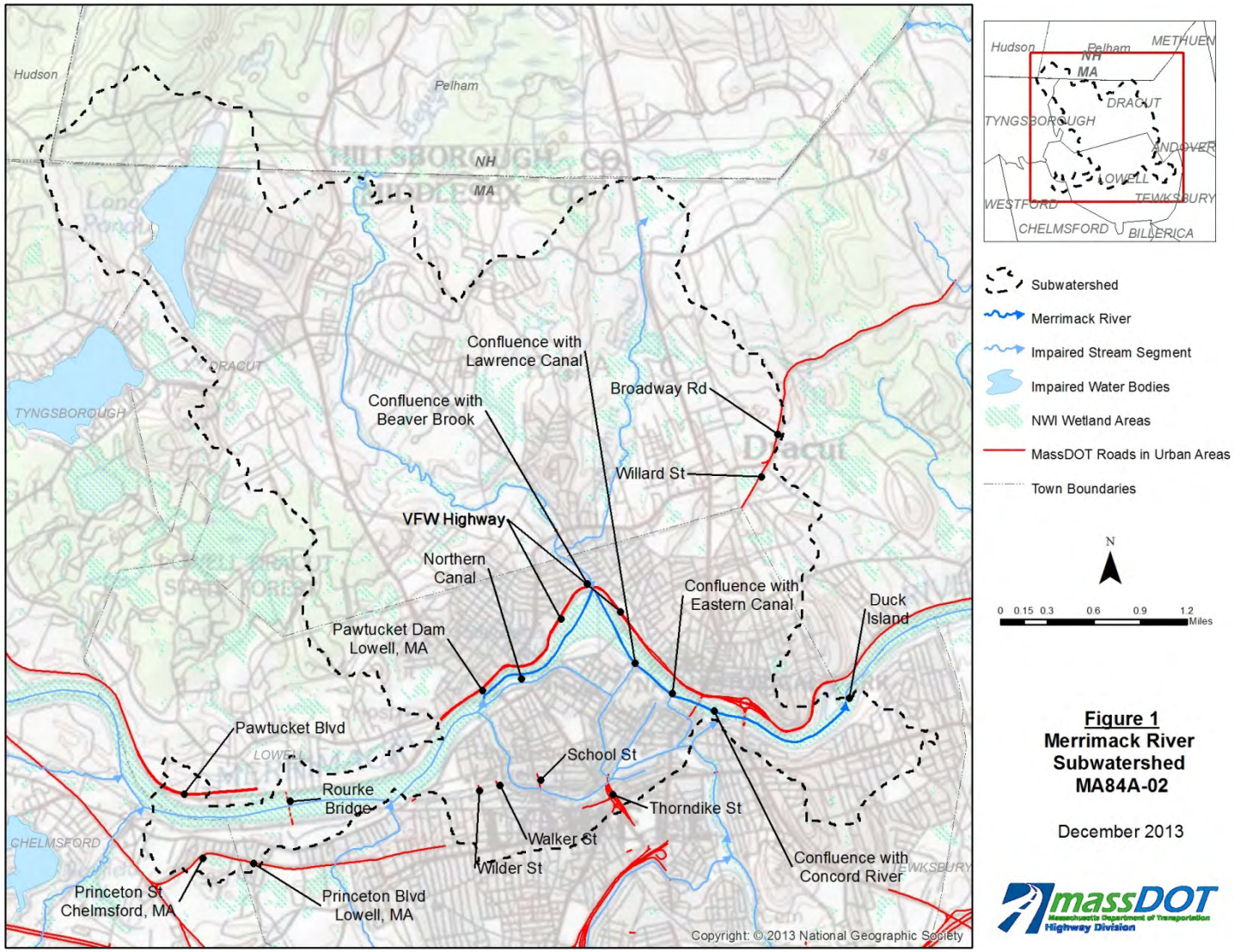


Subwatershed
Merrimack River
Impaired Stream Segment
Impaired Water Bodies
NWI Wetland Areas
MassDOT Roads in Urban Areas
Town Boundaries

N

0 0.15 0.3 0.6 0.9 1.2 Miles

Figure 1
Merrimack River Subwatershed MA84A-02

December 2013

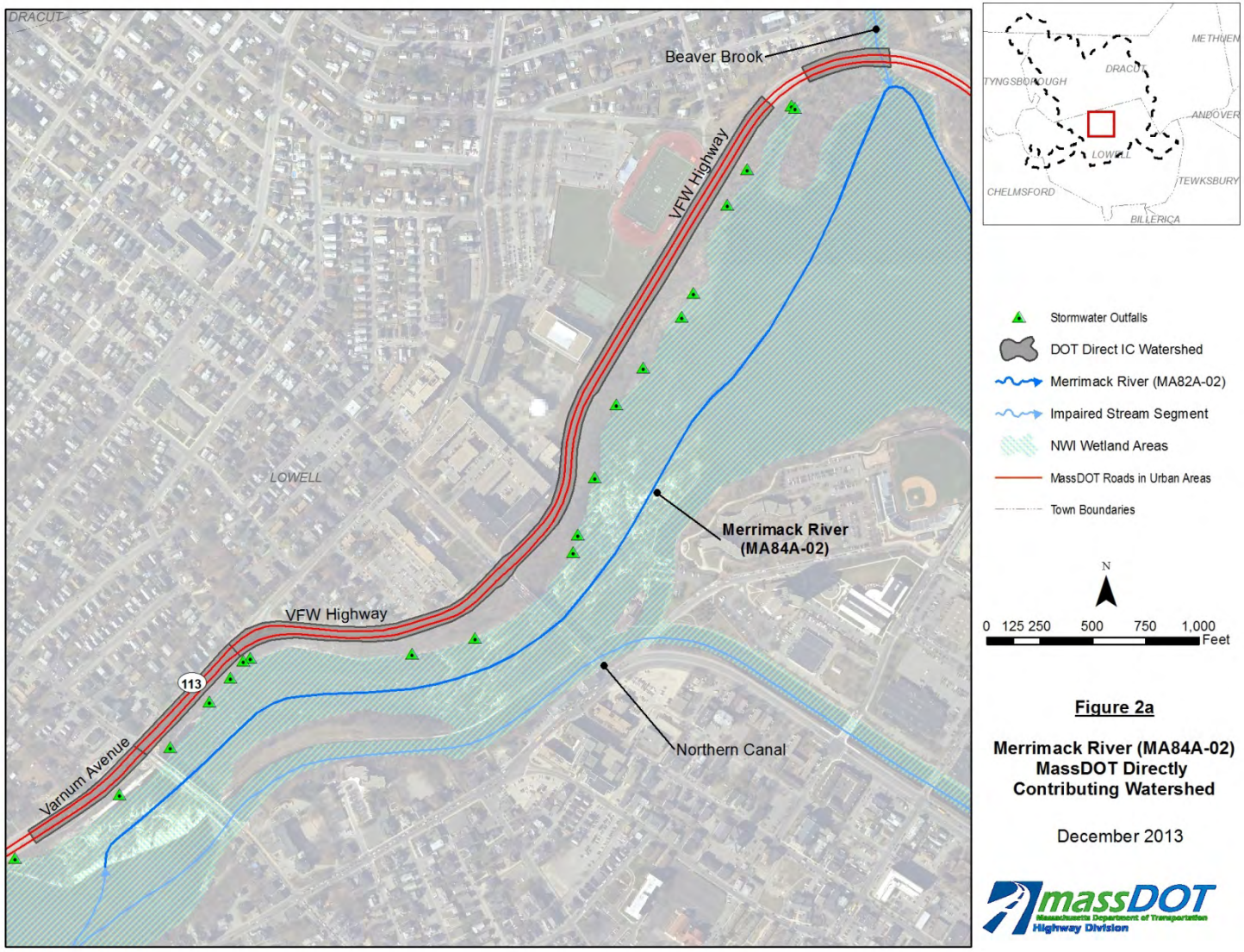


Figure 2a

Merrimack River (MA84A-02)
MassDOT Directly Contributing Watershed

December 2013

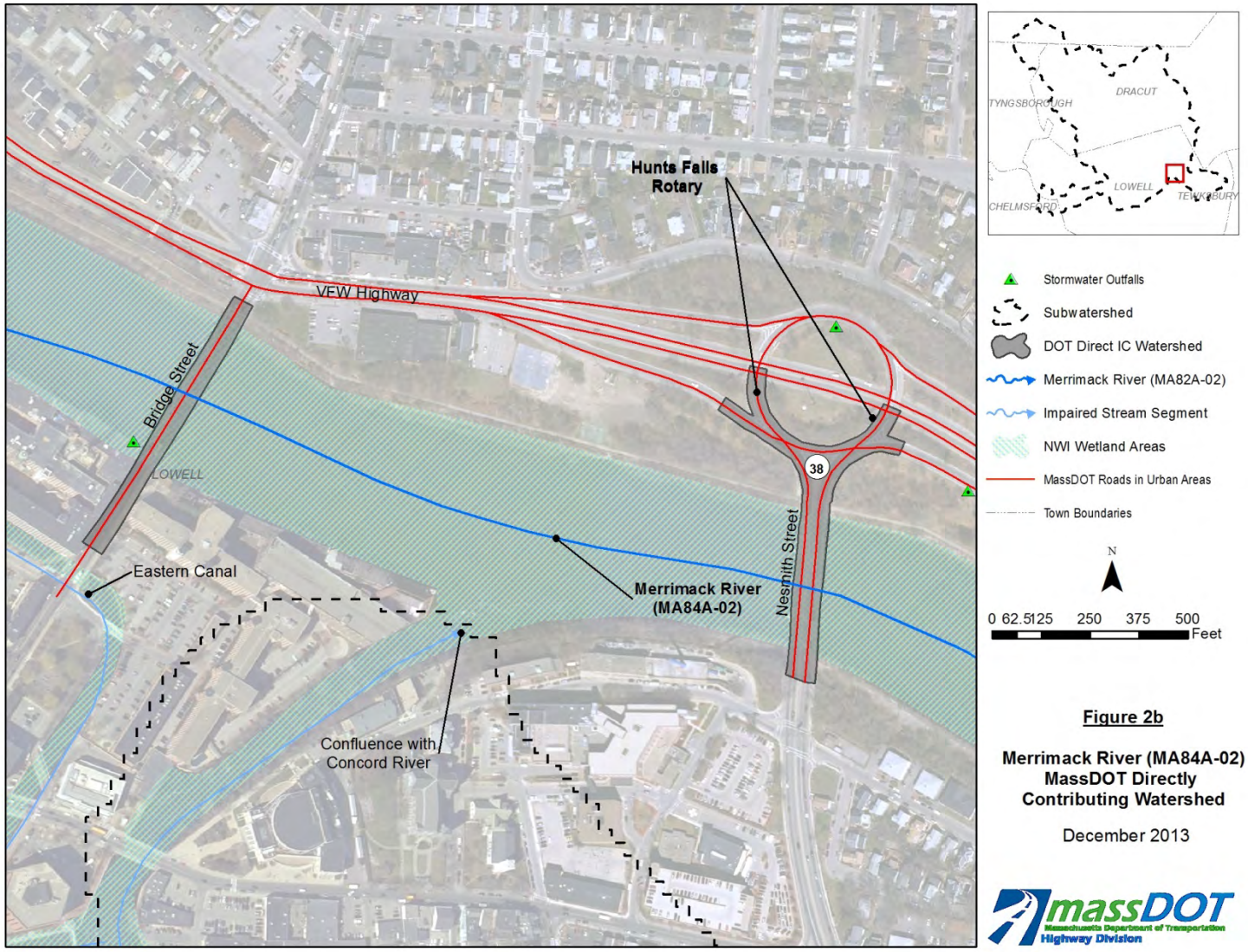
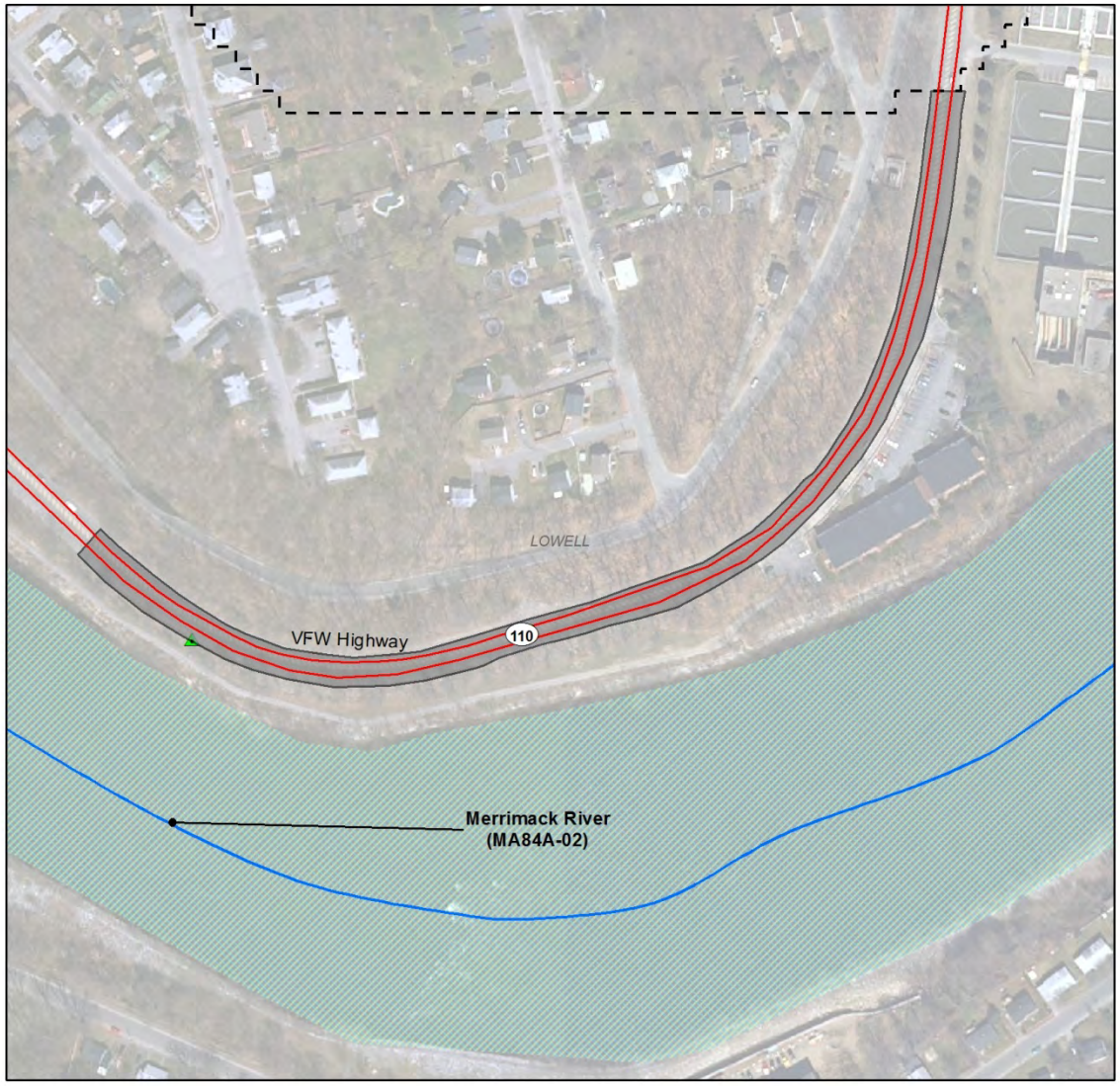
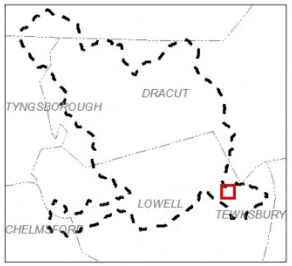


Figure 2b

Merrimack River (MA84A-02)
MassDOT Directly Contributing Watershed

December 2013





Stormwater Outfalls
Subwatershed
DOT Direct IC Watershed
Merrimack River (MA82A-02)
NWI Wetland Areas
MassDOT Roads in Urban Areas

N

0 45 90 180 270 360
Feet

Figure 2c

Merrimack River (MA84A-02)
MassDOT Directly Contributing Watershed

December 2013

Impaired Waters Assessment for Merrimack River (MA84A-03) – Progress Report

Impaired Water Body

Name: Merrimack River

Location: Lowell, Dracut, Tewksbury, Andover and Lawrence, MA

Water Body ID: MA84A-03

Impairments

Merrimack River (MA84A-03) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). Merrimack River (MA84A-03) is impaired for the following:

- Escherichia coli
- mercury in fish tissue
- PCB in fish tissue
- total phosphorus

According to MassDEP's *Merrimack River Watershed 2004 Water Quality Assessment Report* (MassDEP, 2010), the primary contact recreational use is impaired from wet weather discharges from an unknown source due to elevated *E. coli* counts. The MassDEP recommends that fish tissue toxics monitoring is conducted to evaluate the current fish consumption advisory and that dissolved oxygen monitoring be conducted to evaluate diurnal variation (MassDEP, 2010).

This segment of the Merrimack River includes intakes for public water supply and is also receiving waters for CSOs extending from Lowell to Lawrence. Brox Industries, Inc. is authorized to discharge a maximum daily flow of 1.58 MGD of treated stormwater and process generated wastewater into the MA84A-03 subwatershed, and Lowell Regional Wastewater Utilities is authorized to discharge an average monthly flow of 32 MGD of treated effluent to the Merrimack River (MA84A-03) (MassDEP, 2010).

A draft Pathogen TMDL has been prepared 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) 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.

Site Description

Segment MA84A-03 of the Merrimack River is an 8.8 mile Class B water body that begins at the Lowell Regional Wastewater Utilities outfall at Duck Island and extends to Essex Dam in Lawrence, MA. From the outfall at Duck Island in Lowell, segment MA84A-03 continues northeast for approximately 1.4 miles to the confluence with Richardson Brook in Dracut; continues southeast approximately 0.4 miles to the confluence with Trull Brook in Tewksbury; continues approximately 3 miles northeast to the confluence with Fish Brook in Andover, MA; and continues another 4 miles in a winding northeasterly direction before concluding at the crossing of South Broadway in Lawrence, MA. Refer to Figure 1 for the subwatershed of MA84A-03.

Several roadways that lie within the subwatershed to segment MA84A-03 do not directly drain to the river as they are a significant distance from the River and stormwater runoff would be intercepted by wetlands, other impaired and non-impaired streams, or upland areas. These

roadways include Interstate 495 in Tewksbury and Andover, Route 38 in Tewksbury, and Route 113 in Dracut. MassDOT's property directly contributing stormwater runoff to the Merrimack River (MA84A-03) includes portions of Merrimack Street, Route 110 (Lowell Boulevard and Lowell Street), Route 113 (North Lowell Street), Riverside Drive, and I-93 (see Figure 2A through 2F). An overview and details of the direct drainage watersheds and outfalls are presented in greater detail below.

Route 110

Route 110 (Merrimack Avenue) is determined to be an urban roadway from western boundary of the subwatershed to approximately 3,500 feet east of Richardson Brook. This section of Route 110 (Merrimack Avenue) was determined to directly drain to the Merrimack River (MA84A-03) via several outfalls to the River for the entire length. Several tributaries to the Merrimack River (MA84A-03) flow beneath the roadway and receive direct drainage; however due to their close proximity to the Merrimack river, the drainage in these areas was also considered directly contributing to the Merrimack river. as shown in Figures 2A through 2C. Richardson Brook flows from the north and continues under Merrimack Avenue to its confluence with the Merrimack River (Figure 2A). In this location, half of the roadway drains directly to Richardson Brook (MA84A-12) due to the pitch of the roadway. In two locations west of Richardson Brook, there are non-impaired, unnamed stream segments shown to flow beneath the roadway. Based on field observations, these non-impaired segments either do not exist or were observed to be dry swales/ditches that would convey stormwater to the Merrimack River during storm events. Therefore, any roadway runoff to these non-impaired segments is considered directly contributing to the Merrimack River (MA84A-03).

Route 110 continues through Dracut to the east and north where a section of the roadway is not considered urban roadway. At approximately the Dracut/Methuen municipal boundary, the urban roadway portion of Route 110 (Lowell Boulevard) begins again. A majority of the roadway from the municipal boundary to the Route 110/113 Rotary directly discharges to the Merrimack River (MA84A-03) via catch basins and outfalls with the exception of a few areas (Figures 2B and 2C). Figure 2B shows two sections of the roadway that are not directly contributing to this segment. The section to the south was observed to have topography and infrastructure that directed runoff from a portion of the roadway to the west side of Route 110 rather than to the Merrimack River (MA84A-03). Therefore, this drainage was determined to be indirect as there was no conveyance to the River and any drainage would likely infiltrate into the ground. A section of roadway to the north on Figure 2B was determined to drain to Griffin Brook; however, it was determined that due to the proximity of the roadway crossing and the confluence of Griffin Brook to the Merrimack River that the drainage would be considered direct to the Merrimack River. Two additional non-impaired streams are shown on 2B, however, these were checked in the field and they either did not exist or they did not receive runoff from the roadway.

On Figure 2C, direct and indirectly contributing areas along Route 110 (Lowell Street) are shown. Two additional non-impaired named tributaries flow beneath Route 110; Sawyer Brook and Bartlett Brook. Based on field observations, portions of Route 110 spanning either side of each of these tributaries was determined to directly drain to these tributaries; however, due to the proximity of the tributaries confluences to the Merrimack River, all portions of the roadway were considered Directly contributing to the Merrimack River (MA84A-03),. All other portions of the roadway along this stretch were determined to directly discharge to the Merrimack River (MA84A-03) via catch basins and outfalls.

Route 113

A portion of Route 113 (North Lowell Street) was determined to directly drain to the Merrimack River via a 48" RCP located west of the Route 110/Route 113 Rotary (Figure 2C and 2E). Based on

topography and stormwater infrastructure (catch basins), drainage flows toward the rotary and enters the infrastructure that discharges to the Merrimack River (MA84A-03).

Route 110/113/I-93 Rotary

Stormwater drainage from the Route 110/113/I-93 rotary directly discharges to the Merrimack River (MA84A-03). Based on available plans and field observations, ditches, catch basins, outfalls and other drainage infrastructure that are in place to convey drainage to two 48" reinforced concrete pipes (RCP) that discharge to the River (Figure 2E). Ditches and channels were observed northeast and northwest of the rotary that convey flow to the respective 48" RCP structures.

Riverside Drive

Riverside Drive parallels Merrimack River bank from its intersection with Route 110 east of the Route110/113 rotary and into Lawrence MA. The section of Riverside Drive that is designated as urban extends approximately 10,000 feet from the intersection with Route 110. As shown on Figure 2D, a majority of the roadway directly discharges stormwater to the Merrimack River (MA84A-03) via catch basins and outfalls, with the exception of one small area that was observed to enter a municipal sewer system and likely conveyed to the wastewater treatment facility. In addition, a portion of the roadway was observed to discharge through outfalls to an unnamed, non-impaired stream that flows under the roadway and into the Merrimack River. Since this stream is unnamed and it is in close proximity to the River segment, this drainage was considered to be direct drainage to the assessment segment. In addition, this stream was observed to be a man-made channel with stone retaining walls providing a clear-cut channel to convey flow.

Interstate 93

The portion of I-93 that directly discharges stormwater to the Merrimack River (MA84A-03) is shown in Figures 2E and 2F. Figure 2E shows the subwatershed boundary to the north, which is also the topographic high point, where drainage would shed downslope and toward the river. From this point south, stormwater flows to the drainage system that connects to the infrastructure within the rotary. This drainage system is conveyed to one of the two 48" RCP that discharge to the Merrimack River (MA84A-03).

The I-93 Bridge continues over the Merrimack River where scuppers were observed to convey drainage on the bridge directly into the River. There were several scuppers observed on the north-bound and south bound sides of the bridge.

Approximately 1,500 feet south of the Merrimack River (MA83-03), drainage from I-93 continues to directly discharge to the River via stormwater infrastructure (i.e. catch basins and outfalls, rocklined channels or paved waterways). South of this portion of the roadway, field observations indicated that the stormwater infrastructure directed drainage to non-impaired stream segments that discharged to wetland areas, and therefore does not directly contribute to the Merrimack River (MA83-03). Some infrastructure directs flow from I-93 to unnamed non-impaired streams that are tributaries to the Merrimack; however, the drainage was considered indirect to the Merrimack River as the stormwater entered the tributary more than 1,500 feet upstream of the confluence with the Merrimack River. Other areas drained to existing wetlands where it would reside and be treated within the wetland area.

Assessment under BMP 7U

Of the impairments listed for Segment Merrimack River (MA84A-03), one is potentially linked to stormwater runoff. 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:

- total 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.

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 *E. coli* has been addressed by the *Draft Pathogen TMDL for the Merrimack River Watershed* (MassDEP, no date). MassDOT has assessed its contribution to this impairment and compliance with the corresponding TMDL separately in the section titled "Assessment of Pathogen Impairment 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 Merrimack River (MA84A-03):

Table 1. Site Parameters for Merrimack River (MA84A-03)

Type*	Parameter	Quantity**	Unit of Measure
Subwatershed	Watershed Area	19,086	acres
Subwatershed	Impervious Cover (IC) Area	3,903	acres
Subwatershed	Percent Impervious	20.4	%
Subwatershed	IC Area at 9% Goal	1,718	acres
Subwatershed	Target Reduction % in IC	56.0	%
Reductions Applied to DOT Direct Watershed	MassDOT's IC Area Directly Contributing to Impaired Segment	56.3	acres
Reductions Applied to DOT Direct Watershed	MassDOT's Target Reduction in Effective IC (56.0% of DOT Directly Contributing IC)	31.5	acres

*The majority of the total watershed is located in New Hampshire; therefore, IC calculations for the total watershed were not applicable for DOT property.

**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 56.0%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 31.5 acres.

Existing BMPs

Based on the site visit, there are no existing BMPs in the Merrimack River (MA84A-03) directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to Merrimack River (MA84A-03).

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMP's is less than the target reduction of 31.5 acres, MassDOT will consider the implementation of additional BMPS.

Flat grassy areas within the Route 110/113/93 rotary on either side of where Route 93 passes over the rotary have the potential to be used for BMPs, as displayed in **Photos 1**. The photos show well vegetated areas flat open areas.

Photo 1. Vegetated area east of Route 93 within the Route 110/113 Rotary

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 are assessed 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 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, and has a pet waste management program underway to address this source where necessary.
- 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

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 Merrimack River (MA84A-03) 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 31.5 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to the Merrimack River (MA84A-03) to identify existing BMPs and determined that there were no existing BMPs present.

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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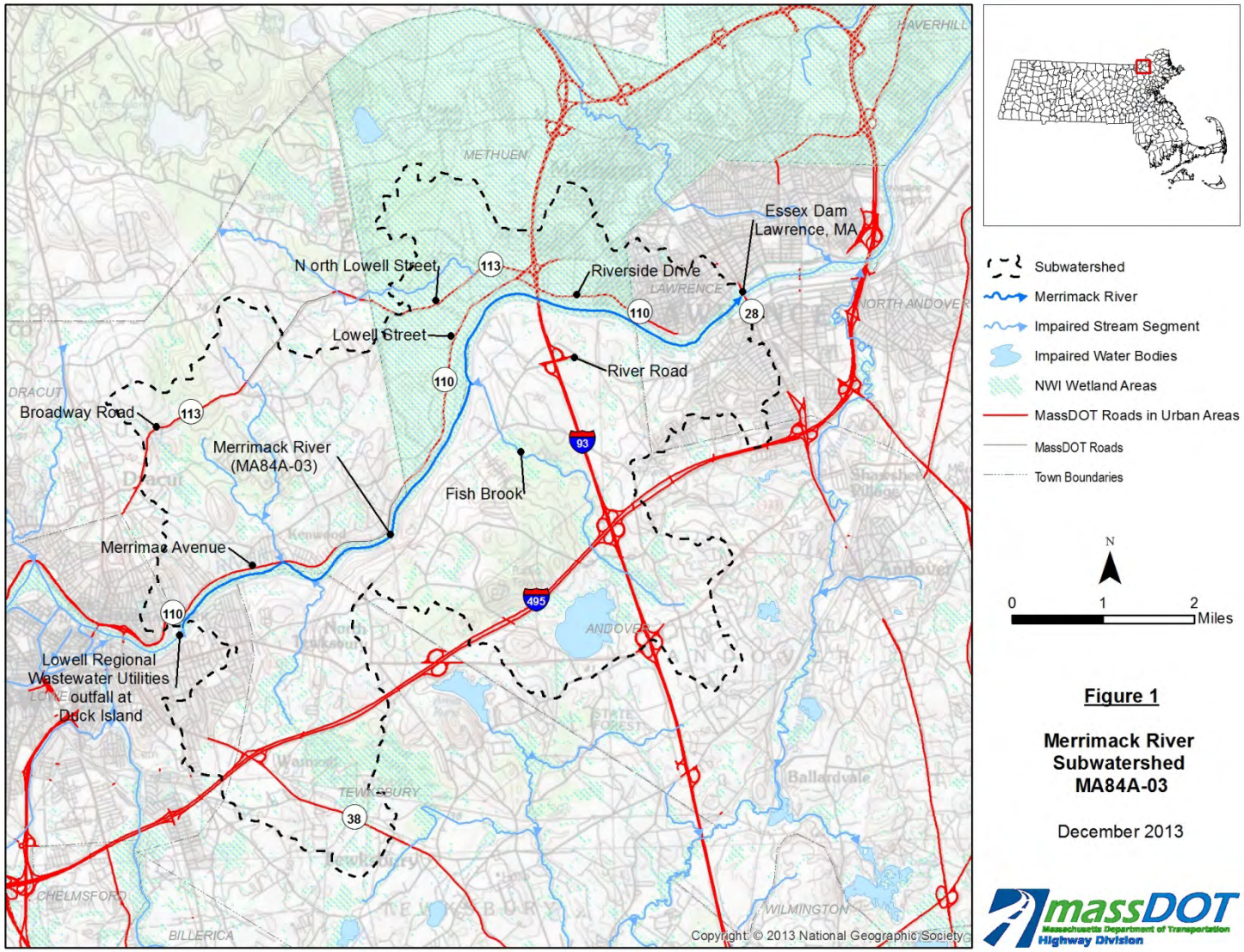

Figure 1

Merrimack River Subwatershed MA84A-03

December 2013

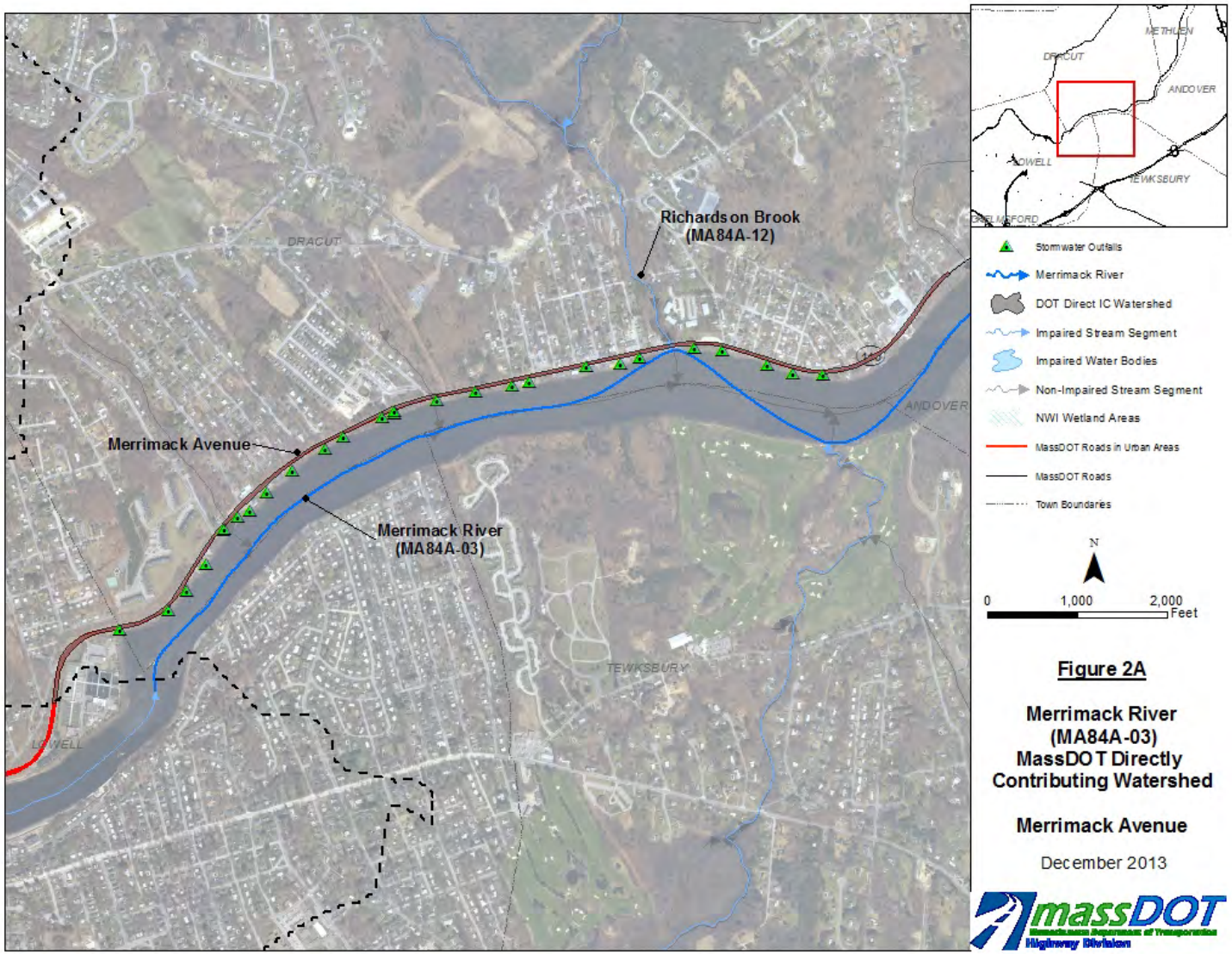

Figure 2A

Merrimack River (MA84A-03) MassDOT Directly Contributing Watershed

Merrimack Avenue

December 2013

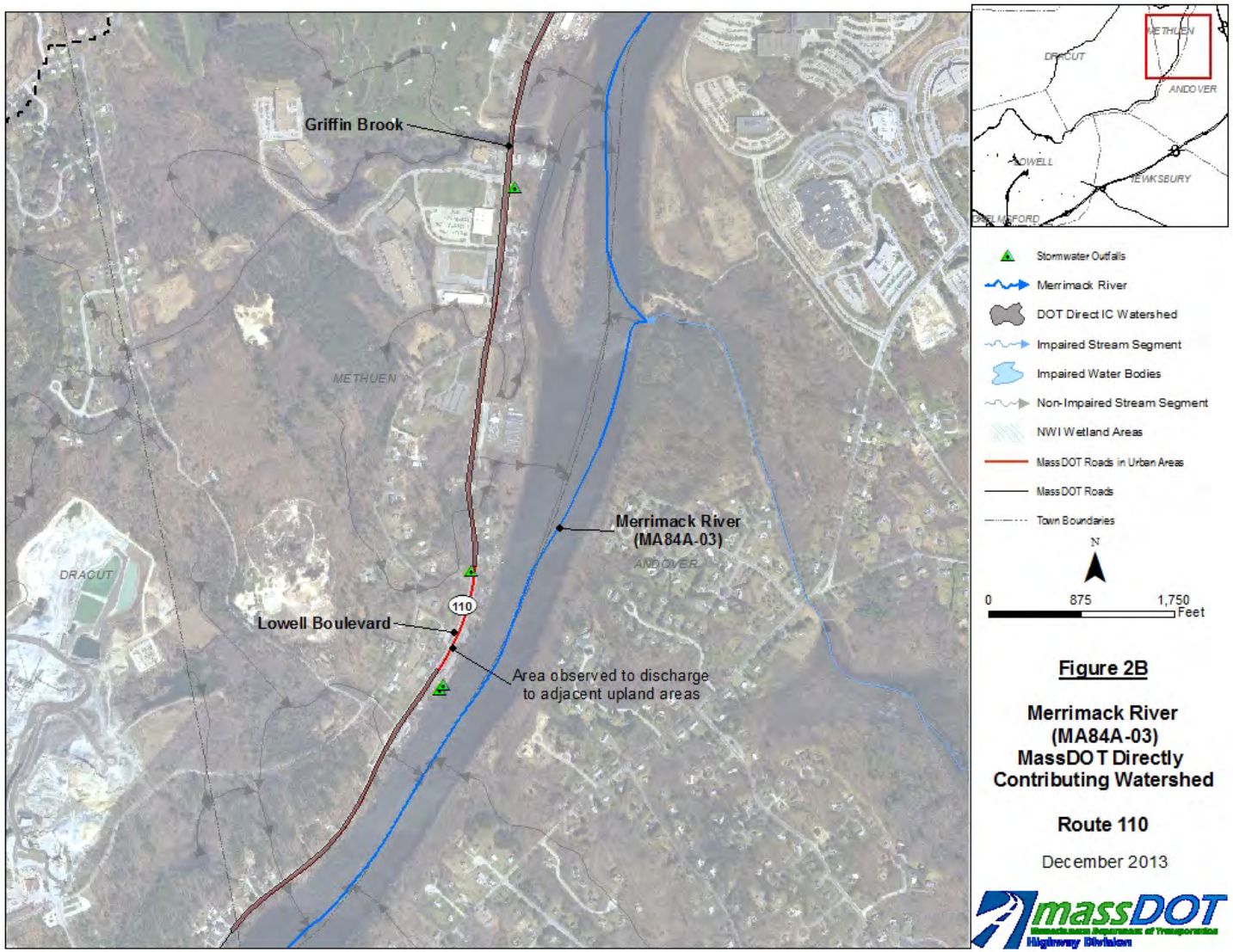

Figure 2B

Merrimack River (MA84A-03) MassDOT Directly Contributing Watershed

Route 110

December 2013

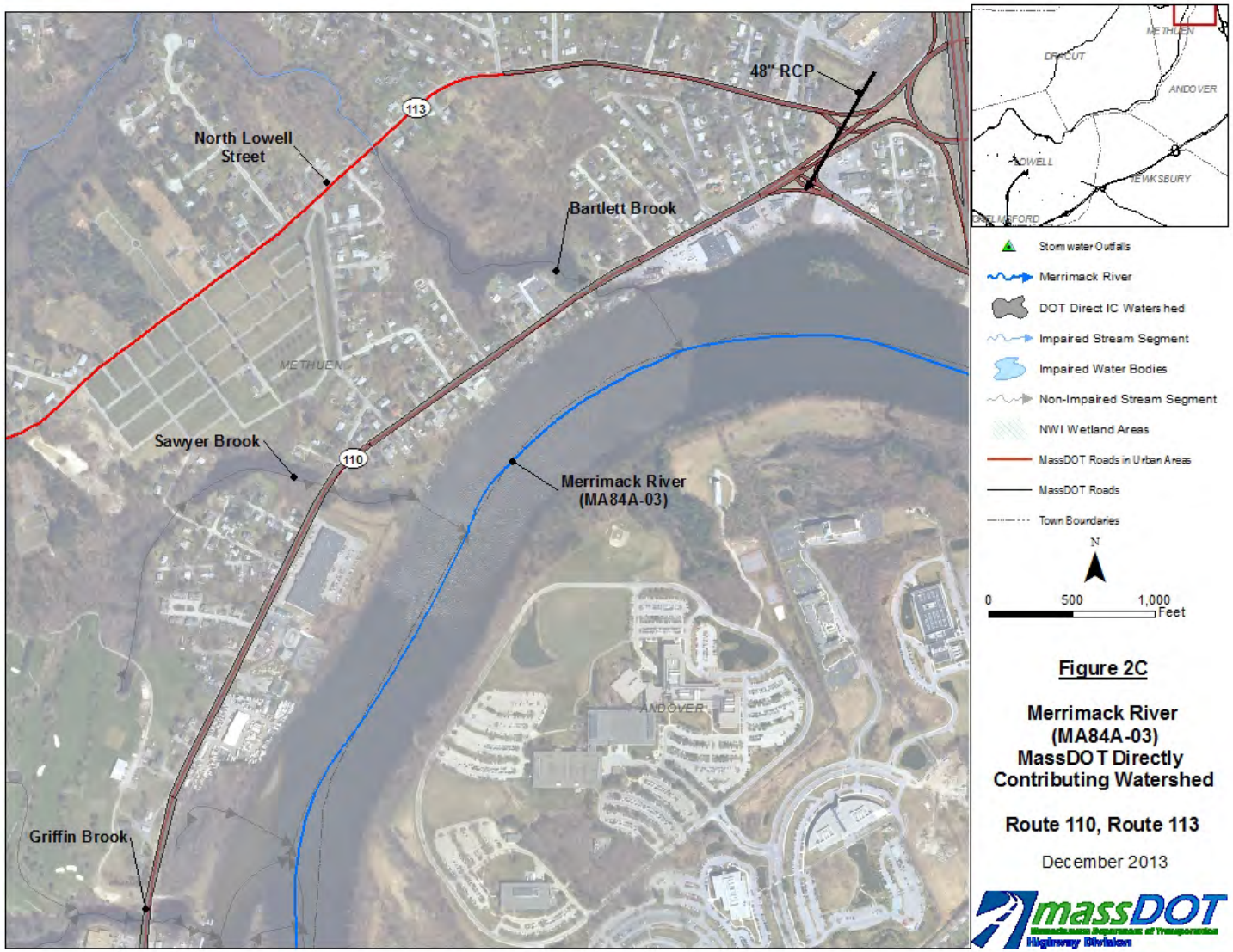

Figure 2C

Merrimack River (MA84A-03) MassDOT Directly Contributing Watershed

Route 110, Route 113

December 2013

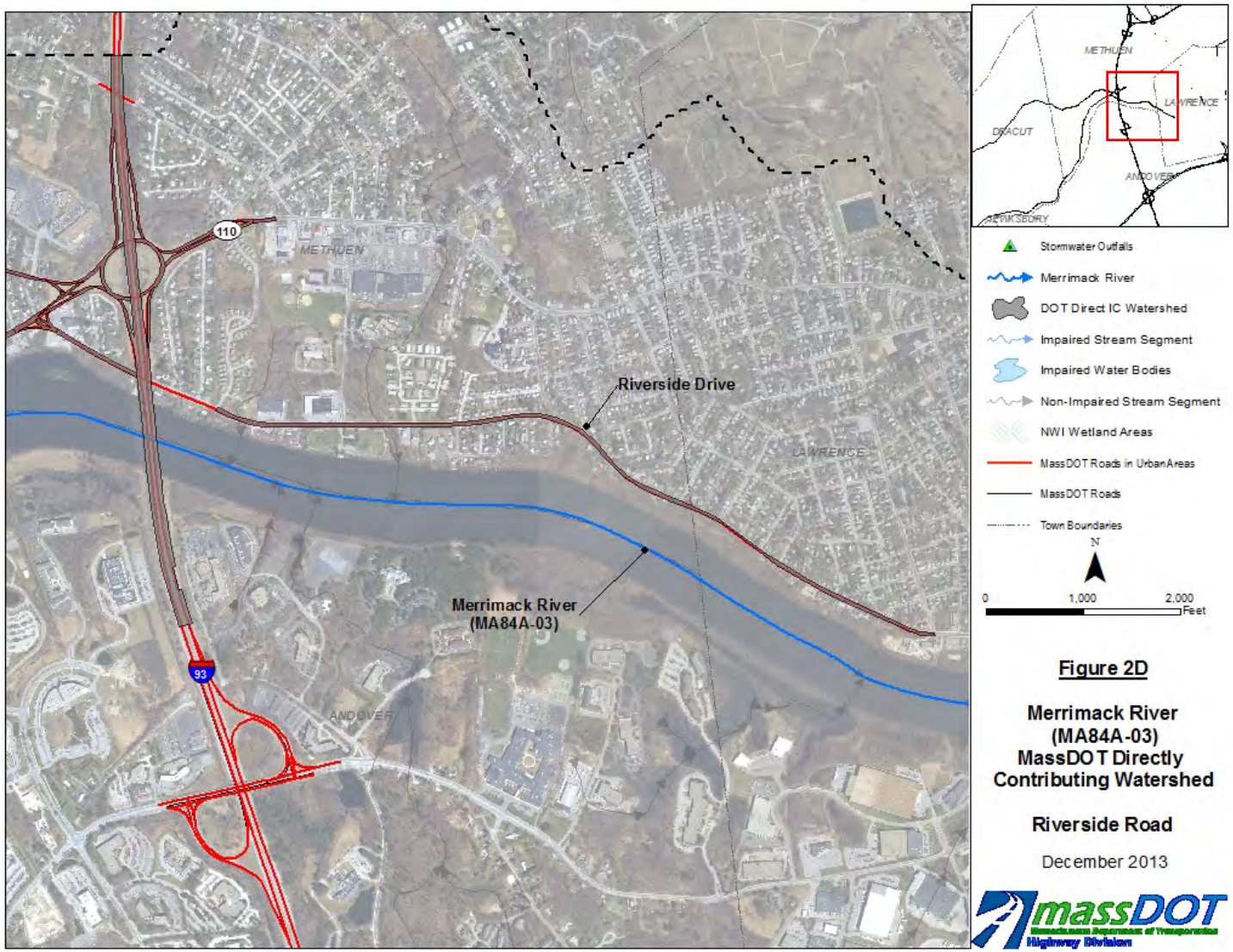

Figure 2D

Merrimack River (MA84A-03) MassDOT Directly Contributing Watershed

Riverside Road

December 2013

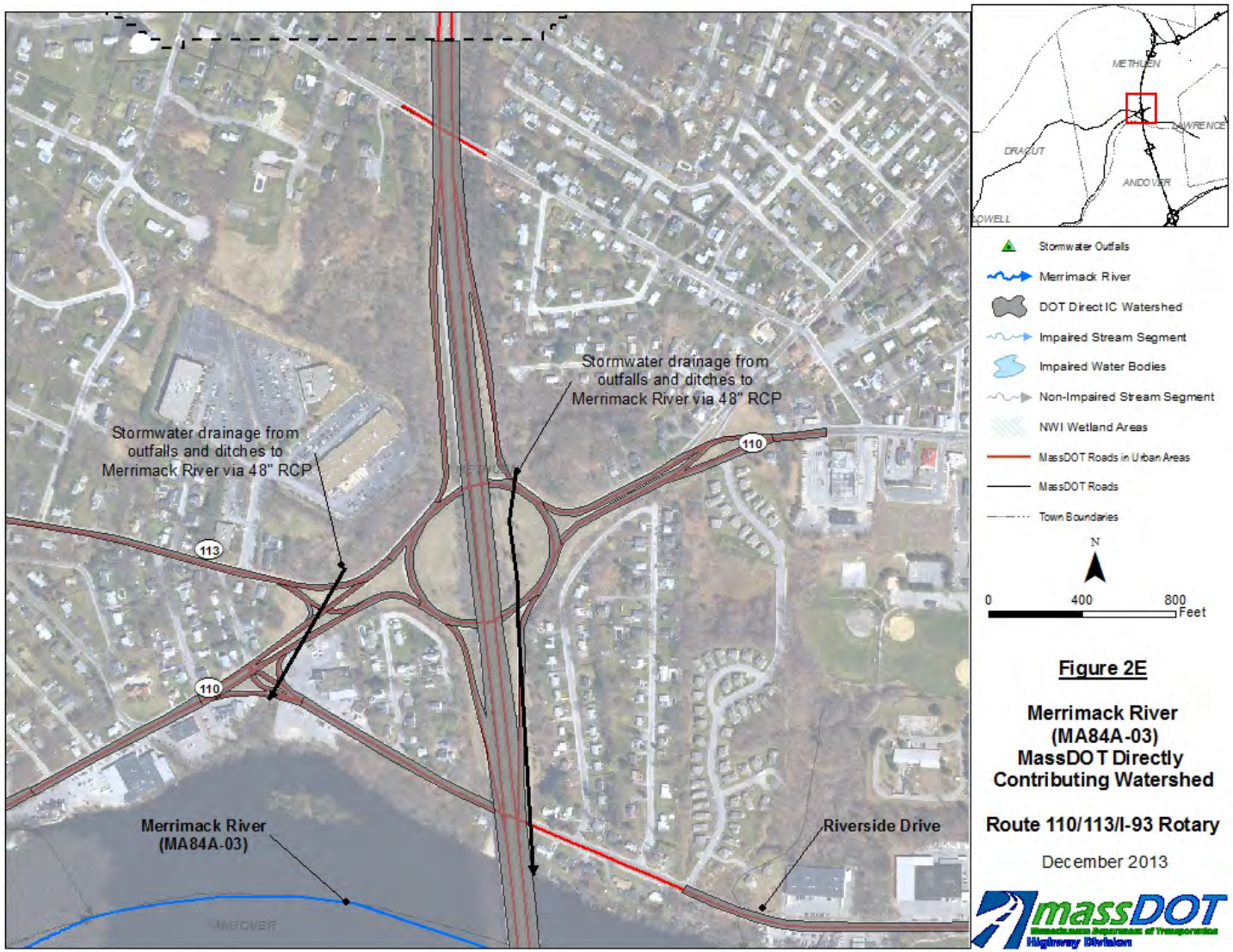

Figure 2E

Merrimack River (MA84A-03) MassDOT Directly Contributing Watershed

Route 110/113/I-93 Rotary

December 2013

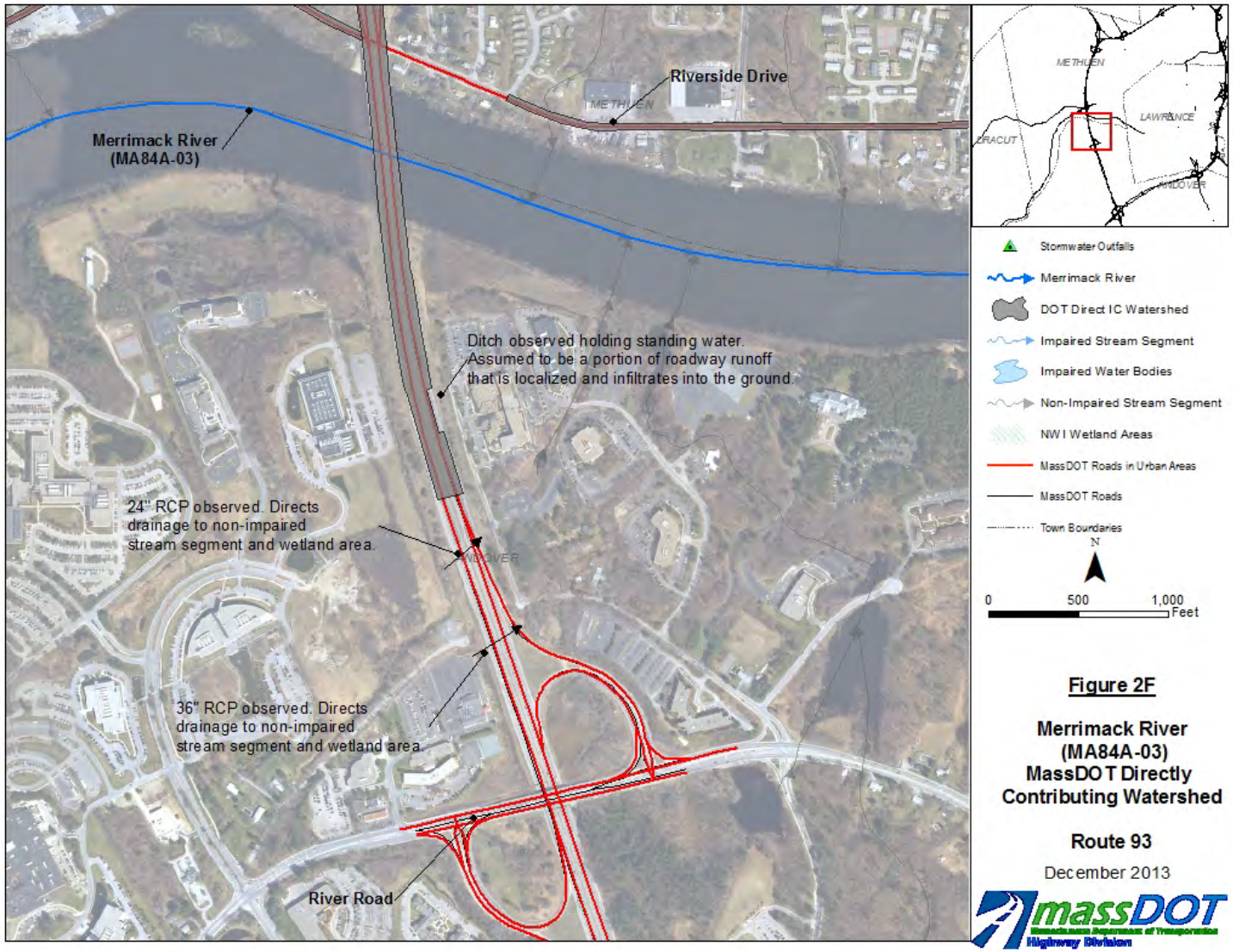

Figure 2F

Merrimack River (MA84A-03) MassDOT Directly Contributing Watershed

Route 93

December 2013

Impaired Waters Assessment for Merrimack River (MA84A-04) – Progress Report

Impaired Water Body

Name: Merrimack River

Location: Haverhill, Lawrence, Methuen, and North Andover, MA

Water Body ID: MA84A-04

Impairments

Merrimack River (MA84A-04) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters*. This segment of the Merrimack River is impaired for the following:

- Escherichia coli
- PCB in fish tissue
- Phosphorus (total)

According to MassDEP's *Merrimack River Watershed 2004-2009 Water Quality Assessment Report* (MassDEP, 2010), sources for the Escherichia coli impairment include wet weather discharges (point source and combination of stormwater, SSO, or CSO). Segment MA84A-04 of the Merrimack River is also covered by the Draft Pathogen Total Maximum Daily Load (TMDL) for the Merrimack River Watershed (MassDEP, no date).

Relevant Water Quality Standards

Water Body Classification: Class B, CSO

Applicable State Regulations:

- *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 dissolve 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

Segment MA84A-04 of the Merrimack River begins at the Essex Dam in Lawrence and flows north-northeast for approximately 10 miles to its confluence with the Little River in Haverhill. The total watershed to Segment 84A-04 is approximately 3,105,859 acres in size and extends from Massachusetts into New Hampshire. The localized subwatershed to Segment MA84A-04 is approximately 7,939 acres in size and spans the towns of Boxford, Haverhill, Lawrence, Methuen, and North Andover in Massachusetts. The subwatershed is shown in Figure 1.

MassDOT's property directly contributing stormwater runoff to Segment MA84A-04 of the Merrimack River is comprised of portions of the following roadways:

- Interstate 495 (I-495)
- Bank Road in Haverhill
- Western Avenue in Haverhill

- River Street in Haverhill
- Railroad Avenue Bridge in Haverhill
- Lowell Street bridge in Lawrence
- O'Leary Bridge in Lawrence (Rt. 28)
- Duck Bridge in Lawrence (Union Street)
- South Union Street Bridge in Lawrence
- Commonwealth Drive in Lawrence
- Marston Street in Lawrence
- Merrimack Street in Methuen

In general, stormwater runoff along I-495 within the subwatershed to Segment MA84A-04 flows through small, localized collection systems and discharges to the northbound and southbound shoulders of the highway. I-495 crosses Segment MA84A-04 in three locations and direct discharges are concentrated in these areas. In total, approximately 29.1 acres of impervious cover (IC) along I-495 and its entry/exit ramps discharge directly to Segment MA84A-04.

In Haverhill, Bank Road, Western Avenue, and portions of River Street run parallel to Segment MA84A-04 along its western bank. Combined, approximately 14 acres of MassDOT's IC along these roadways discharge directly to the subject water body. MassDOT also owns the Railroad Avenue Bridge over Segment MA84A-04 in Haverhill. The majority of the stormwater from this bridge flows from a high point at the northern edge of the bridge into two catch basins approximately 600 feet south. These catch basins appear to discharge directly to the river. The remainder of the stormwater from the bridge flows into the municipal stormwater system, which also discharges directly to Segment MA84A-04. A total of approximately 0.7 acres of IC from the Railroad Avenue Bridge discharges directly to the subject water body.

In Lawrence, MassDOT owns four bridges that all discharge directly to Segment MA84A-04: the Lowell Street Bridge, the O'Leary Bridge, the Duck Bridge, and the South Union Street Bridge. The Lowell Street Bridge spans a railroad nearby Segment MA84A-04. Stormwater from approximately 0.08 acres of IC along this bridge appears to flow into the adjacent municipal stormwater system. Due to the urban nature of this area and its close proximity to Segment MA84A-04, it is assumed that the municipal system discharges directly to the subject water body. The O'Leary Bridge along Rt. 28 crosses Segment MA84A-04 at its most upstream end. Scuppers along the length of the bridge capture stormwater runoff from approximately 1.7 acres of IC and discharge directly to Segment MA84A-04. The Duck Bridge is located along Union Street and spans Segment MA84A-04. The bridge was recently renovated and has a concrete deck with scuppers along its entire length. These scuppers collect stormwater runoff from approximately 0.6 acres of IC along the bridge and also discharge directly to Segment MA84A-04. The South Union Street Bridge spans a railroad just south of the Duck Bridge along South Union Street. Stormwater from approximately 0.1 acres of IC along this bridge appears to flow into the adjacent municipal stormwater system. Due to the urban nature of this area and its close proximity to Segment MA84A-04, it is assumed that the municipal system discharges directly to the subject water body.

MassDOT also owns Commonwealth Drive and Marston Street in Lawrence. Catch basins along these roadways and adjacent entry/exit ramps for I-495 collect stormwater runoff from approximately 8.7 acres of IC. Stormwater then flows into a system that discharges directly to Segment MA84A-04 through a 42" reinforced concrete outfall.

In Methuen, MassDOT owns Merrimack Street, which parallels Segment MA84A-04 and runs adjacent to the water body along its western bank. Approximately 4.7 acres of impervious area along Merrimack Street discharge stormwater directly to the subject water body. MassDOT directly contributing areas are shown in Figures 2a-2d.

Assessment under BMP 7U

None of the impairments for Segment MA84A-04 of the Merrimack River have been addressed by a TMDL. MassDOT assessed the impairments 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 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), 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:

- Phosphorus (total)

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 Escherichia Coli is assessed separately in the section of this report 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 MA84A-04 of the Merrimack River:

Table 1. Site Parameters for Merrimack River (MA84A-04)

Type*	Parameter	Quantity**	Unit of Measure
Subwatershed	Subwatershed Area	7,939	acres
Subwatershed	Impervious Cover (IC) Area	2,450	acres
Subwatershed	Percent Impervious	30.9	%
Subwatershed	IC Area at 9% Goal	714.5	acres
Subwatershed	Target Reduction% in IC	70.8	%
Reductions Applied	MassDOT's IC Area Directly Contributing to Impaired Segment	59.7	acres
Reductions Applied	MassDOT's Target Reduction in Effective IC (70.8% of DOT Directly Contributing IC)	42.3	acres

*The majority of the total watershed is located in New Hampshire; therefore, IC calculations for the total watershed were not applicable for DOT property.
**Rounding accounts for differences in calculations.

The subwatershed is greater than 9% IC, 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 70.8%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 42.3 acres.

Existing BMPs

MassDOT has two existing structural Best Management Practices (BMPs) in the directly contributing watershed to Segment MA84A-04 of the Merrimack River. Figure 3 shows the location of the two BMPs. For the Impervious Cover Method, existing BMPs receive credit for removing the effects of IC depending on their type, size relative to the IC that they process, and the local soil conditions. The following sections describe each existing BMP and discuss any applicable IC reduction credit.

EX-BMP-1: This BMP is located in the infield area between Marston Street, I-495 SB, and the entry/exit ramps connecting the two roadways. Catch basins along these roadways discharge stormwater to the BMP. Construction plans indicate that this is a wet pond, with a PVC membrane liner to prevent infiltration and promote a permanent pool of water. Construction plans also indicate that this BMP has an outlet control structure consisting of a concrete box with a 12" diameter orifice and an overflow grate set on top of the box.

A site visit performed by AECOM on November 5, 2013 confirmed the presence of the PVC liner and the outlet control structure. There was a standing pool of water measuring approximately 300 feet in length by 65 feet in width, and the outlet control structure had a rectangular orifice measuring approximately 12" by 12". Wetland vegetation surrounded the pond. Desktop analysis indicates that the underlying soils are characterized as Udorthents. This soil type requires an on-site investigation to determine suitability or limitation for intended uses.

The contributing watershed to EX-BMP-1, shown in Figure 3, is approximately 2.37 acres. Because EX-BMP-1 is not an infiltration-style BMP, it was classified as an extended detention basin due to its ability to store runoff and provide flow control via its outlet control structure. Although EX-BMP-1 is able to fully store the first flush of runoff from its contributing watershed, the low-level orifice is sized too large to provide a sufficient amount of drawdown time. For this reason, the BMP was assigned no IC reduction credit.

EX-BMP-1. Extended Detention Basin/Wet Pond.

EX-BMP-2: This BMP is located in the infield area between I-495 NB and the I-495 entry ramp from Marston Street. Catch basins along these roadways discharge stormwater to the BMP. Construction plans indicate that this is a wet pond, with a PVC membrane liner to prevent infiltration and promote a permanent pool of water. Construction plans also indicate that this BMP has an outlet control structure consisting of a concrete box with a 10" diameter orifice and an overflow grate set on top of the box.

A site visit performed by AECOM on November 5, 2013 revealed that the BMP had not been constructed as designed. The BMP was situated approximately 200 feet north of the location indicated on the construction plans. There was no evidence of a PVC liner, but there was an outlet control structure with a rectangular orifice measuring approximately 12" by 5" with an overflow grate set on top. The basin itself appeared to be filled in by sediments and was grassed over, with a remaining depth of approximately 6 inches. Desktop analysis indicates that the underlying soils are characterized as Udorthents. This soil type requires an on-site investigation to determine suitability or limitation for intended uses.

The contributing watershed to EX-BMP-2, shown in Figure 3, is approximately 2.73 acres. Because EX-BMP-2 is not an infiltration-style BMP, it was classified as an extended detention basin due to its ability to store a small amount of runoff and provide flow control via its outlet control structure. EX-BMP-2 is filled in with sediments, however, and is unable to fully store the first flush of runoff from its contributing watershed. In addition, the low-level orifice is sized too large to provide a sufficient amount of drawdown time. For this reason, the BMP was assigned no IC reduction credit.

EX-BMP-2. Extended Detention Basin/Wet Pond.

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-1	Extended Detention Basin	Udorthents (site investigation required)	3.2	2.37	0	0
EX-BMP-2	Extended Detention Basin	Udorthents (site investigation required)	0.4	2.73	0	0
Total	N/A	N/A	N/A	N/A	N/A	0

*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 BMP's is less than the target reduction of 42.3 acres, MassDOT will consider the implementation of additional BMPs.

Consideration was given to converting the two existing BMPs described above into infiltration basins. If these BMPs were converted into infiltration basins, they could reduce MassDOT's directly contributing IC area by 4.79 acres. However, several site conditions warrant further exploration before this can be confirmed as a feasible option. EX-BMP-1 is located less than 1,000 feet from Segment MA84A-04 of the Merrimack River. The BMP currently has a PVC liner prevent infiltration. This is most likely designed to prevent road salt from infiltrating into the ground due to the close proximity to the river. However, if this is not the case then the liner may be removed to promote infiltration. Further investigation should be conducted to confirm the design intent of the liner. EX-BMP-2 is located less than 500 feet from Segment MA84A-04. Construction plans for this BMP also indicate a PVC liner. Field inspection revealed variations from the original design, and the liner

could not be visually confirmed. Further investigation should be conducted to verify that the liner exists, and then to confirm the design intent of the liner (if necessary).

In addition, both EX-BMP-1 and EX-BMP-2 are situated on soils classified as Udorthents. Further investigation should be performed to determine the infiltration rates of the soils and whether or not they are suitable for an infiltration-style BMP. As mentioned above, EX-BMP-1 and EX-BMP-2 are located less than 1,000 feet and 500 feet, respectively, from the river segment. Additional investigation should be performed to determine the groundwater elevations in both areas. Such close proximity to the river suggests that this may potentially be an issue.

Assessment of Pathogen Impairment under BMP 7U

MassDOT assessed the pathogen impairment 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 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 are assessed 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, and has a pet waste management program underway to address this source where necessary.
- 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

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 MA84A-04 of the Merrimack 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 42.3 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Segment MA84A-04 to identify existing BMPs and found that existing BMPs no reduction in effective IC. This information is summarized in Table 3 below.

Table 3. Effective IC Reductions under Existing & Proposed Conditions

Type of Reduction	Quantity	Unit of Measure
IC in Directly Contributing Watershed	59.7	acres
Target Reduction in Effective IC	42.3	acres
IC Effectively Reduced by Existing BMPs	0	acres
IC Remaining to Mitigate with Proposed BMPs	42.3	acres

MassDOT should reduce its effective IC within the directly contributing watershed by an additional 42.3 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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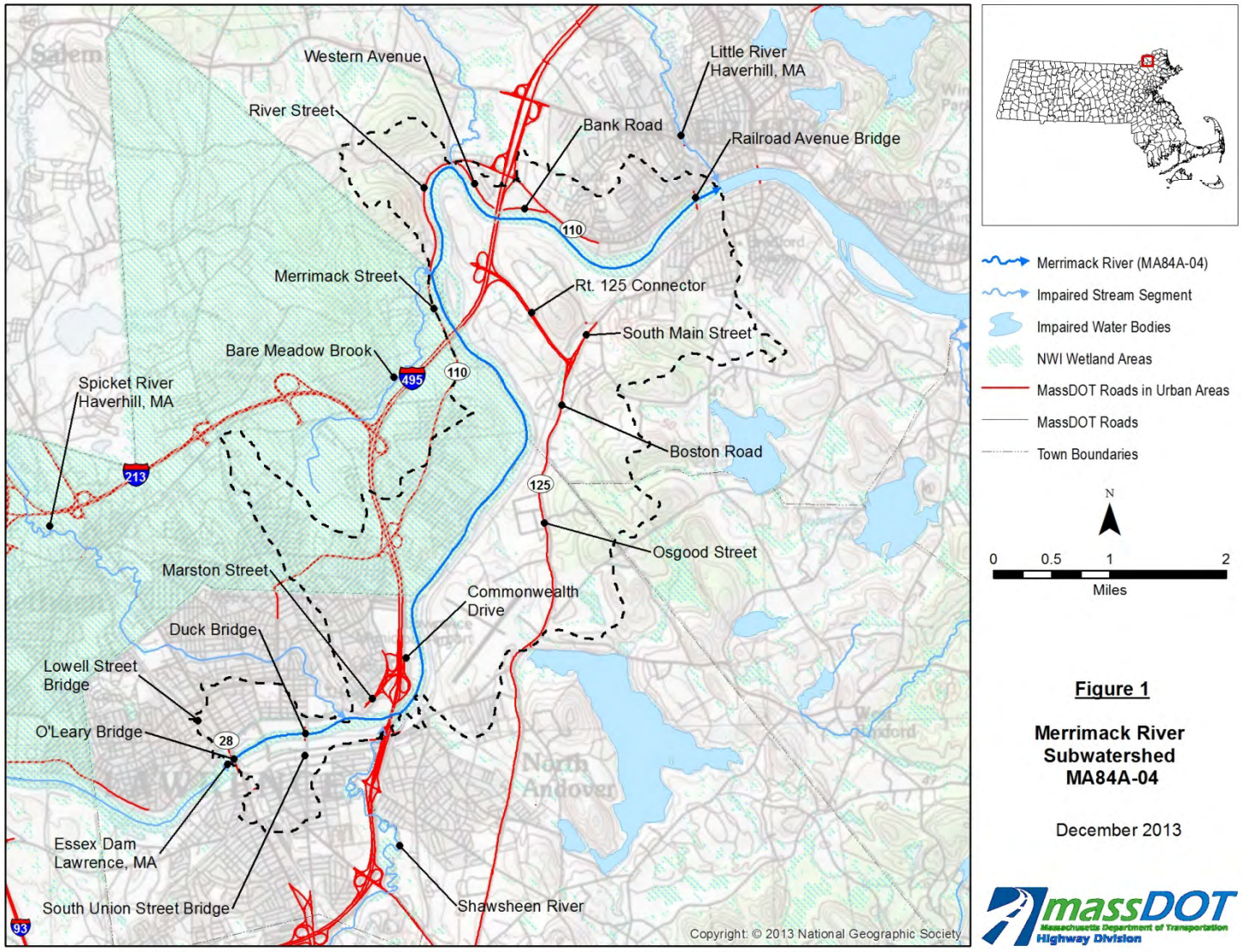


Figure 1

Merrimack River Subwatershed MA84A-04

December 2013

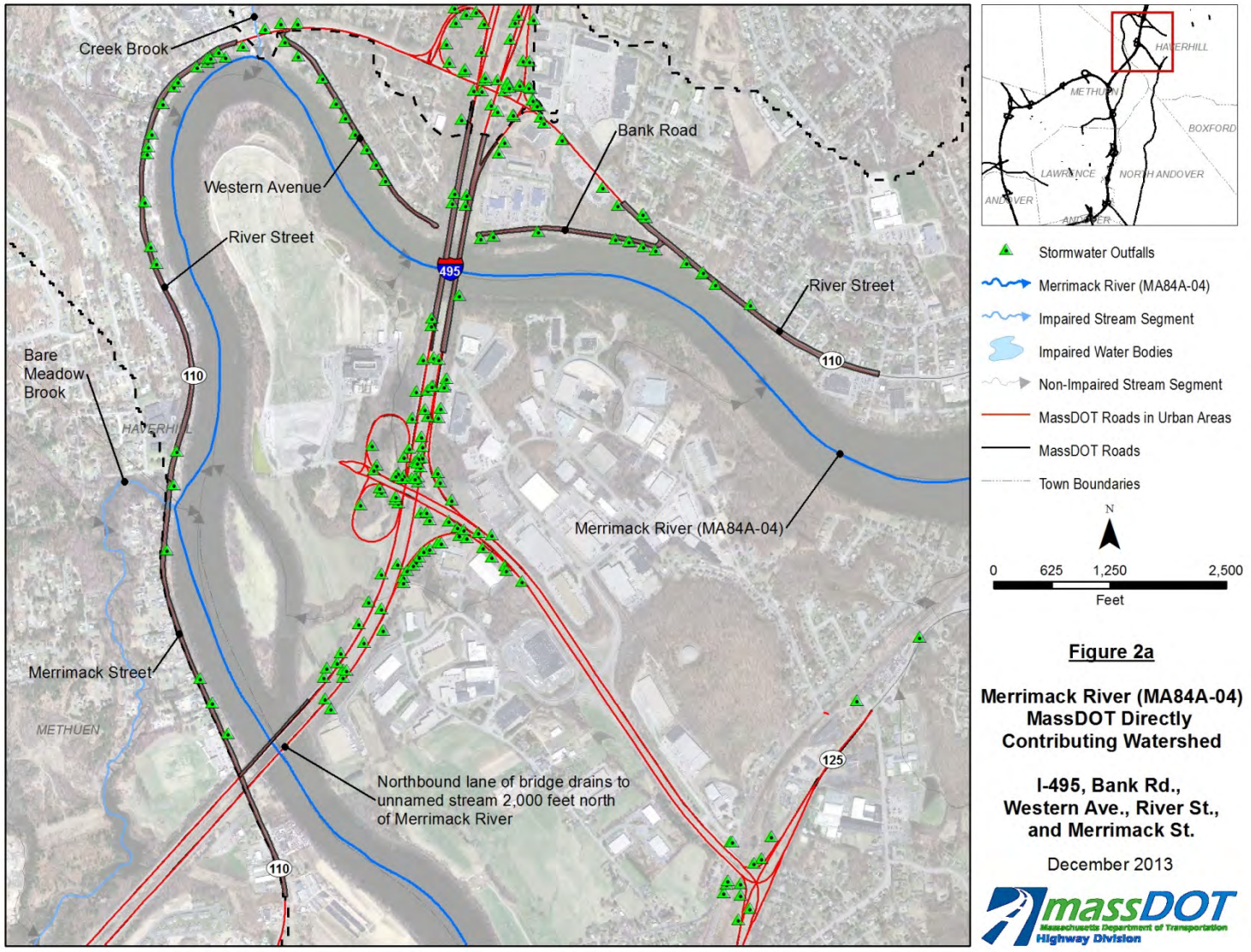
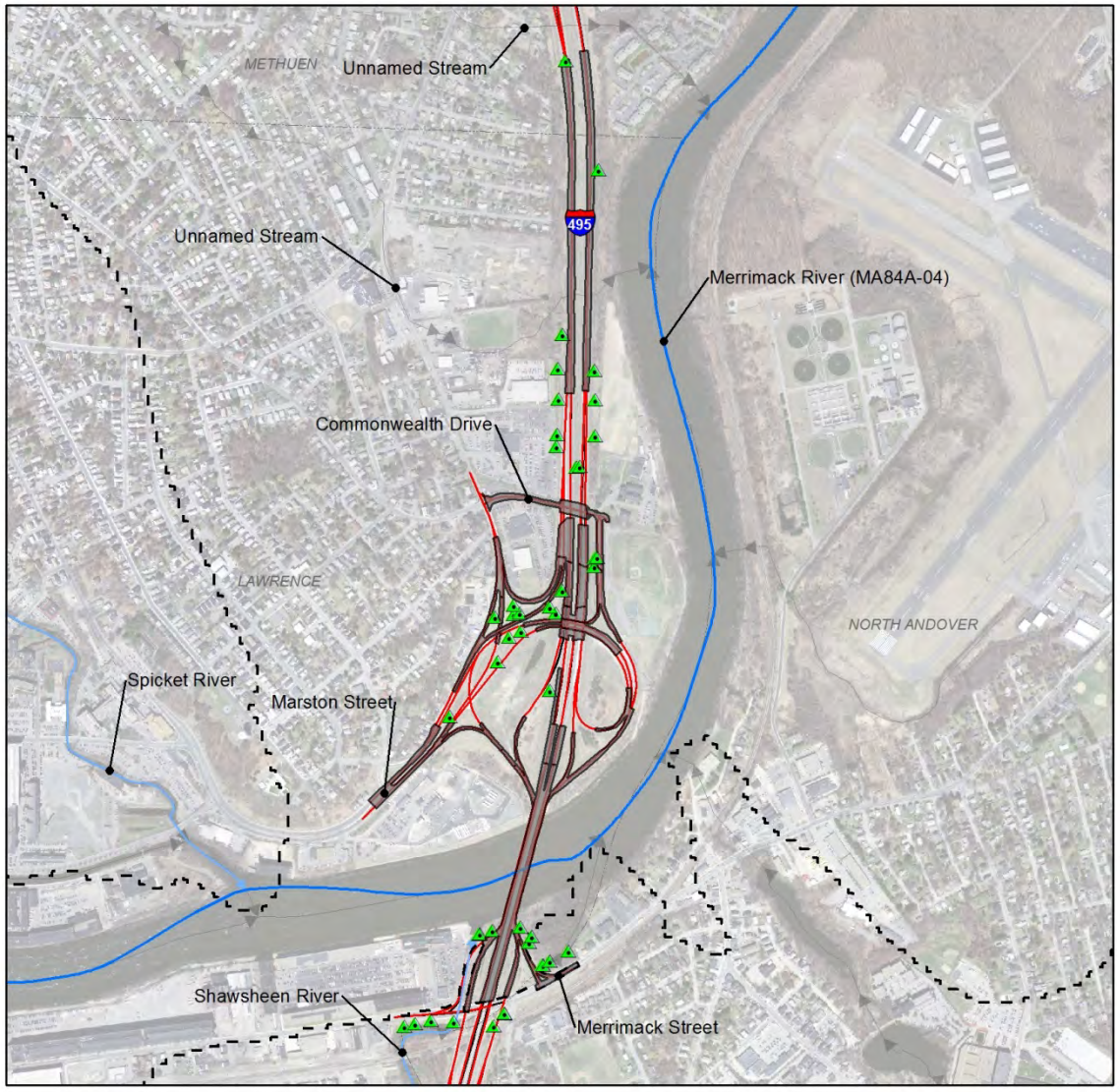


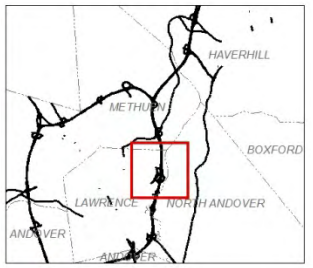
Figure 2a

Merrimack River (MA84A-04)
MassDOT Directly Contributing Watershed

I-495, Bank Rd., Western Ave., River St., and Merrimack St.

December 2013





Stormwater Outfalls
Merrimack River (MA84A-04)
Impaired Stream Segment
Impaired Water Bodies
Non-Impaired Stream Segment
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 500 1,000 2,000
Feet

Figure 2b

Merrimack River (MA84A-04)
MassDOT Directly Contributing Watershed

I-495, Marston Street, and Commonwealth Drive

December 2013

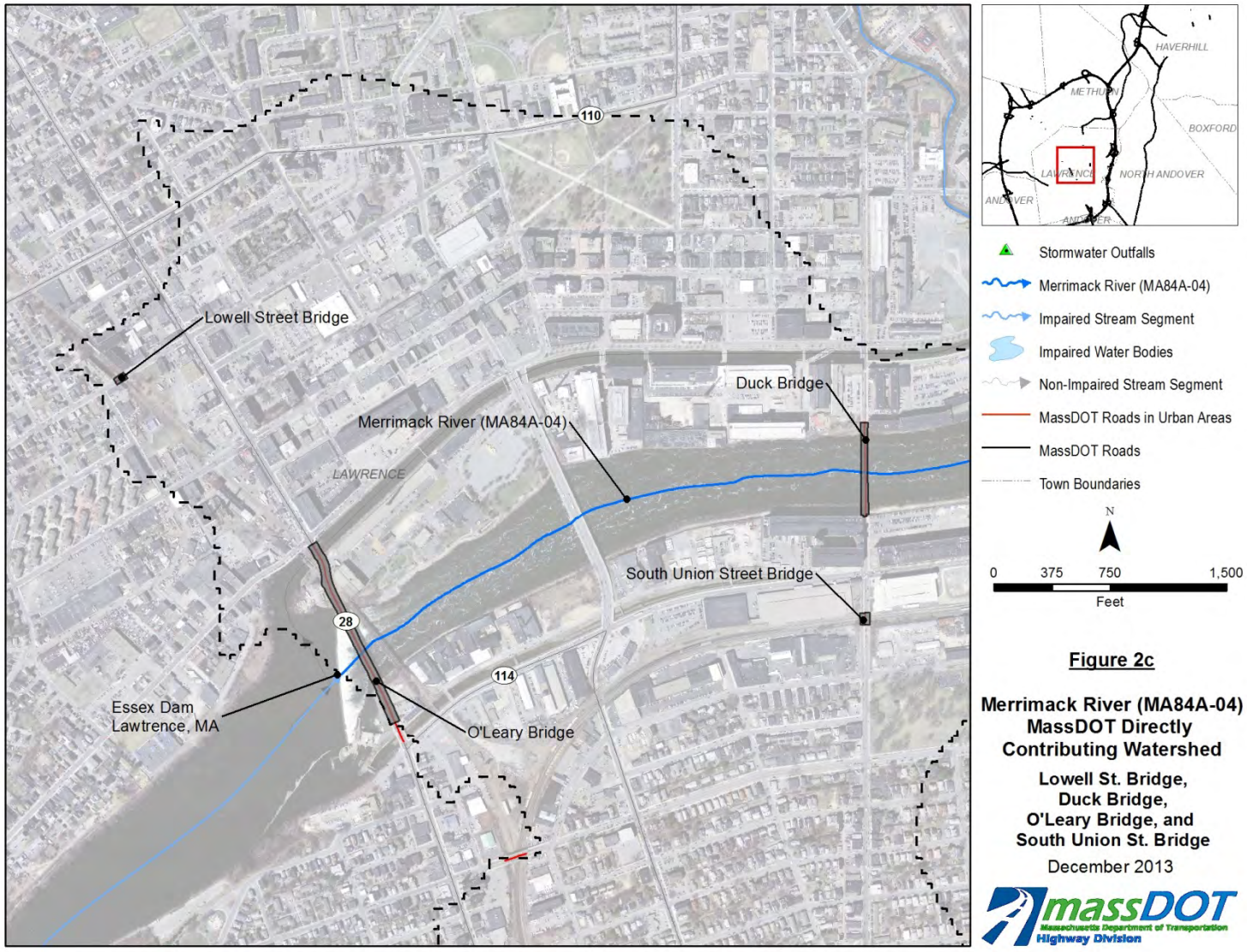


Figure 2c

Merrimack River (MA84A-04)
MassDOT Directly Contributing Watershed

Lowell St. Bridge,
Duck Bridge,
O'Leary Bridge, and
South Union St. Bridge

December 2013

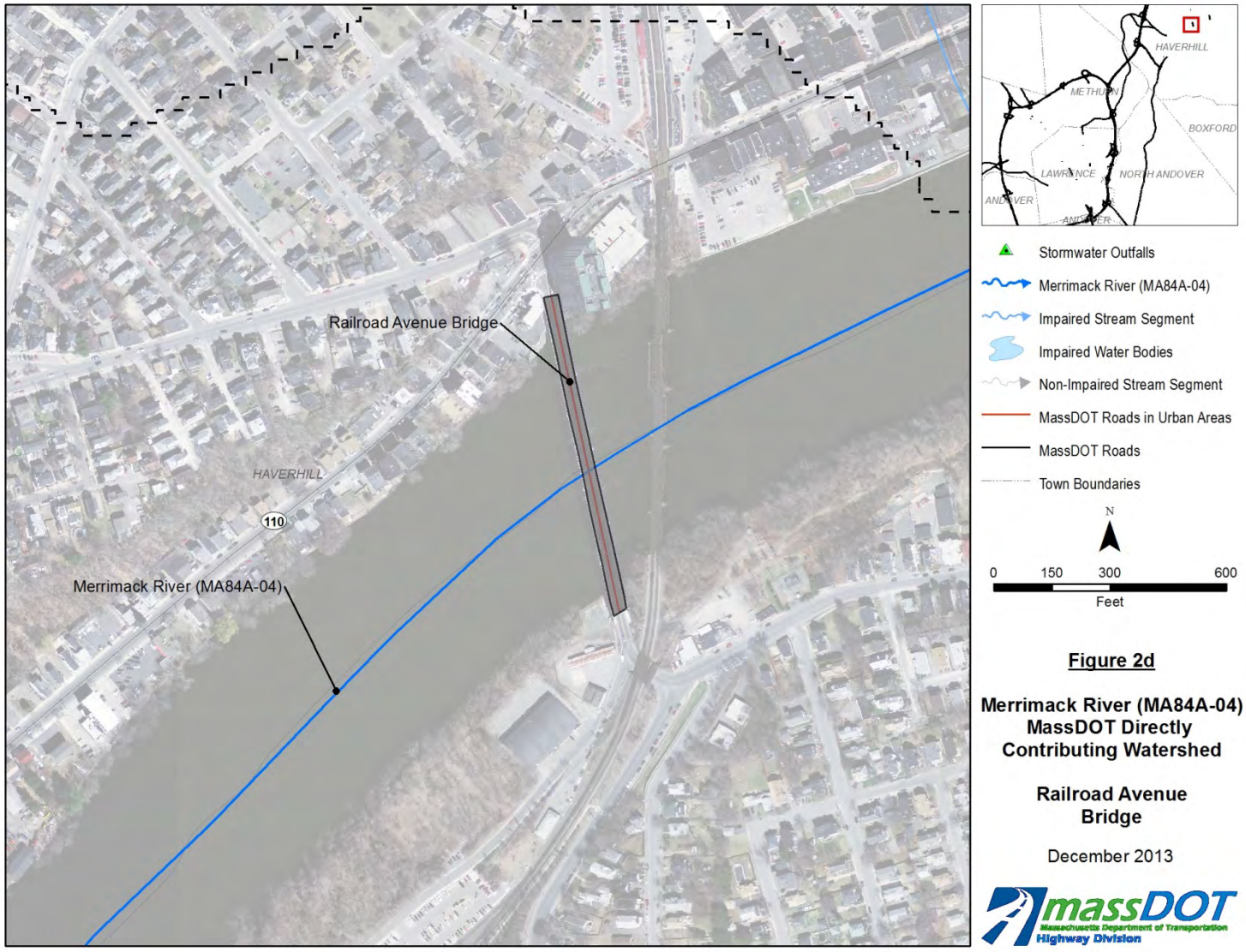


Figure 2d

Merrimack River (MA84A-04)
MassDOT Directly Contributing Watershed

Railroad Avenue Bridge

December 2013

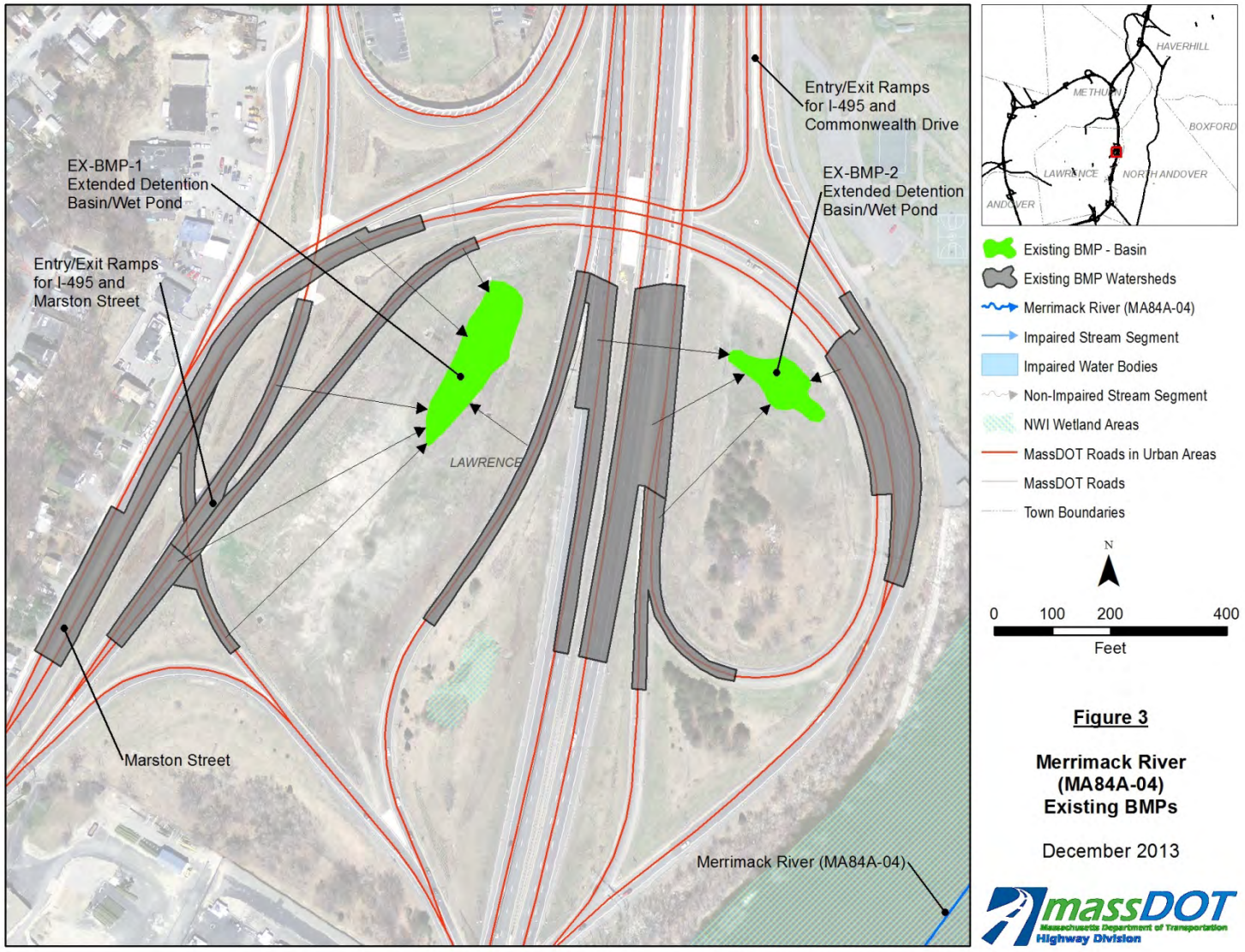


Figure 3

Merrimack River (MA84A-04) Existing BMPs

December 2013

Impaired Waters Assessment for Lowell Canals (MA84A-29) – Progress Report

Impaired Water Body

Name: Lowell Canals

Location: Lowell, MA

Water Body ID: MA84A-29

Impairments

Lowell Canals (MA84A-29) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2012 Integrated List of Waters* (MassDEP, 2013). Lowell Canals (MA84A-29) is impaired for the following:

- DDT
- lead
- mercury in fish tissue
- PCP in fish tissue

According to MassDEP's *Merrimack River Watershed 2004 Water Quality Assessment Report* (MassDEP, 2010), the following facilities have National Pollutant Discharge Elimination Permits (NPDES) to discharge to Lowell Canals (MA84A-29): Boott Hydropower, Inc. (MAG250949), Lowell Cogeneration Company (MA0031071), and Lowell National Historical Park (MAG250732). Boott Hydropower, Inc. is authorized to discharge 0.00144 MGD of non-contact cooling water from the Hamilton Power Station on Jackson St. in Lowell into the Merrimack River via the Hamilton Canal. The Lowell Cogeneration Company, L.P. is authorized to discharge a monthly average flow of 0.0865 MGD (0.115 MGD maximum daily) of cooling tower blowdown, boiler blowdown, demineralizer wastewater and water softener regeneration wastewater from its facility on Western Ave. to the Pawtucket Canal to the Merrimack River. The Lowell National Historical Park is authorized to discharge an average monthly flow of 0.360 MGD (0.4 MGD daily maximum) of non-contact cooling water from the Boott Cotton Mills Museum to the Eastern Canal of the Merrimack River.

Relevant Water Quality Standards

Water Body Classification: Class B\TWS

Applicable State Regulations:

- *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

Segment MA84A-29 of the Lowell Canals begins at the confluence of Pawtucket and Northern Canals with the Merrimack River, adjacent to the Pawtucket Dam in Lowell, MA. See Figure 1 for canal and lock locations and canal flow direction, based on locations from NPS, 1975. Pawtucket Canal continues southeast approximately 1 mile then continues northeast approximately 1,300 feet to the confluence with Hamilton and Western Canals. The impaired section of Hamilton Canal continues northeast approximately 1,100 feet from the confluence with Pawtucket Canal. Pawtucket Canal continues approximately 400 feet north from the confluence with Hamilton Canal to Swamp Locks, where it becomes Lower Pawtucket Canal and continues approximately 2,200 feet to the confluence with Eastern Canal and Lower Locks, where it flows into the Concord River, which flows into the Merrimack River. Eastern Canal continues from the confluence with Lower Pawtucket Canal northeast, then northwest, then northeast approximately 2,300 feet to the confluence with the Merrimack River. The impaired segment of Merrimack Canal continues from the confluence with Pawtucket Canal approximately 2,600 feet northeast to Merrimack Dam.

Northern Canal continues from the confluence with the Merrimack River northeast then southeast approximately 4,300 feet to the confluence with Western Canal. The Pawtucket Gatehouse controls the flow of water into the Northern Canal. Western Canal continues from the confluence with Northern canal approximately 3,200 feet southwest to the confluence with Pawtucket Canal. Lawrence Canal continues from the confluence with Northern and Western Canals at Tremont Gatehouse approximately 1,300 ft to the confluence with the Merrimack River.

Lowell Canals (MA84A-29) is classified as impaired due to lead, DDT, and mercury and PCB in fish tissue according to the *Merrimack River Watershed 2004 Water Quality Assessment Report*. The total length of Lowell Canals (MA84A-29) (the impaired portion of the canal system) is approximately 4.9 miles (total length of all canals combined is approximately 5.6 miles); refer to Figure 1 for the subwatershed of Lowell Canals (MA84A-29).

MassDOT's property directly contributing stormwater runoff to the Lowell Canals is comprised of (but not limited to) portions of the intersection of Thorndike Street, Route 3A, Lord Overpass, Middlesex Street and associated ramps, and Bridge Street. Refer to Figures 2a and 2b for the location of these roadways within the subwatershed to segment MA84A-29 of Lowell Canals. An overview and details of the direct drainage watersheds and outfalls are presented in greater detail below. Wilder Street, Walker Street, and School Street do not directly contribute to the Lowell Canals; runoff from these roadways drains to the municipal combined sewer system (see Figure 1 for locations of these roadways).

As shown in Figure 2a, runoff from the ramp from Thorndike Street to Middlesex Street, the portion of the ramp from Middlesex Street to Dutton Street south of Pawtucket Canal, the Middlesex Street portion of Lord Overpass, portions of Thorndike Street (north and south), the ramp from Chelmsford Street to Route 3A south and a portion of the ramp from Route 3A to Lord Overpass is collected in

catch basins and piped north to the Pawtucket Canal. The portion of Middlesex Street to the west of the bridge over the railroad tracks, Chelmsford Street, Lord Overpass (Route 110) and Thorndike Street and ramps southeast of the subwatershed boundary do not directly discharge to segment MA84A-29 of the Lowell Canals.

Runoff from the ramp from Middlesex Street to Dutton Street from where it crosses over Pawtucket Canal is collected in catch basins and piped to the Western Canal. The portion of ramp southeast of the bridge over Pawtucket Canal is piped to Pawtucket Canal, as previously mentioned.

Bridge Street drains through bridge scuppers (located within the bridge over the Eastern Canal) between the railroad tracks along Amory Street and the bridge over the canal, as shown in Figure 2b. The MassDOT portion of Bridge Street to the southwest of the railroad tracks does not directly discharge to the canal. Runoff from the portion of Bridge Street from the canal approximately 60 ft to the northeast of the canal is collected in catchbasins and piped to the Eastern Canal, as shown in Figure 2b. Runoff from the portion of Bridge Street to the northeast of the DOT portion of the road that drains to Eastern Canal flows to the Merrimack River and does not directly discharge to the Eastern Canal.

Assessment under BMP 7U

None of the impairments for Lowell Canals (MA84A-29) 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 impairment:

- lead

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, MassDOT concluded that the impairments for PCB in fish tissue and DDT is unrelated to storm water runoff. The *Nationwide Urban Runoff Program* (NURP) conducted by the EPA found that PCB and DDT were detected in less than 1% of 121 stormwater samples collected and that it "should be considered to pose a minimal threat to the quality of surface waters from runoff contamination" (EPA, 1983). Therefore, MassDOT concluded that storm water runoff from its roadways does not contribute to the impairment of DDT or PCB in fish tissue.

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 MA84A-29 of Lowell Canals:

Table 1. Site Parameters for Lowell Canals (MA84A-29)

Type*	Parameter	Quantity	Unit of Measure
Subwatershed	Subwatershed Area	885	Acres
Subwatershed	Impervious Cover (IC) Area	302	Acres
Subwatershed	Percent Impervious	34.1**	%
Subwatershed	IC Area at 9% Goal	79.7**	Acres
Subwatershed	Target Reduction% in IC	73.5**	%

Type*	Parameter	Quantity	Unit of Measure
Reductions Applied	MassDOT's IC Area Directly Contributing to Impaired Segment	3.2	Acres
Reductions Applied	MassDOT's Target Reduction in Effective IC (73.5% of DOT Directly Contributing IC)	2.4	Acres

*The majority of the total watershed is located in New Hampshire; therefore, calculations for the total watershed were not applicable for DOT property.
**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 73.5%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 2.4 acres.

Existing BMPs

Based on the site visit, there are no existing BMPs in the Lowell Canals (MA84A-29) directly contributing watershed that are mitigating potential stormwater quality impacts prior to discharge to Lowell Canals (MA84A-29).

Mitigation Plan

Because the total mitigation of impervious surface achieved by MassDOT's existing BMPs is less than the target reduction of 2.4 acres, MassDOT will consider the implementation of additional BMPs.

Vegetated areas along both sides of Thorndike Street north of Lord Overpass have the potential to be used for BMPs, as displayed in **Photos 1** and **2**. The photos show well vegetated areas along both sides of the roadway.

Photo 1. Vegetated area to the northeast of Thorndike Street between Thorndike Street (right) and the ramp from Middlesex Street to Dutton Street (left) (facing southeast).

Photo 2. Vegetated area to the southwest of Thorndike Street between Thorndike Street (right) and the ramp from Thorndike Street to Middlesex Street (left) (facing northwest from Lord Overpass).

Conclusions

MassDOT used the IC Method to assess Lowell Canals (MA84A-29) 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 2.4 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Lowell Canals (MA84A-29) to identify existing BMPs and found that no BMPs exist to reduce 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.

References

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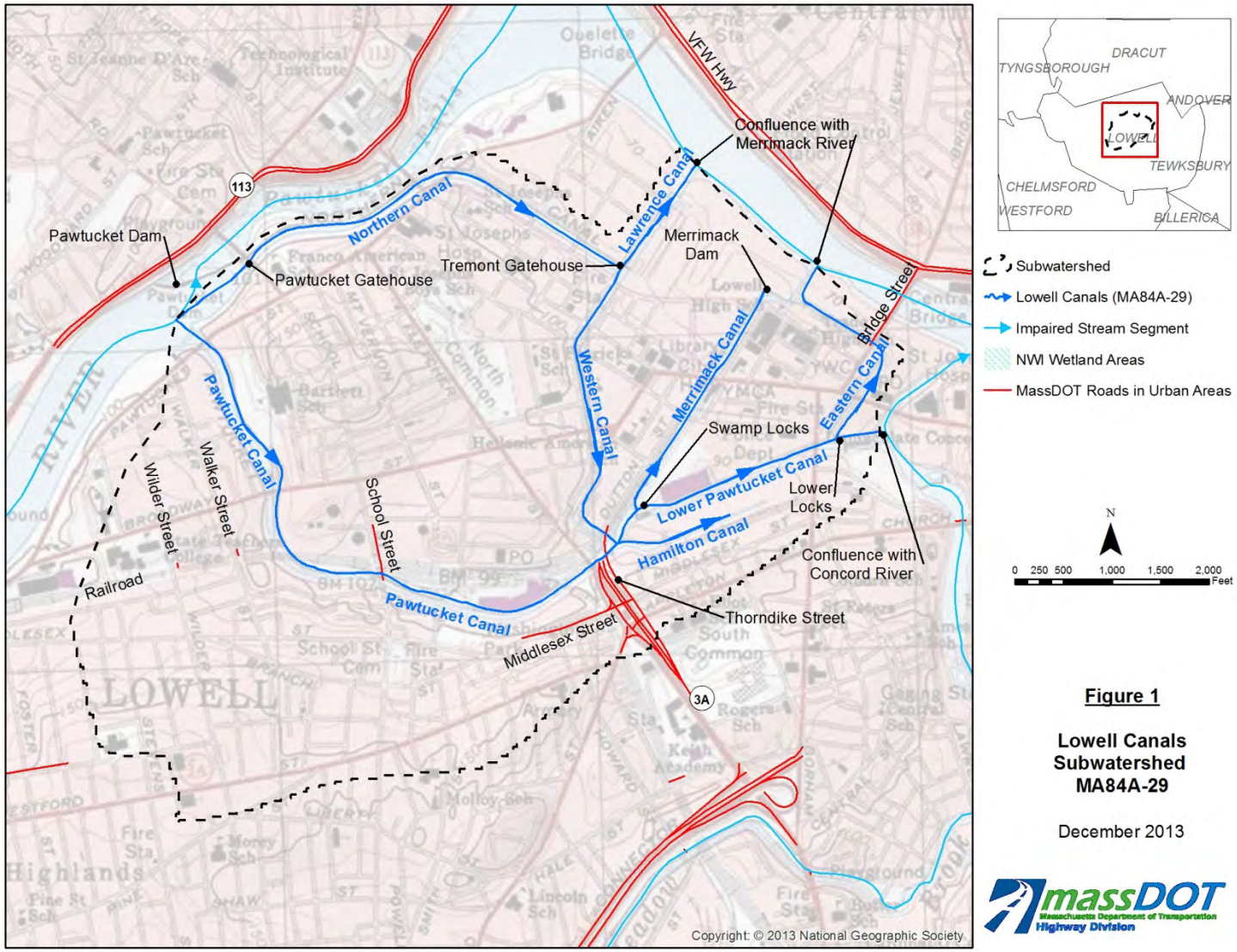


Subwatershed
Lowell Canals (MA84A-29)
Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas

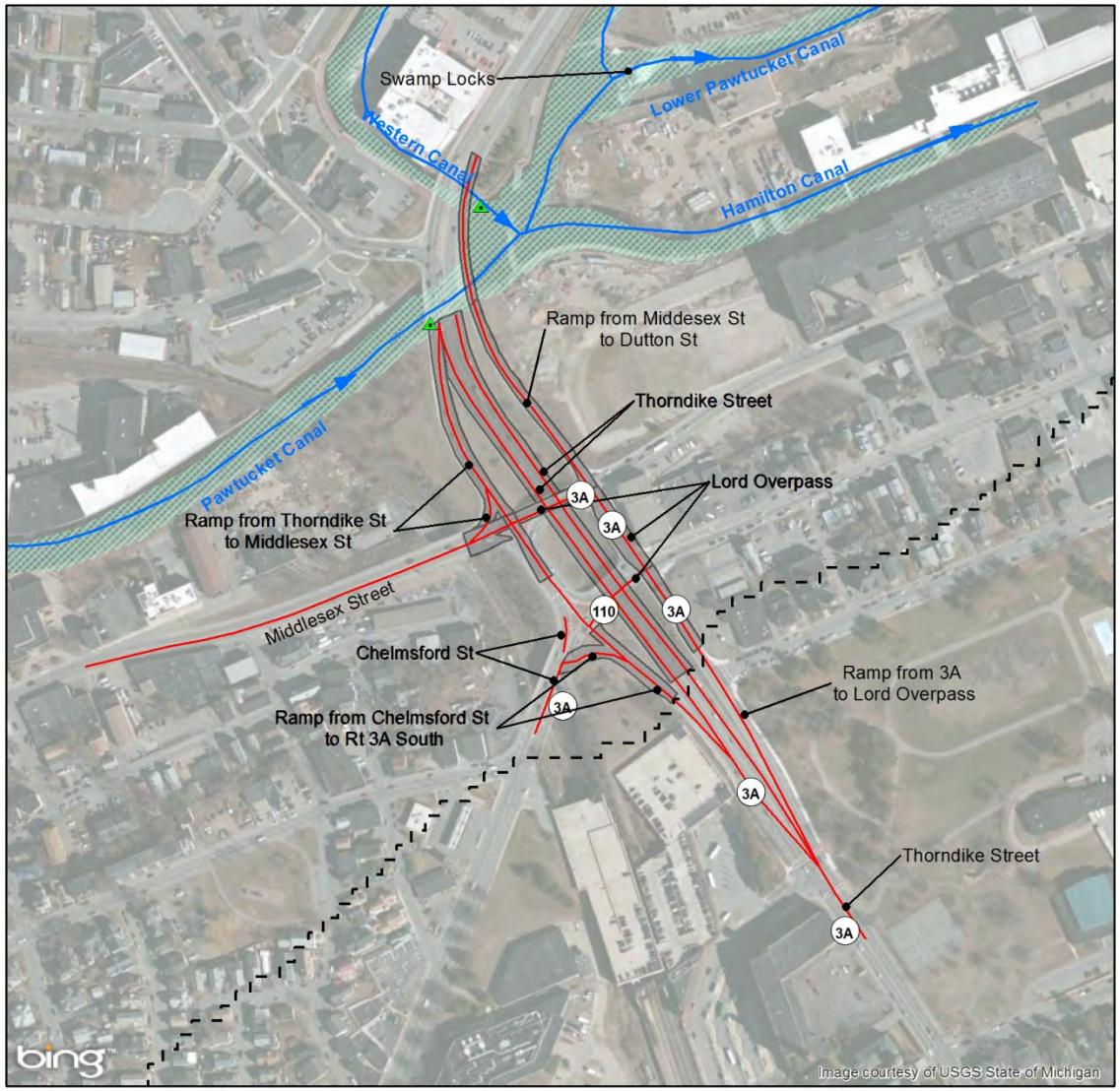
N

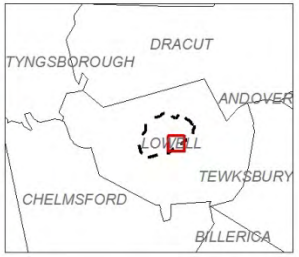
0 250 500 1,000 1,500 2,000 Feet

Figure 1

Lowell Canals Subwatershed MA84A-29

December 2013





Stormwater Outfalls
Subwatershed
DOT Direct IC Watershed
Lowell Canals (MA84A-29)
NWI Wetland Areas
Mass DOT Roads in Urban Areas

N

0 62.5 125 250 375 500 Feet

Figure 2a

Lowell Canals (MA82A-29)
MassDOT Directly Contributing Watershed

December 2013

Stormwater Outfalls
Subwatershed
DOT Direct IC Watershed
Lowell Canals (MA84A-29)
Impaired Stream Segment
NWI Wetland Areas
Mass DOT Roads in Urban Areas

N

0 15 30 60 90 120 Feet

Figure 2b

Lowell Canals (MA82A-29)
MassDOT Directly Contributing Watershed

December 2013

Impaired Waters Assessment for Proctor Brook (MA93-39) – Progress Report

Impaired Waterbody

Name: Proctor Brook

Location: Peabody, MA

Water Body ID: MA93-39

Impairments

Proctor Brook (MA93-39) 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, Proctor Brook is impaired for the following:

- (debris/floatables/trash)*
- aquatic macroinvertebrate bioassessments
- fecal coliform
- foam/flocs/scum/oil slicks
- total nitrogen
- total phosphorus
- sedimentation/siltation
- taste and odor

MassDEP's *North Coastal Watersheds 2002 Water Quality Assessment Report* (MassDEP, 2007) states that Proctor Brook is impaired for primary contact recreational use, secondary contact recreational use, and aesthetics due to elevated fecal coliform bacteria, trash/debris, oil sheens, and odor.

MassDEP's final pathogen TMDL titled, "*Final Pathogen TMDL for the North Coastal Watershed March 2012*", (MassDEP, 2012) states that Proctor Brook is a medium priority for additional bacterial source sampling and implementation of BMPs.

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *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.
- 3*14 CMR 4.05 (3)(b) 7 Oil and Grease.* These waters shall be free from oil and grease, petrochemicals and other volatile or synthetic organic pollutants.
- 3*14 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)(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.
- *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.

Site Description

Proctor Brook (MA93-39) begins at the outlet of a small pond north of Downing Street in Peabody, MA and continues for 2.9 miles southeast, passing under Route 128, through a piped section in Peabody Square, and ending at the Grove Street bridge in Salem, MA. The total watershed and subwatershed for Proctor Brook are shown in Figure 1.

Stomwater runoff from MassDOT property is conveyed to Proctor Brook through a system of catch basins, drainage pipes, paved swales, and unnamed streams. The MassDOT property directly contributing stormwater runoff to Proctor Brook is illustrated on Figures 2 and 3 and is described below.

The Proctor Brook subwatershed includes a section of Route 128 from the Centennial Drive exit to the Andover Street exit (Rte 114). Stormwater runoff from Route 128 in the vicinity of the

Centennial Drive exit is directed via pipes and paved swales to a large wetland area adjacent to Summit St. It appears that this wetland area was originally intended as a detention basin, but has evolved into a 1.5 acre wetland area that includes dense forest cover. There is no control structure and it appears that all runoff is contained within the wetland area. Runoff flowing to this area is considered an indirect discharge.

Stormwater runoff from a 550-foot long section of Route 128 north of Forest Street and Ellis Street is directed to an extended detention basin located next to Summit Street. The basin is described in detail in the Existing BMPs section of this report. The basin discharges through a control structure to a 24 inch drain pipe that passes under Route 128 and connects to an unnamed stream. The stream passes through a 36 inch culvert and discharges to Proctor Brook. The stormwater runoff entering the basin, and ultimately Proctor Brook, is considered a direct discharge.

Stormwater runoff generated on Route 128 between the detention basin watershed and Lowell Street is conveyed by drain pipes to an unnamed stream and 36 inch culvert (same location as detention basin discharge) that ultimately discharges to Proctor Brook.

Stormwater runoff generated on Route 128 between Lowell Street and the Andover Street exit is collected by catch basins and conveyed through drain pipes to Proctor Brook.

MassDOT owns bridges within the Proctor Brook subwatershed at Endicott Street and Warren Street. Stormwater runoff from the Endicott Street bridge is conveyed by surface drainage and drain pipes to an unnamed stream below the bridge, and is therefore considered an indirect discharge. Stormwater runoff from the Warren Street bridge is collected in catch basins and conveyed by drain pipes in Crowninshield Street and Central Street to Proctor Brook. This is considered a direct discharge.

Assessment under BMP 7U

Six of the impairments for Proctor Brook 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:

- aquatic macroinvertebrate bioassessments
- foam/flocs/scum/oil slicks
- total nitrogen
- total phosphorus
- sedimentation/siltation
- taste and odor

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.

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 Proctor Brook (MA93-39):

Table 1. Site Parameters for Proctor Brook (MA93-39)

Type	Parameter	Quantity	Unit of Measure
Total Watershed	Watershed Area	6,960	acres
Total Watershed	Impervious Cover (IC) Area	2,171	acres
Total Watershed	Percent Impervious	31.2	%
Subwatershed	Watershed Area	2,810	acres
Subwatershed	Impervious Cover (IC) Area	1,012	acres
Subwatershed	Percent Impervious	36.0	%
Subwatershed	IC Area at 9% Goal	253	acres
Subwatershed	Target Reduction % in IC	75.0	%
Reductions Applied to DOT Direct Watershed	MassDOT's IC Area Directly Contributing to Impaired Segment	12.4	acres
Reductions Applied to DOT Direct Watershed	MassDOT's Target Reduction in Effective IC (75.0% of DOT Directly Contributing IC)	9.3	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 75%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 9.3 acres.

Existing BMPs

MassDOT has one existing BMP in the Proctor Brook directly contributing watershed that is mitigating potential stormwater quality impacts prior to discharge to Proctor Brook, as shown in Figure 4. 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 D.

Ex-BMP-1: The stormwater drainage system in Route 128 directs runoff from a roadway subcatchment adjacent to Forest St. to an extended detention basin next to Summit St. The subcatchment is approximately 550 feet long and the midpoint is near Henry Terrace. The BMP watershed is shown on Figure 4. The detention basin measures approximately 330 feet by 110 feet. Water would have to fill to a height of approximately 3.5 feet before flowing out over the spillway. The basin was observed to have standing water and wetland vegetation. This area was characterized as an extended detention basin with an effective IC removal efficiency of 33%, providing a reduction of 0.4 acres of IC.

Ex-BMP-1. Outlet Structure

Ex – BMP-1 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-1	Extended Detention Basin	D	8.0	1.1	33%	0.4

*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 BMP is less than the target reduction of 9.3 acres, MassDOT will consider the implementation of new 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:

- 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, and has a pet waste management program underway to address this source where necessary.
- 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

The Final Pathogen TMDL for the North Coastal Watershed (CN 155.0) covers Proctor Brook and its tributaries. According to the TMDL, the main potential source of fecal coliform contamination in Proctor Brook Harbor is due to CSOs. Sanitary sewer overflows and discharges from MS4 systems are also suspected sources of fecal coliform contamination (MassDEP, 2007).

Unlike other TMDLs that establish pollutant load allocations based on mass per time, many bacteria and pathogen TMDLs in Massachusetts establish bacterial TMDLs that are concentration based and equivalent to the MassDEP water quality standard for the receiving water body. This requirement therefore requires that at the point of discharge to the receiving water, all sources include bacteria concentrations that are equal or less than the MassDEP water quality standard for the receiving water body.

The TMDL prioritized the North Coastal Watershed impaired segments based on a simple approach due to limited source information and data within each segment. Proctor Brook was classified as a high priority segment since its measured fecal coliform concentrations were equal to or greater than 10,000 cfu/100 mL in past water quality monitoring studies.

In general, 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

The TMDL report also indicates that structural BMPs may be appropriate to address runoff from impervious areas in instances where fecal coliform concentrations cannot be reduced by other means.

The following BMPs are specifically identified as being ongoing and/or planned in order to meet the bacteria TMDL for the North Coastal Watershed:

- Study and Rehabilitation of Closed Coastal Shellfishing Beds
- Identification and elimination of illicit sources
- Stormwater runoff management
- Septic tank controls
- Wastewater Treatment Plants
- Recreational waters use management
- Watershed resident education
- Additional monitoring

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

MassDOT believes that existing efforts are consistent with the current and draft MS4 permit requirements and TMDL recommendations in regard to pathogens. MassDOT has documented the locations of its stormwater outfalls. In addition, as part of its pet waste management program, MassDOT has determined that no MassDOT rest stops are located within the subwatershed of this water body. At rest stops that have been identified as being within subwatersheds of water bodies impaired for pathogens, MassDOT will be installing signs informing the public of the need to remove pet waste in order to minimize contributions of pathogens to the impaired water body, and pet waste removal bags and disposal cans will be provided.

The TMDL report identifies that non-structural BMPs should be implemented first, but that structural BMPs may be necessary to address runoff from impervious areas in some instances. MassDOT feels that it is not a beneficial approach to implement structural BMPs in advance of other ongoing BMP efforts identified in the watershed, given the documented variability of pathogen concentrations in highway runoff, and the low probability of achieving substantial gains towards meeting the TMDL with solely implementing IC reductions and controls.

Furthermore, MassDOT has an ongoing inspection and monitoring program aimed at identifying and addressing illicit discharges to MassDOT's stormwater management system. Any illicit discharges to MassDOT's system could contribute pathogens to impaired waters, however, MassDOT's existing Illicit Discharge Detection and Elimination (IDDE) program is aimed at identifying and addressing these contributions. District maintenance staff is trained to conduct regular inspections of MassDOT infrastructure and note any signs of potential illicit discharges, such as dry weather flow and notable odors or sheens. Similarly, resident engineers overseeing construction projects also receive training to note any suspicious connections or flows, and report these for follow-up investigation and action as appropriate. MassDOT will continue to implement this Illicit Discharge Detection and Elimination (IDDE) training, and District staff will continue to report any suspicious flows requiring further investigation. MassDOT investigates any suspicious flows noted, and will work with owners of confirmed illicit discharges to remove these flows, and thereby minimize the possibility of pathogen contributions to receiving waters. At present, there are

Conclusions

MassDOT used the IC Method to assess Proctor 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 9.3 acres to achieve the targeted reduction in effective IC. MassDOT evaluated its property within the directly contributing watershed to Proctor Brook to identify existing BMPs and found that existing BMPs provide 4.5% of the target reduction in effective IC. This information is summarized in Table 3 below.

Table 3. Effective IC Reductions under Existing & Proposed Conditions

Type of Reduction	Quantity	Unit of Measure
IC in Directly Contributing Watershed	12.4	acres
Target Reduction in Effective IC	9.3	acres
IC Effectively Reduced by Existing BMPs	0.4	acres
IC Remaining to Mitigate with Proposed BMPs	8.9	acres

MassDOT should reduce its effective IC within the directly contributing watershed by 8.9 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 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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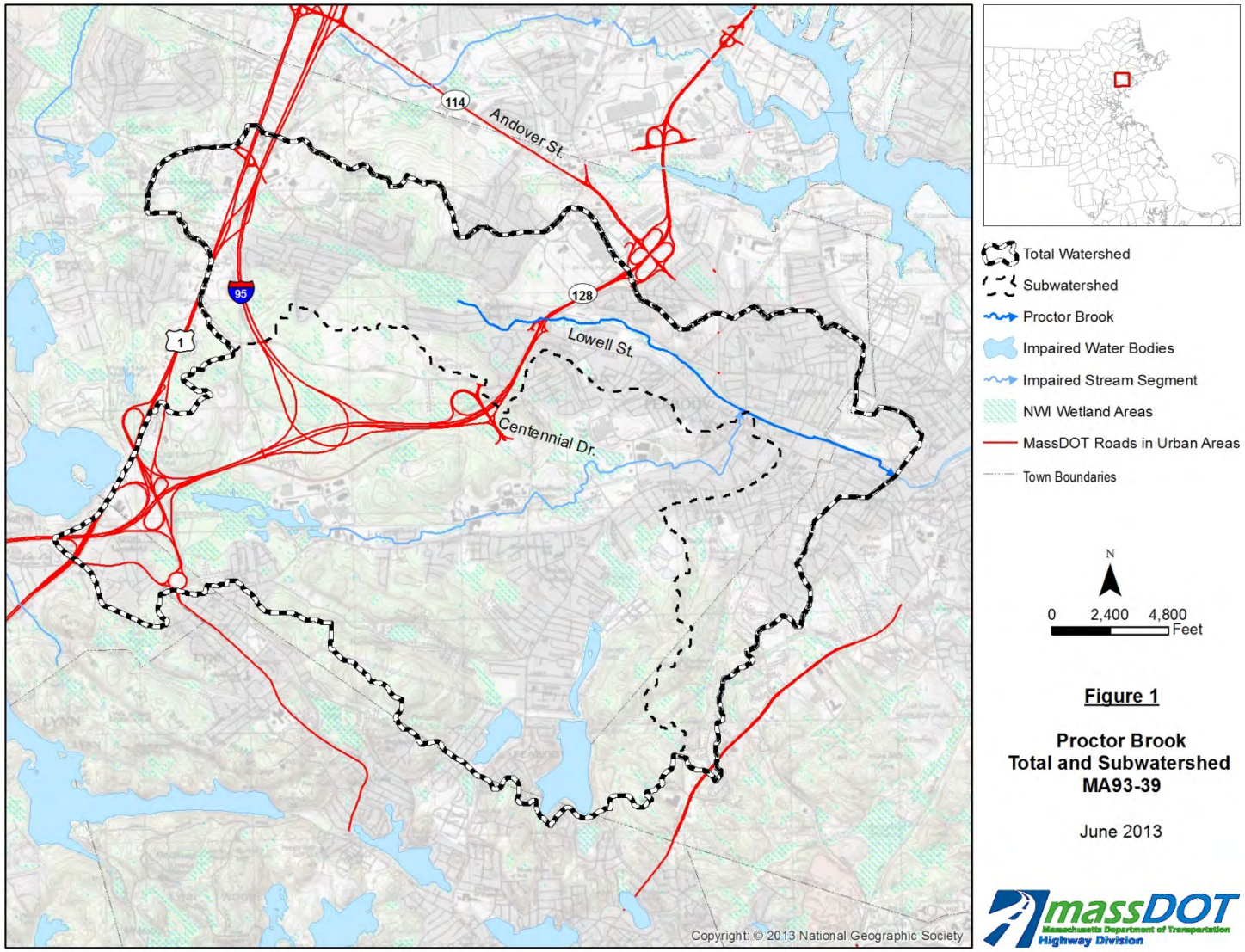
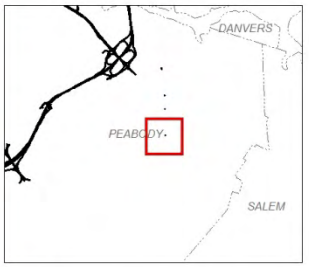


Figure 1

Proctor Brook
Total and Subwatershed
MA93-39

June 2013



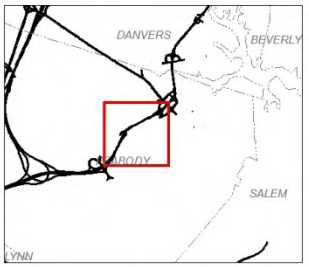
DOT Direct IC Watershed
Proctor Brook
NWI Wetland Areas
MassDOT Roads in Urban Areas
Town Boundaries

N
0 75 150 300
Feet

Figure 2

Proctor Brook (MA93-39)
MassDOT Directly Contributing Watershed
Warren Street Bridge

June 2013



DOT Direct IC Watershed
Proctor Brook
NWI Wetland Areas
MassDOT Roads in Urban Areas
Town Boundaries

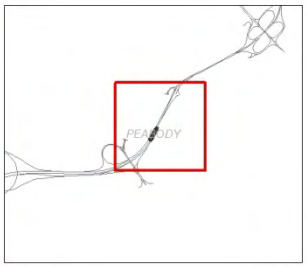
N

0 300 600 1,200 Feet

Figure 3

Proctor Brook (MA93-39)
MassDOT Directly Contributing Watershed
Rte. 128

June 2013



BMP - Extended Detention Basin
BMP Watershed
Proctor Brook
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
Town Boundaries

N

0 100 200 400
Feet

Figure 4

**Proctor Brook (MA93-39)
Existing BMP and
BMP Watershed**

June 2013