

Attachment 6:

Nitrogen Non-TMDL Groundwater Assessments

Attachment 6 includes 5 assessments for water bodies that are nitrogen impaired and are located within a USGS delineated groundwatershed on Cape Cod, Buzzards Bay, or South Coastal Massachusetts.

List of Impaired Water Bodies

MA94-16	Plymouth Harbor
MA96-01	Barnstable Harbor
MA96-15	Boat Meadow River
MA96-33	Herring River*
MA96-88	Cedar Pond*

*Not on Appendix L-1 list.

Impaired Waters Assessment for Plymouth Harbor (MA94-16)

Summary

Impaired Water¹	Stormwater Impairments:	<i>Fecal Coliform; Nutrient/Eutrophication Biological Indicators</i>
	Category:	<i>5 (Waters requiring a TMDL)</i>
	Final TMDLs:	None
	WQ Assessment:	<i>South Shore Coastal Watersheds 2001 Water Quality Assessment Report²</i>
Location	Towns:	<i>Plymouth</i>
	MassDOT Roads:	<i>Route 3A, Plimoth Plantation Highway, Route 3, Route 44, Route 80</i>
Assessment Method(s)	7R (TMDL Method) <input type="checkbox"/>	7U (Non-TMDL Method) <input checked="" type="checkbox"/>
BMPs	Existing:	<i>Nine Wet Ponds</i>
MassDOT Area and Targets	Nitrogen	
	Estimated MassDOT Load:	<i>1,877 lbs/yr</i>
	Reduction Provided by BMP's	<i>112 lbs/yr</i>
	Existing Load to Water Body:	<i>121,340 lbs/yr</i>
	MassDOT Contribution to Existing Load:	<i>1.45 %</i>

Site Description

Plymouth Harbor (MA94-16) is a 2.53 square mile water body extending from the tip of Plymouth Beach, located along a peninsula that separates Plymouth Harbor to the northeast from Plymouth Bay (MA94-17), to High Cliff along the coastline in Plymouth, Massachusetts. Duxbury Bay

¹ MassDEP, March 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. Massachusetts. Available at: <http://www.mass.gov/eea/docs/dep/water/resources/07v5/12list2.pdf>

² MassDEP, March 2006. South Shore Coastal Watersheds 2001 Water Quality Assessment Report. Available at: <http://www.mass.gov/eea/docs/dep/water/resources/71wqar09/94wqar2.pdf>

(MA94-15) is located immediately to the north of Plymouth Harbor and is hydrologically connected with Plymouth Harbor. Figure 1 illustrates the groundwatershed for Plymouth Harbor (MA94-16), which spans Plymouth and Kingston, Massachusetts.

Plymouth Harbor (MA94-16) is located within a USGS-delineated groundwatershed rather than in a surface watershed. The watersheds for Cape Cod and adjacent Southeastern Massachusetts Communities were provided by USGS based on groundwater modeling and contributing groundwater areas as delineated and published in the USGS 451 groundwater contributing areas data.^{3,4} Cape Cod and adjacent Southeastern Massachusetts Communities are based on groundwater delineations and not ground surface topography.⁴ The USGS groundwatersheds for portions of the South Shore Coast, including this impaired segment, were slightly modified by MassDEP.² The MassDEP modified version was used for this assessment. For groundwatershed assessments with impairments related to nitrogen, if a discharge occurs inside the groundwatershed boundary, it is considered to be a discharge that contributes to the impaired segment. If the discharge point is outside of the groundwatershed boundary, it is not considered to contribute to the impaired segment. MassDOT property within the urban area and within the groundwatershed area is considered in this assessment as contributing to Plymouth Harbor (MA94-16).

MassDEP's Water Quality Assessment Report titled South Shore Coastal Drainage Areas 2001 Water Quality Assessment Report² lists the Aquatic Life as "impaired" due to total nitrogen. The suspected sources of nitrogen are municipal point source discharges, discharges from municipal separate storm sewer systems (MS4s), and municipal urbanized high density area. Shellfish Harvesting Use was also listed as "impaired". The report states that the known cause of the impairment is elevated fecal coliform bacteria. The suspected sources of bacteria include discharges from MS4s and municipal point source discharges. Additionally, the town of Plymouth is a Phase II community that has permit coverage under the NPDES MS4 program (MAR041150). The permit requires the town of Plymouth to develop, implement, and enforce a stormwater management program and to reduce the discharge of pollutants from their system. The Primary and Secondary Contact Recreational Uses and Aesthetics were also assessed and given a status of "support". The Fish Consumption Use was not assessed.

MassDOT property within the watershed of Plymouth Harbor includes Route 3, Plimoth Plantation Highway, Route 3A, Route 44, and Route 80 (Figure 1).

Route 3 traverses the groundwatershed in a south-east to north-west direction, on the west side of Plymouth Harbor (Figures 2a, 2c-2e). Route 44 is located west of Plymouth Harbor (Figures 2a-2c), and coincides with Route 3 between Exit 6 and Exit 7. The majority of the runoff from Route 44 is collected with catch basin networks and directed to eight wet ponds which are located within the on-off ramps from Commerce Way to Route 44, along Route 44 between Commerce Way and Route 3, and at the interchange with Route 3 at Exit 7. These wet ponds also receive runoff from a portion of Route 3 from Exit 7 to the northern boundary of the Plymouth Harbor groundwatershed (Figure 2a). Another wet pond is located at Exit 6 of Route 3, within the on ramp from Samoset Street to Route 3 southbound (Figure 2c). As shown in Table 1, nitrogen from the contributing areas is partially treated in the wet ponds. The remaining nitrogen travels via groundwater flow to Plymouth Harbor. Runoff from the remaining portion of Route 3 (Figures 2a, 2d, 2e) is collected with catch basins and discharges to depressions along the road where it infiltrates within the Plymouth Harbor groundwatershed.

³ USGS. (2009). Groundwater contributing areas for Cape Cod and Plymouth-Carver Regions of Massachusetts. Data Series 451 (1 of 3).

⁴ Walter, D.A., Masterson, J.P., and Hess, K.M., 2004, Ground-Water Recharge Areas and Travel times to Pumped Wells, Ponds, Streams, and Coastal Water Bodies, Cape Cod, Massachusetts, Scientific Investigations Map I-2857, 1 sheet. Available at: <http://pubs.water.usgs.gov/sim20042857>.

Route 3A is located approximately 0.12 miles south of Plymouth Harbor. Runoff from the northern portion of Route 3A from Sandwich Road to a high point near the intersection of Plimoth Plantation Access Road with Route 3A is collected with catch basins which discharge to depressions along Route 3A within the groundwater watershed of Plymouth Harbor (Figures 2f, 2g). Runoff from the southern portion of Route 3A from Plimoth Plantation Access Road to the southern end of the urban section of Route 3A, and the intersection with Plimoth Plantation Highway (Figure 2f) is collected with a complex catch basin network which discharges at multiple locations into Eel River (MA94-23), and ultimately discharges to Plymouth Harbor. Runoff from Route 3A from the northern groundwater watershed boundary to the intersection of Route 3A with Boundary Lane (Figure 2i) is collected with catch basins and discharged within the groundwater watershed of Plymouth Harbor.

Plimoth Plantation Highway is located south of Plymouth Harbor and connects Route 3A with Route 3 (Figures 2e, 2f). Runoff from Plimoth Plantation Highway is collected with catch basin networks that discharge within the Plymouth Harbor groundwater watershed and ultimately discharge to Plymouth Harbor via groundwater flow.

Route 80 is located west of Plymouth Harbor (Figure 2h). Runoff from Route 80 is collected with catch basins and discharged along the road where infiltrates into the ground and travels to Plymouth Harbor via groundwater flow.

Portions of Route 3 and Route 3A south of Plymouth Harbor (Figure 1) exit the urban area and are therefore considered non-contributing to the nitrogen load for Plymouth Harbor groundwater watershed. In addition, portions of Route 44 and Route 80 portions of Route 6 are located within Zone II Wetland Protected Areas.

Existing BMPs

MassDOT identified nine existing BMPs in place with the potential to treat roadway runoff from the discharging area before reaching the impaired water segment. All BMPs are wet ponds within the Plymouth Harbor (MA94-16) groundwater watershed.

A wet pond (BMP 1) is located within the on-ramp of Route 44 to Route 3. This BMP receives runoff from the on-ramp of Route 44 to Route 3 south bound, and a section of Route 3 (Figure 2c).

Six other wet ponds (BMPs 2 - 6) are located in a depressed area at the interchange of Route 44 to Route 3 (Exit 7 on Route 3). These BMPs receive runoff from a section of Route 3, Route 44 north bound on-ramp, Route 3 south bound on ramp, and a section of Route 44 (Figure 2a).

A wet pond (BMP 7) is located on the north side of Route 44 (Figure 2a) which receives runoff from both west bound and east bound of Route 44 from a high point in the vicinity of Commerce Way to the interchange with Route 3.

Two other wet ponds (BMPs 8 and 9) are located within the on- and off- ramps of Route 44 to Commerce Way. They receive and treat runoff from the on- and off- ramps at this exit (Figure 2b).

Assessment

In cases where a TMDL has been approved, MassDOT assesses the water body for the impairments covered by the TMDL under the BMP 7R methodology.⁵ MassDOT separately assesses the water body for any stormwater-related impairments that are not covered by the TMDL under the BMP 7U methodology.⁶ MassDOT assessed Plymouth Harbor (MA94-16) using the methodologies described below.

This assessment has been completed based on the *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*.¹ MassDEP has released a proposed *Massachusetts Year 2014 Integrated List of Waters*, which has been reviewed for any proposed changes to the condition of the water bodies.⁷ The condition of Plymouth Harbor is not proposed to change.

BMP 7U for Pathogen Impairment

MassDOT assessed the indicator bacteria (fecal coliform) impairment using the approach described in BMP 7U of MassDOT's Stormwater Management Plan (SWMP) which applies to impairments that have been assigned to a water body not covered by a final TMDL. MassDOT included a review of the *Draft Pathogen Total Maximum Daily Load (TMDL) for the South Coastal Watershed* as an informational review as part of this assessment even though, due to their draft status, draft TMDLs are not formally part of the Impaired Waters Retrofit program.⁸

Pathogen concentrations in stormwater vary widely and concentrations can vary by an order of magnitude within a given storm event at a single location making it difficult to predict pathogen concentrations in stormwater with accuracy. MassDOT generally will not conduct site specific assessments of pathogen loading for each water body impaired for pathogens but instead developed an iterative adaptive management approach to address impaired waters and permit condition requirements and an approach to stormwater management. Greater detail of the assessment methodology is provided in MassDOT's BMP 7U Pathogen Methodology.⁹

The *Draft Pathogen Total Maximum Daily Load (TMDL) for the South Coastal Watershed* identified various sources of fecal contamination. Dry weather sources include animal feeding operations, animal grazing in riparian zones, leaking sewer pipes, stormwater drainage systems (illicit connections), failing septic systems, wildlife, recreational activities, and illicit boat discharges. Wet weather sources include wildlife and domesticated animals, stormwater runoff including MS4s, combined sewer overflows (CSOs), and sanitary sewer overflows (SSOs).

Section 7.0 of the Draft Pathogen TMDL discussed the need to eliminate sewer connections to drainage systems, leaking sewer pipes, SSOs, and failing septic systems. A program is needed

⁵ MassDOT, July 2010. BMP 7R: TMDL Watershed Review. Available at:

http://www.massdot.state.ma.us/Portals/8/docs/environmental/npdes/BMP_7R_TMDL_WatershedReview.pdf

⁶ MassDOT, April 2010. BMP 7U: Water Quality Impaired Waters Assessment and Mitigation Plan. Available at:

http://www.massdot.state.ma.us/Portals/8/docs/environmental/npdes/BMP_7U_ImpairedWaterbodiesAssessment.pdf

⁷ MassDEP, June 2014. Massachusetts Year 2014 Integrated List of Waters – Proposed Listing of the Condition of Massachusetts' Waters Pursuant to Sections 305(b), 314 and 303(d) of the Clean Water Act. Massachusetts. Available at: <http://www.mass.gov/eea/docs/dep/water/resources/07v5/14iwlisp.pdf>

⁸ MassDEP. Draft Pathogen TMDL for the South Coastal Watershed. Available at <http://www.mass.gov/eea/docs/dep/water/resources/n-thru-y/scoastl1.pdf>

⁹ MassDOT, December 2014. Description of MassDOT's Application of BMP 7U for Pathogen Related Impairments. Available at:

<http://www.massdot.state.ma.us/Portals/8/docs/environmental/impairedWaters/Year5/Attachment5.pdf>

to identify sources and encourage responsible entities to take corrective actions. Due to the impact of stormwater runoff on pathogen levels, the Draft Pathogen TMDL recommends intensive application of non-structural BMPs throughout the watershed. Structural controls may be necessary if non-structural BMPs are not successful. The report recommends a basin-wide implementation strategy to eliminate illicit sources and implement stormwater BMPs.

The following BMPs are specifically identified as being ongoing and/or planned in order to meet the bacteria TMDL for the South Coastal watershed, which includes the Plymouth Harbor:

- Agricultural BMPs
- Illicit discharge detection and elimination
- Implementation of stormwater management plans by MS4s
- Septic system upgrades
- Waste water Treatment Plant (WWTP) BMPs to meet effluent limits
- Watershed resident education
- Additional monitoring

BMP 7U for Nitrogen

MassDOT assessed the contribution of nitrogen from MassDOT properties to this water body using the approach described in BMP 7U⁶ of MassDOT's Storm Water Management Plan (Water Quality Impaired Waters Assessment and Mitigation Plan), which applies to impairments that have not been addressed by a TMDL, and MassDOT's application of BMP 7U to nitrogen in groundwater-controlled watersheds.¹⁰ MassDEP's Water Quality Assessment Report titled *South Shore Coastal Drainage Areas 2001 Water Quality Assessment Report*² lists the Aquatic Life as "impaired" due to total nitrogen. Nitrogen loading was determined using a mass accounting approach as described in the BMP 7U for nitrogen methodology.

For the nitrogen assessment under BMP 7U, MassDOT used USGS modeling to estimate annual pollutant loads from its property. Based on the USGS SELDM, which was run using an average of precipitation data from the New Bedford and Blue Hills sites and an average of water quality data from Harwich and Marion, MassDOT estimates the nitrogen loading from impervious areas as 7.6 lbs/acre/yr and from pervious areas as 2.5 lbs/acre/yr. The nitrogen loading for MassDOT property in the contributing area is summarized below:

- MassDOT Impervious Area: 171.0 acres
- MassDOT Pervious Area: 231.3 acres
- Estimated Existing MassDOT Load: 1,877.4 lbs/yr

MassDOT estimated the pollutant load reduction provided by existing BMPs by applying treatment reductions to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from different sources depending on the BMP and engineering judgment as described in the Application of BMP 7U to Nitrogen in Groundwater-Controlled Massachusetts Watersheds.

¹⁰ MassDOT, December 2014. Application of BMP 7U to Nitrogen in Groundwater-Controlled Massachusetts Watersheds. Available at: <http://www.massdot.state.ma.us/Portals/8/docs/environmental/impairedWaters/Year5/Attachment7.pdf>

Table 1 Annual MassDOT Groundwatershed Nitrogen Loading under Existing Conditions

BMP ID (TYPE)	Contributing Watershed Size (acres)	Pre-BMP Annual Load (lbs/yr)	BMP Pollutant Load Reduction (lbs/yr)	Post-BMP Annual Load (lbs/yr)	Estimated Annual Removal Efficiency
Existing BMP 1 (Wet Pond)	4.4	33.4	8.3	25.0	25%
Existing BMPs 2-9* (Wet Ponds)	54.5	414.3	103.6	310.7	25%
Total	58.9	447.7	111.9	335.7	N/A

*BMPs 2-9 are grouped for purposes of calculating pollutant load reduction because together they treat stormwater runoff from portions of Route 44 and associated on and off ramps.

Based on the reductions summarized above, MassDOT estimates its post-BMP nitrogen load as summarized below:

- Reduction provided by BMPs: 112 lbs/yr
- Remaining MassDOT Load after Accounting for BMPs Reduction: 1,765 lbs/yr
- Total Existing Groundwatershed Nitrogen Load: 121,340 lbs/yr
- MassDOT Existing Load as a Percentage of Total Groundwatershed Nitrogen Load: 1.45 %

The MassDOT existing load compared to the total groundwatershed nitrogen load is very small and considered negligible based on MassDOT's Nitrogen TMDL Method because it is less than 3.5% of the total nitrogen groundwatershed load. In general, in areas where the MassDOT load is determined to be negligible, MassDOT does not implement BMPs under the Impaired Waters Program (IWP) because of their minimal impact on the overall groundwatershed load.

Proposed Mitigation Plan

As described above, MassDOT's nitrogen contribution to the receiving water is negligible. Therefore, MassDOT has no plans to implement structural BMPs to control nitrogen in stormwater runoff from their property under the Impaired Waters Program.

With respect to the fecal coliform impairment, 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. As discussed in MassDOT's BMP 7U Pathogen Methodology, MassDOT believes that existing efforts are consistent with the current and draft MS4 permit requirements in regard to pathogens.

In addition, as part of its pet waste management program, MassDOT has determined that a MassDOT targeted rest stop is located within the subwatershed of this water body. The rest stop is located on the south bound of Route 3, before the intersection of Route 3 with Plimoth Plantation highway (Figure 1, Figure 2c). MassDOT will be installing signs at rest stops within the subwatersheds of pathogen impaired waterbodies. The signs will inform the public of the need to remove pet waste, which can minimize contributions of pathogens to stormwater runoff. Pet waste removal bags and disposal cans will be provided.

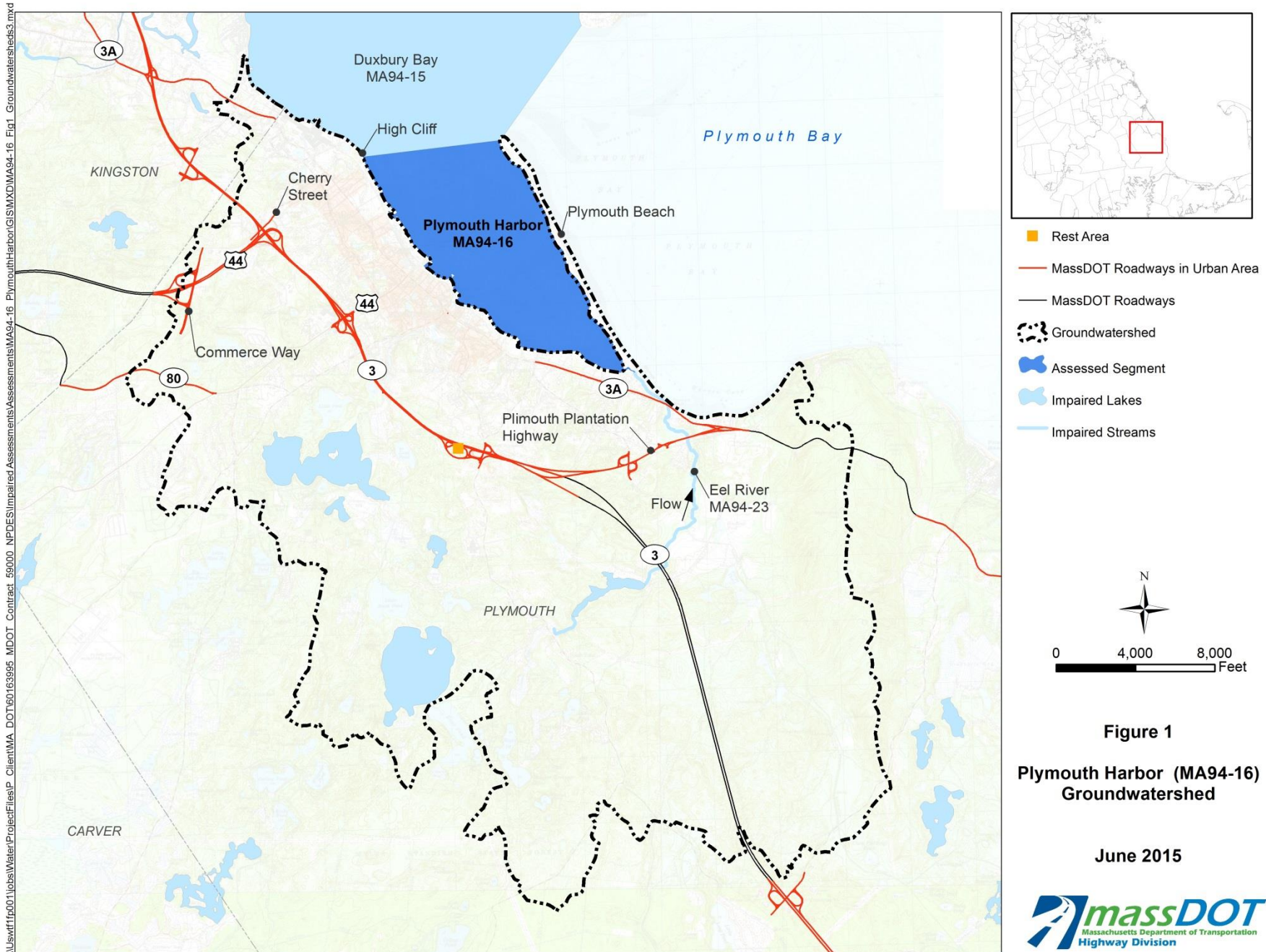
Although the Draft Pathogen TMDL report identifies the benefits of non-structural BMPs and structural BMPs, MassDOT feels that it is not a beneficial approach to implement these BMPs in advance of other ongoing BMP efforts identified in the watershed, given the documented variability of pathogen concentrations in highway runoff, and the low probability of achieving substantial gains towards meeting the TMDL with solely implementing stormwater controls.

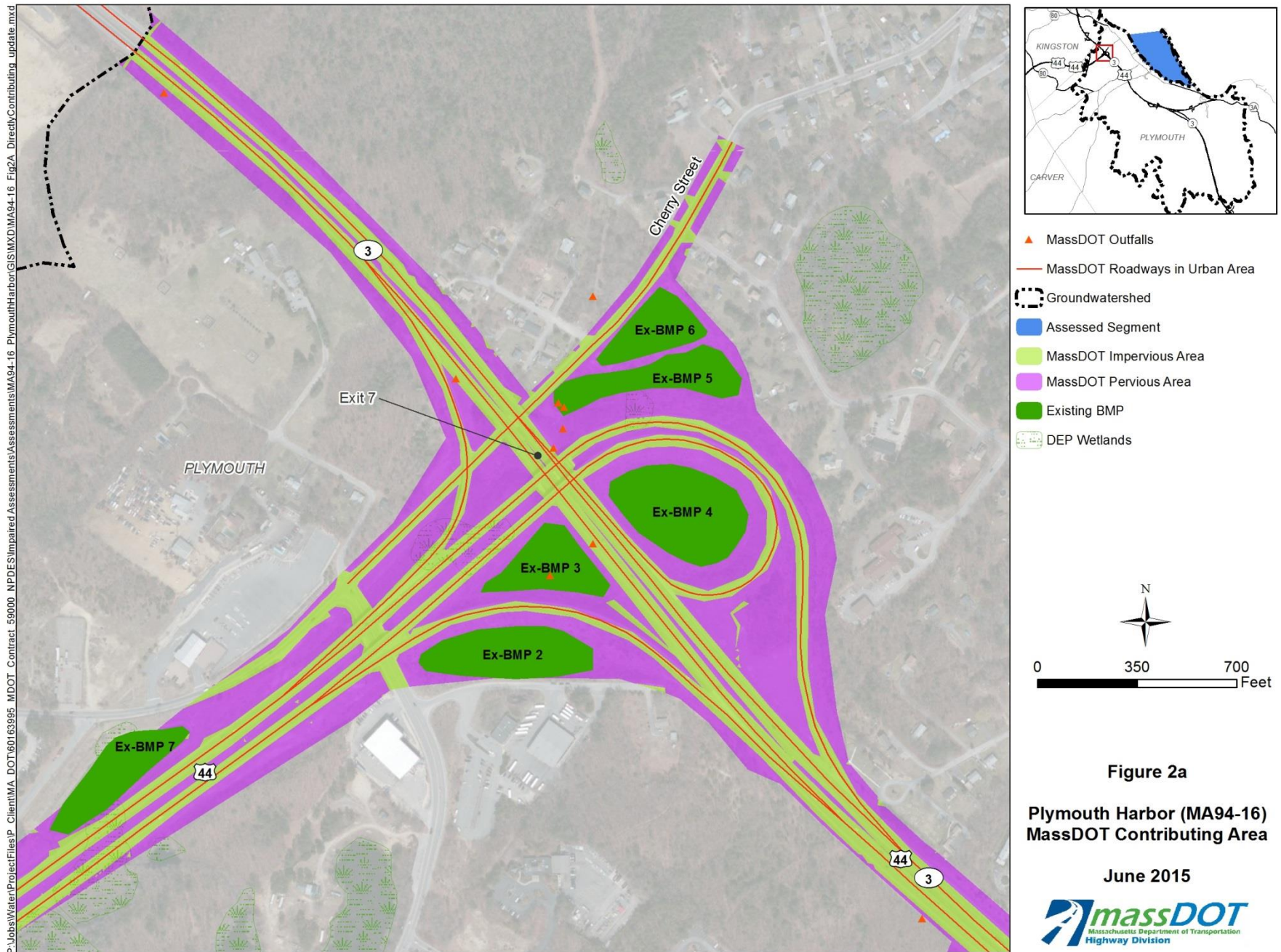
Furthermore, MassDOT has an ongoing inspection and monitoring program aimed at identifying and addressing illicit discharges to MassDOT's stormwater management system. MassDOT investigates any suspicious flows noted, and will work with owners of confirmed illicit discharges to remove these flows, and 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 groundwatershed of this water body that could be contributing pathogens to the impaired water body.

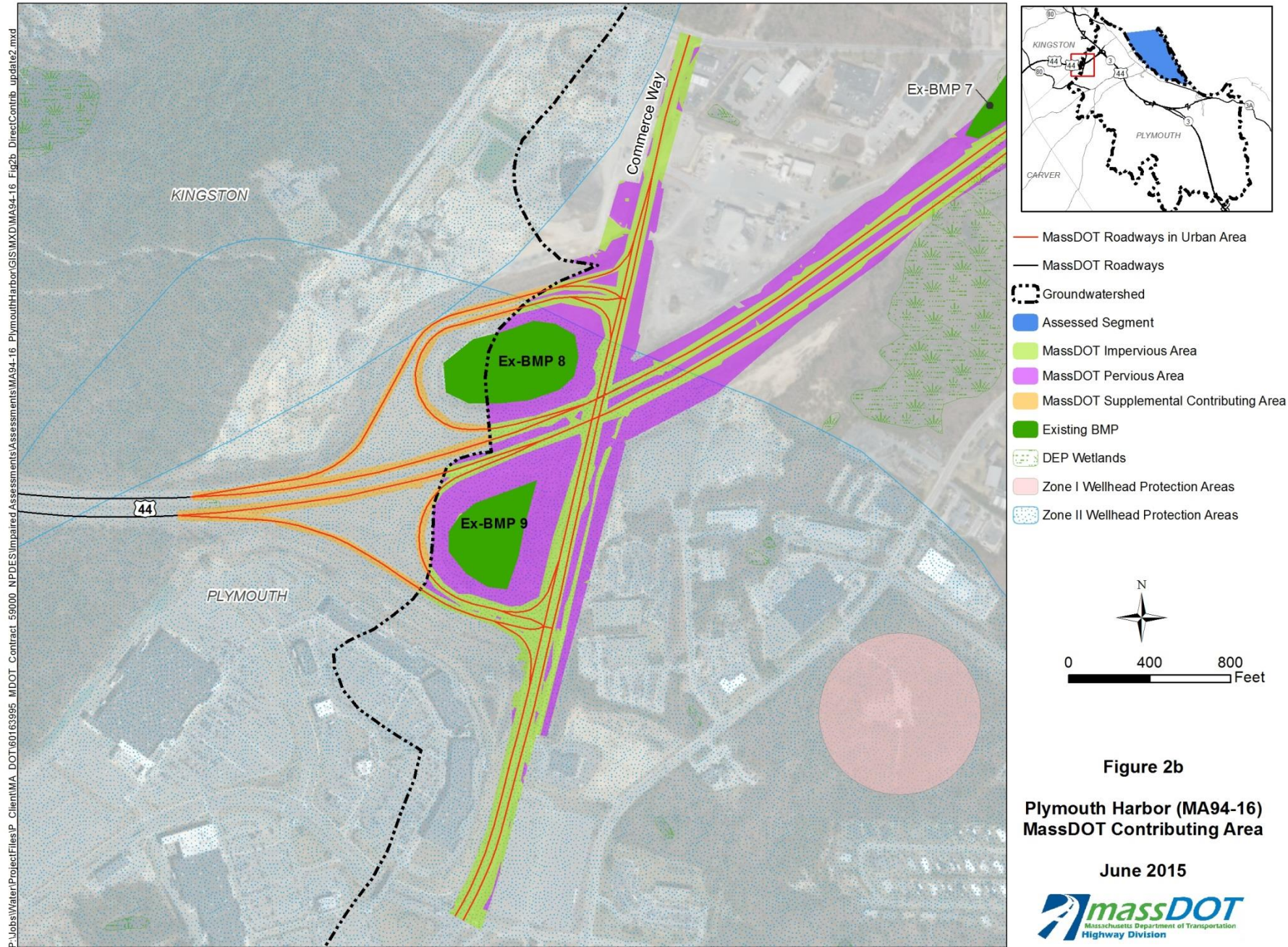
MassDOT has concluded that the BMPs outlined in the SWMP are consistent with its existing permit requirements for Plymouth Harbor. These measures achieve pathogen reductions (including fecal coliform) to the maximum extent practicable and are consistent with the intent of its existing stormwater permit. Pathogen loadings are highly variable and although there is potential for stormwater runoff from MassDOT roadways to be a contributing source it is unlikely to warrant action relative to other sources of pathogens in the groundwatershed.

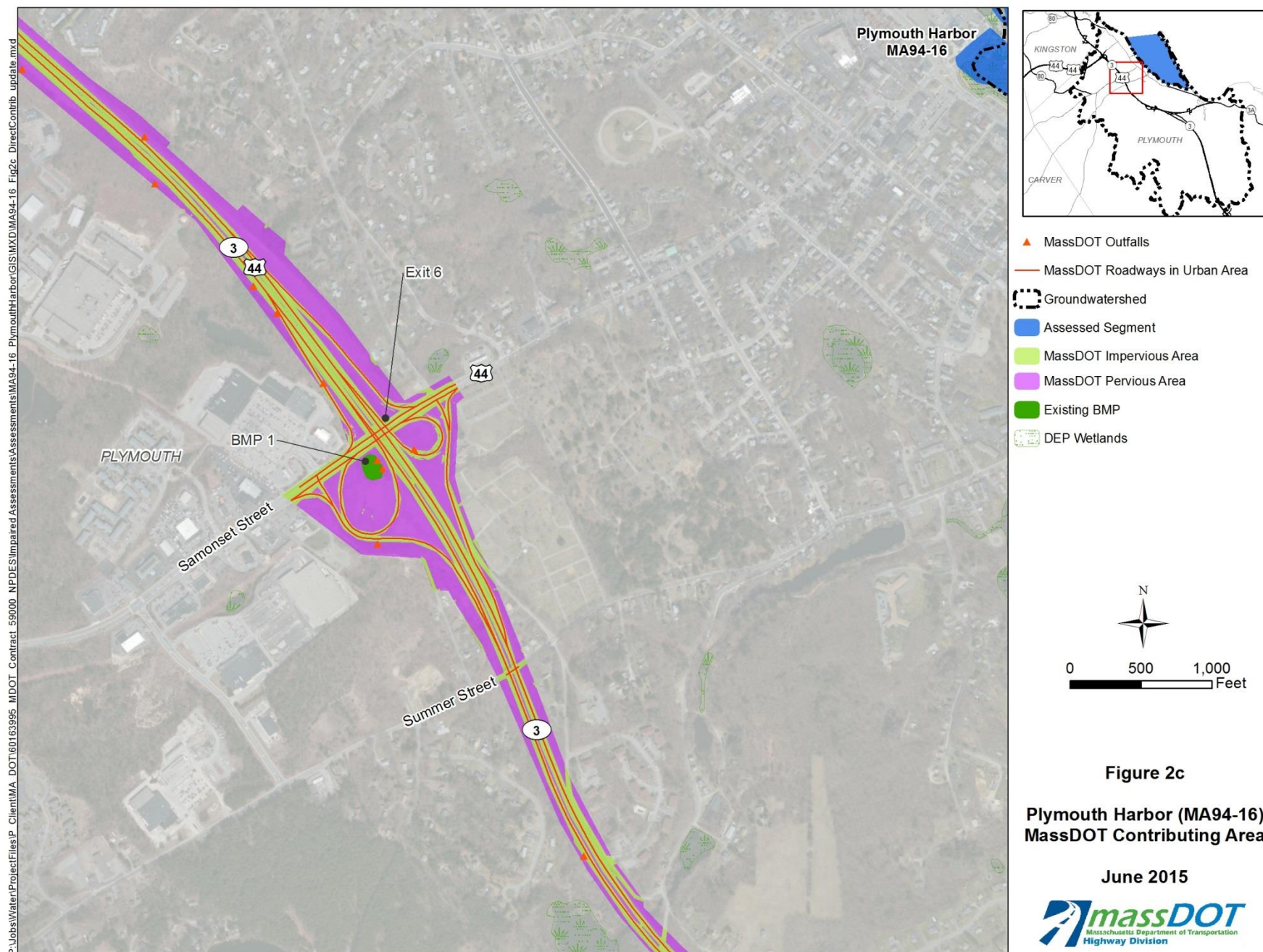
MassDOT will continue to ensure proper non-structural BMPs are being implemented within the groundwatershed of Plymouth Harbor, including regular roadway and drainage system maintenance, erosion and sedimentation control, and outreach and education. As described in MassDOT's Stormwater Handbook,¹¹ MassDOT does not use nitrogen based fertilizers as part of normal operations and maintenance procedures. In the rare circumstance where fertilizers are used, it is for the occasional vegetation establishment associated with recent ground disturbance. Further work by MassDOT on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to address impairments. MassDOT will include an update in NPDES permit annual reports to EPA regarding proposed BMP design either through retrofit or programmed projects, plans for construction of BMPs, reduction achieved by finalized BMP designs and progress made towards meeting target reductions.

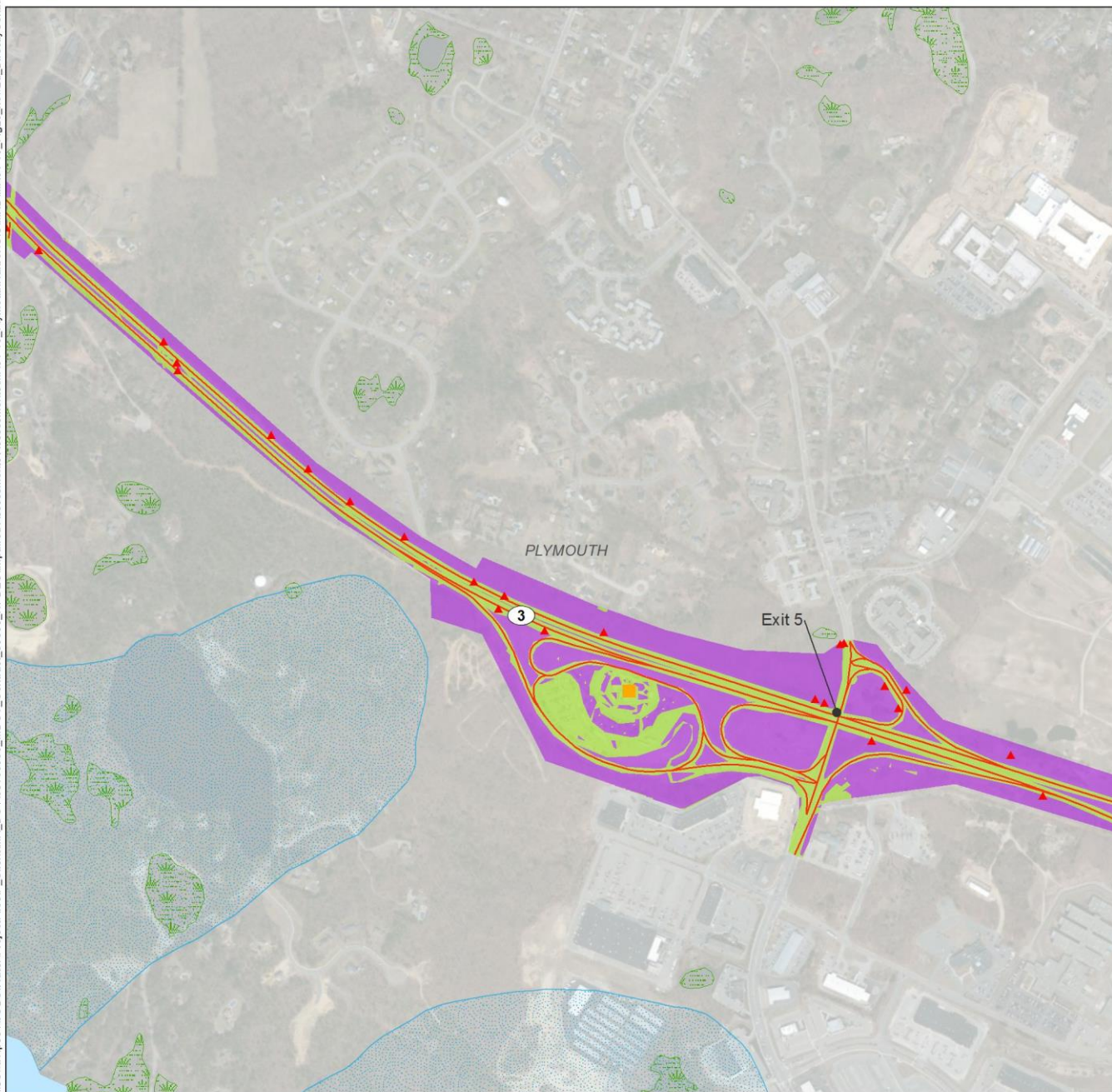
¹¹ MassDOT, May 2004. The MassHighway Storm Water Handbook for Highways and Bridges. Available at: http://www.massdot.state.ma.us/Portals/8/docs/environmental/wetlands/Stormwater_Handbook.pdf











- Rest Area
- MassDOT Outfalls
- MassDOT Roadways in Urban Area
- Assessed Segment
- Impaired Lakes
- MassDOT Impervious Area
- MassDOT Pervious Area
- DEP Wetlands
- Zone II Wellhead Protection Areas

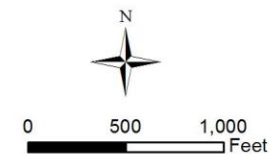
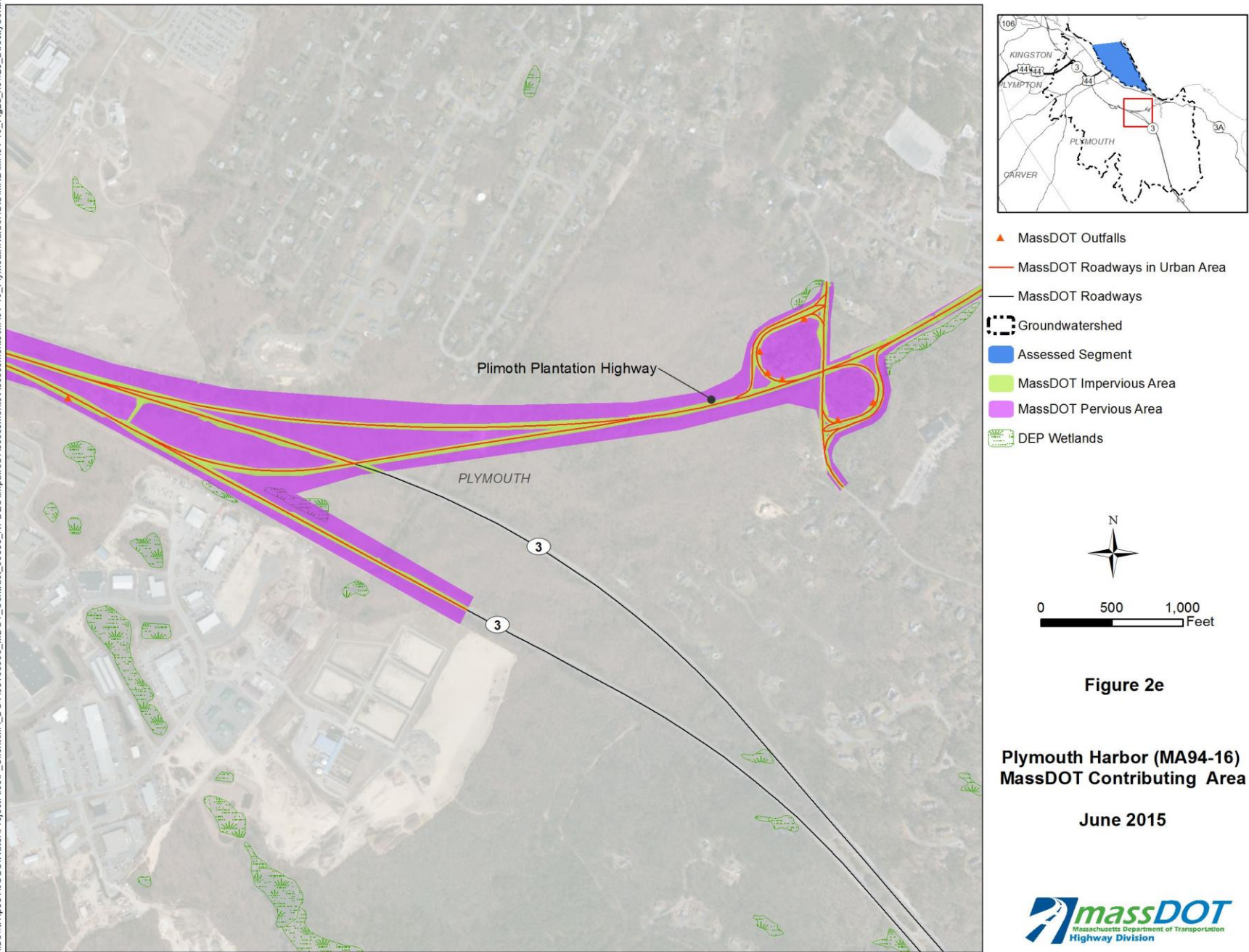


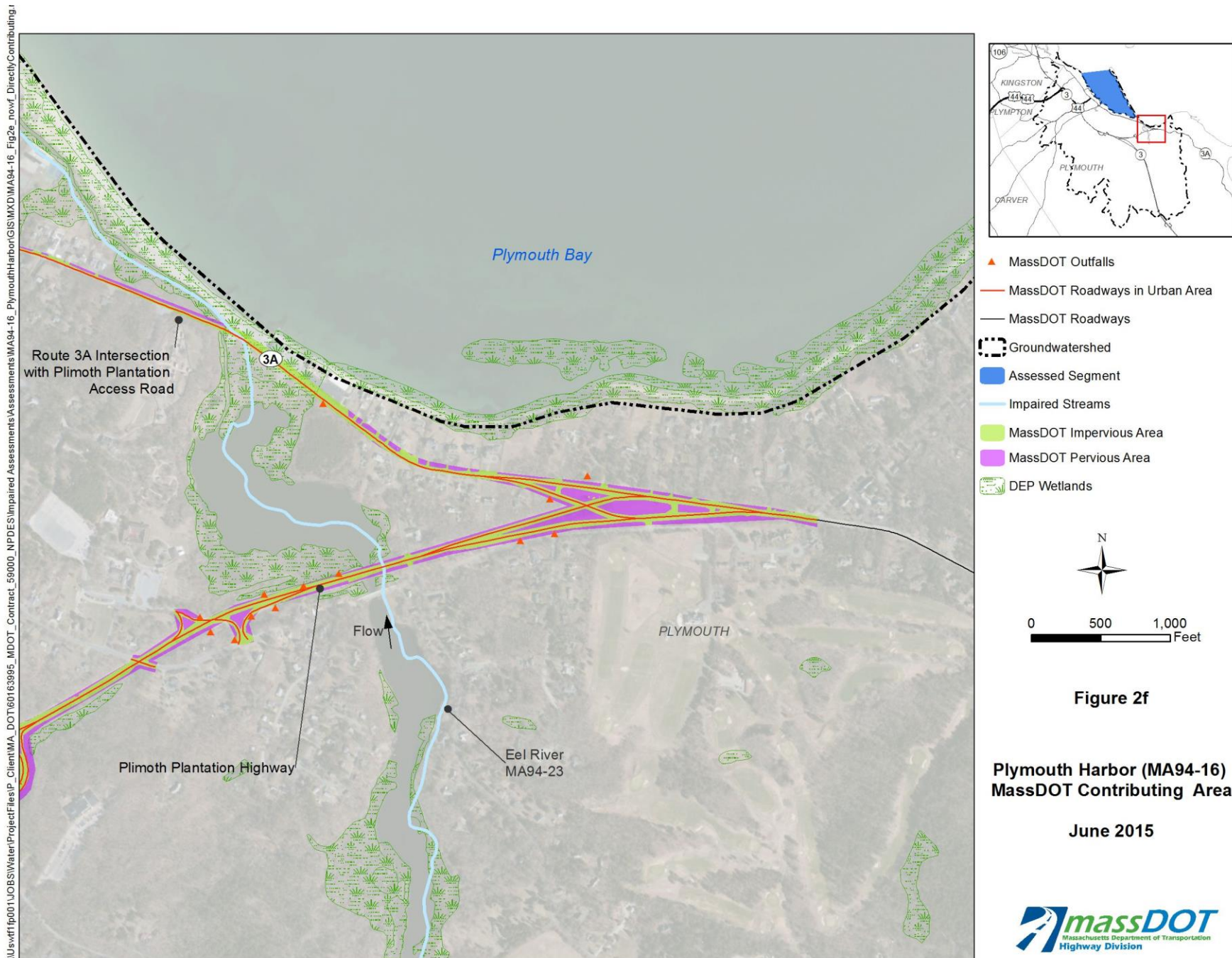
Figure 2d

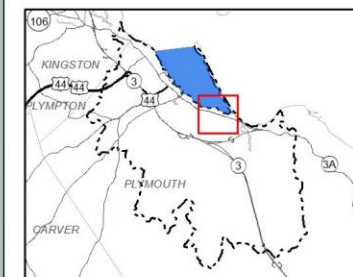
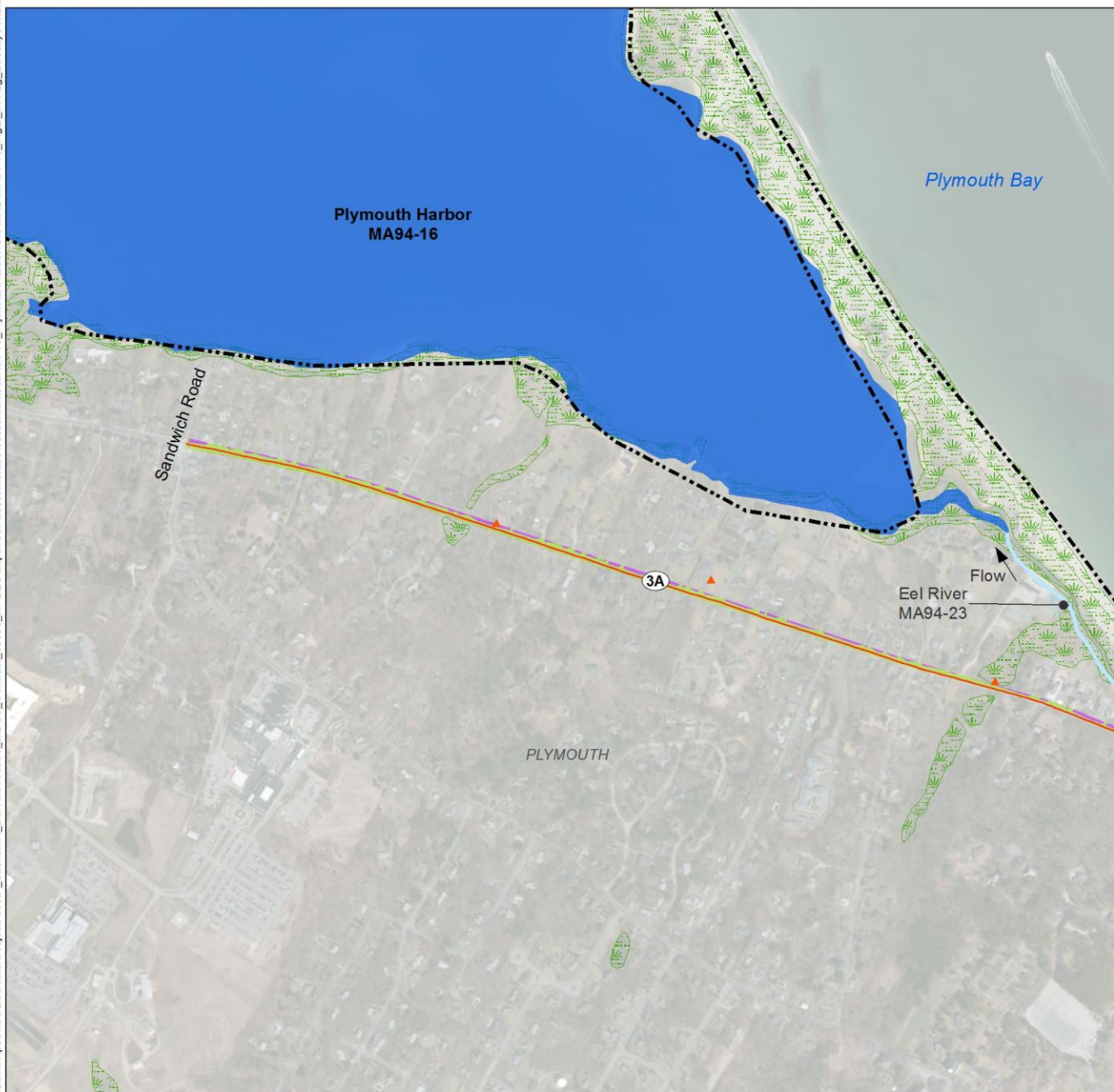
**Plymouth Harbor (MA94-16)
MassDOT Contributing Area**

June 2015









- ▲ MassDOT Outfalls
- MassDOT Roadways in Urban Area
- ⬡ Groundwatershed
- Assessed Segment
- Impaired Streams
- MassDOT Impervious Area
- MassDOT Pervious Area
- DEP Wetlands

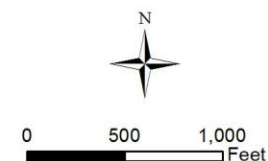
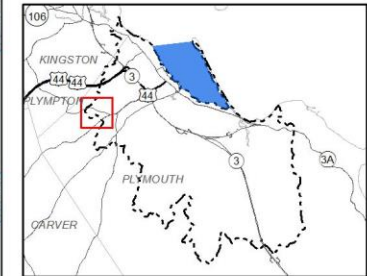
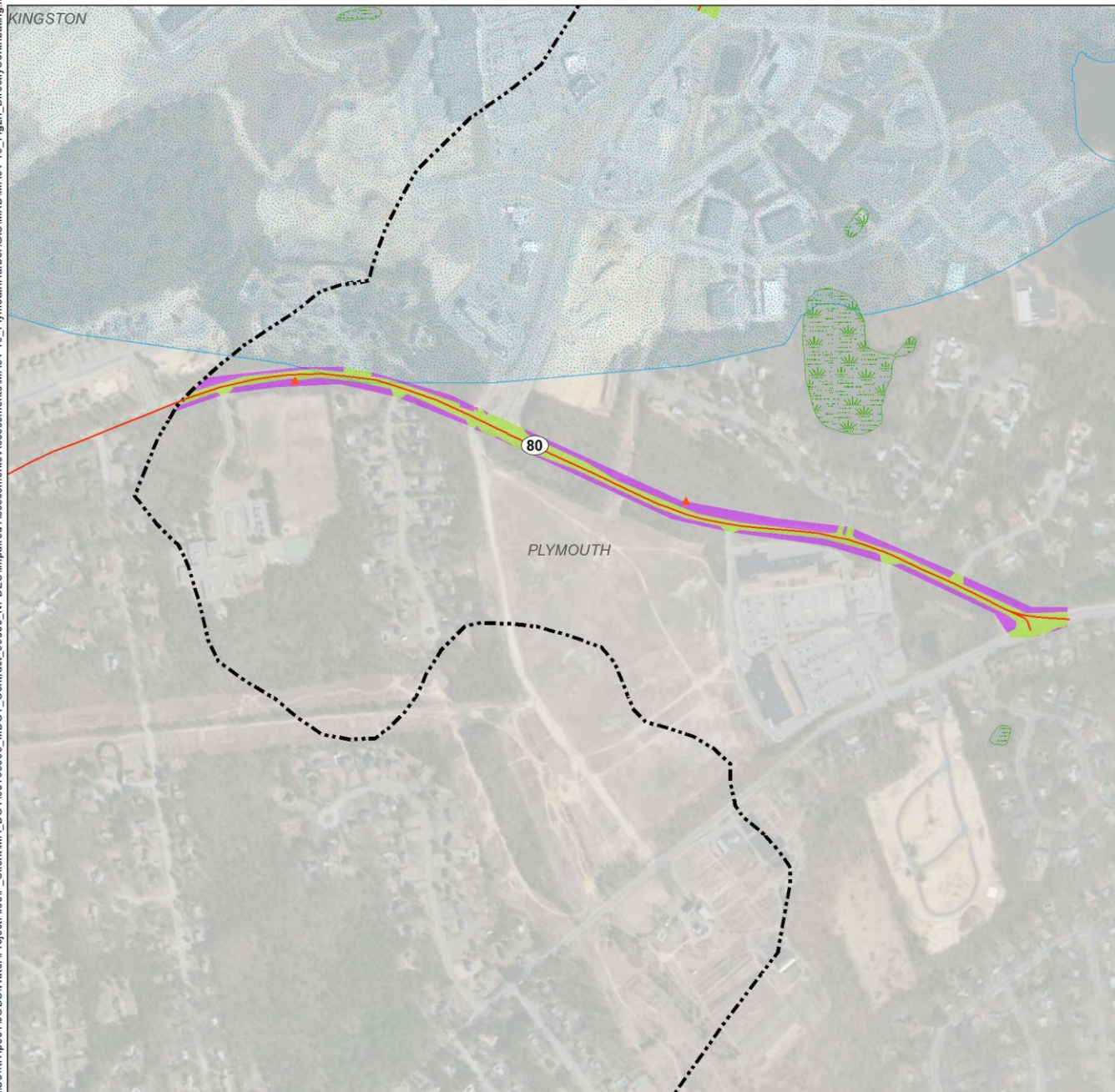


Figure 2g

**Plymouth Harbor (MA94-16)
MassDOT Contributing Area**

June 2015





- ▲ MassDOT Outfalls
- MassDOT Roadways in Urban Area
- ⬡ Groundwatershed
- Assessed Segment
- MassDOT Impervious Area
- MassDOT Pervious Area
- DEP Wetlands
- Zone II Wellhead Protection Areas

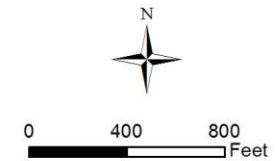


Figure 2h

**Plymouth Harbor (MA94-16)
MassDOT Contributing Area**

June 2015



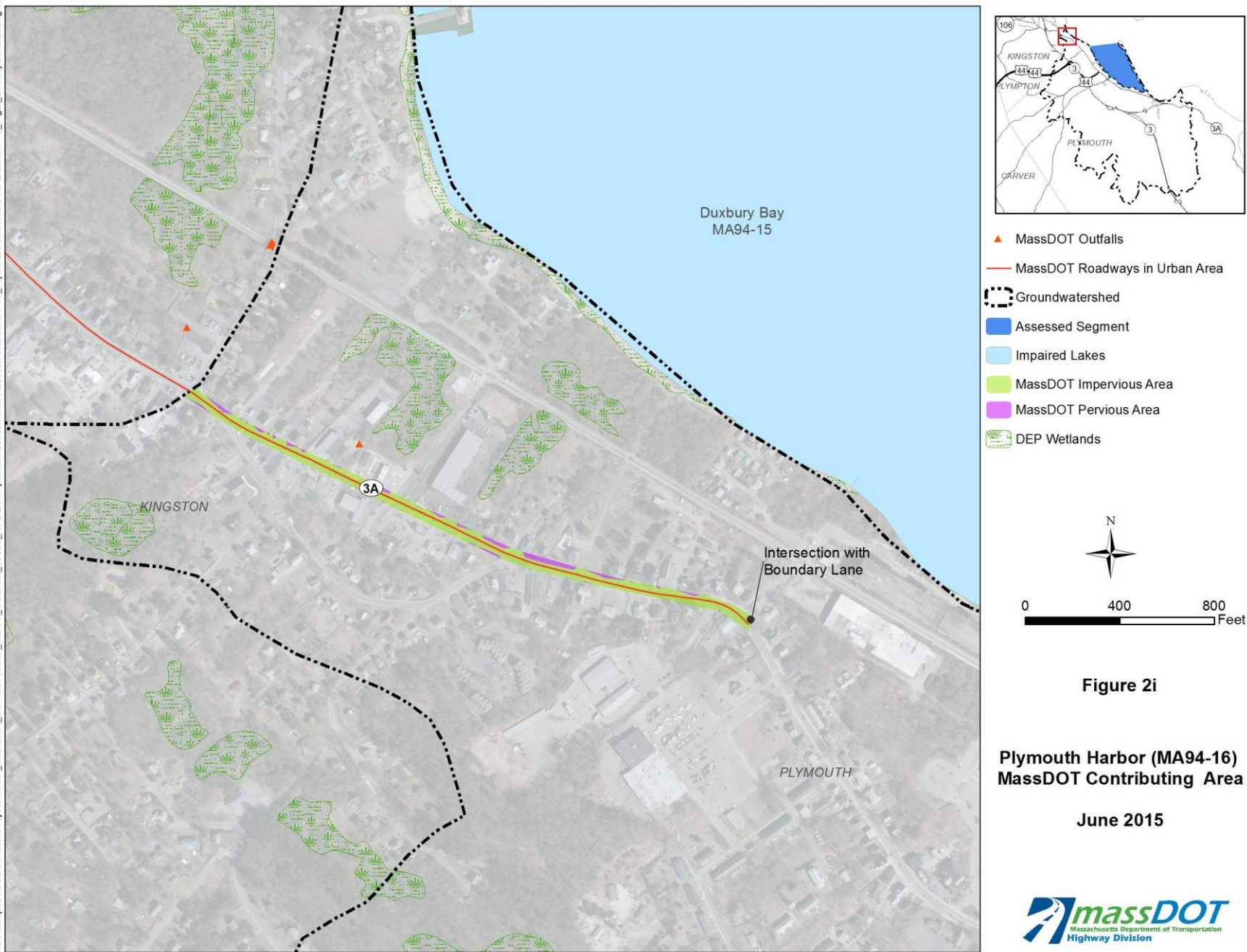


Figure 2i

Plymouth Harbor (MA94-16)
MassDOT Contributing Area

June 2015



Impaired Waters Assessment for Barnstable Harbor (MA96-01)

Summary

Impaired Water¹	Stormwater Impairments:	<i>Estuarine Bioassessments and Fecal Coliform</i>
	Category:	<i>5 (Waters requiring a TMDL)</i>
	Final TMDLs:	<i>Final Pathogen TMDL for the Cape Cod Watershed²</i>
	WQ Assessment:	<i>Cape Cod Coastal Drainage Areas 2004-2008 Surface Water Quality Assessment Report³</i>
Location	Towns:	<i>Barnstable</i>
	MassDOT Roads:	<i>Route 6, Route 6A, Route 132, and Phinneys Lane</i>
Assessment Method(s)	7R (TMDL Method) <input checked="" type="checkbox"/>	7U (Non-TMDL Method) <input checked="" type="checkbox"/>
BMPs	Existing:	<i>None</i>
MassDOT Area and Targets		Nitrogen
	Estimated MassDOT Load:	<i>1,794 lbs/yr</i>
	Existing Load to Water Body:	<i>96,029 lbs/yr</i>
	MassDOT Contribution to Existing Load:	<i>1.87 %</i>

Site Description

Barnstable Harbor (MA96-01) is a 3.2 square mile water body located in the Town of Barnstable. Barnstable Harbor (MA96-01) extends from the mouth of the unimpaired portion of Scorton Creek and the unimpaired Spring Creek east to an imaginary line drawn from Beach Point to the western edge of the Mill Creek Estuary (MA96-37). Figure 1 illustrates the groundwatershed for Barnstable Harbor (MA96-01) located primarily within the Town of Barnstable, with the exception of the western portion located in Sandwich. The groundwatersheds for Cape Cod and adjacent Southeastern Massachusetts Communities were provided by USGS and are based on groundwater modeling developed under the Massachusetts Estuary Program (MEP) and contributing groundwater areas as delineated and published in the USGS 451 groundwater contributing areas

¹ MassDEP, March 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. Massachusetts. Available at: <http://www.mass.gov/eea/docs/dep/water/resources/07v5/12list2.pdf>

² MassDEP, 2009. Final Pathogen TMDL for the Cape Cod Watershed. Available at: <http://www.mass.gov/eea/docs/dep/water/resources/a-thru-m/capecod1.pdf>

³ MassDEP, May 2011. Cape Cod Coastal Drainage Areas 2004-2008 Surface Water Quality Assessment Report. Available at: <http://www.mass.gov/eea/docs/dep/water/resources/71wqar09/96wqar12.pdf>

data.^{4,5} The watersheds for Cape Cod and adjacent Southeastern Massachusetts Communities are based on groundwater delineations and not ground surface topography.⁴ For groundwater assessments with impairments related to nitrogen, if a discharge occurs inside the groundwater boundary, it is considered to be a discharge that contributes to the impaired segment. If the discharge point is outside of the groundwater boundary, it is not considered to contribute to the impaired segment. MassDOT property within the urban area that contributes runoff or infiltration within the groundwater area is considered in this assessment as contributing to Barnstable Harbor (MA96-01).

The land use within the groundwater is predominantly forest and open land. The closest MassDOT owned roadway located within the mapped urban area is Route 6A and is approximately 0.35 miles away from the southern extent of Barnstable Harbor (MA96-01). Route 6 is also a MassDOT owned roadway located within the mapped urban area within the groundwater and is approximately 1.3 miles south of Barnstable Harbor (MA96-01). Route 32 connects Route 6A with Route 6 and traverses the watershed in a north-south direction (Figure 1).

The Cape Cod Watershed Water Quality Assessment Report lists Aquatic Life as “impaired” due to loss of eel grass habitat. Shellfish Harvesting is listed as “support” for 2.7 square miles, and “impaired” for 0.5 square miles due to elevated fecal coliform bacteria from marina/boating pump-out releases, waterfowl, waste from pets, on-site (septic) systems, and discharges from municipal separate storm sewer systems (MS4s). The Town of Barnstable is a Phase II community that has permit coverage under the NPDES MS4 program (MAR041090). The permit requires the Town of Barnstable to develop, implement and enforce a stormwater management program and to reduce the discharge of pollutants from their system. The Primary and Secondary Recreational Uses were assessed as “support” for Barnstable Harbor (MA96-01). Fish Consumption and Aesthetics were not assessed.

Figures 2a – 2o show the MassDOT-owned property within urban area that is contributing to the groundwater of Barnstable Harbor (MA96-01). Route 6 is a divided highway with two lanes in each direction which traverses the groundwater in a west to east direction (Figures 2a-2f). Route 6 is located south of Barnstable Harbor (MA96-01). Runoff from Route 6 is collected with catch basins that discharge perpendicular to the highway in the vicinity of the road where stormwater infiltrates into the ground. Both pervious and impervious areas pertaining to Route 6 between the western and eastern groundwater boundaries of Barnstable Harbor are considered contributing to Barnstable Harbor (MA96-01). There is a rest area along Route 6 at the intersection with Route 132 (Figures 1, 2d) and a second rest area located on the eastbound side of Route 6, near the intersection of Route 6 with Mary Dunn Road (Figures 1, 2f) that both contribute runoff to Barnstable Harbor. In addition, runoff from two weigh stations (Figure 2a) and one pull-off area (Figure 2e) off of Route 6 contribute runoff.

Route 6A is a two-lane road which traverses the groundwater in a northwest to southeast direction (Figures 2d, 2g-2n). Most of Route 6A is owned by DOT, although a segment south of Barnstable Harbor is not under DOT ownership. Runoff from Route 6A discharges mainly to the pervious area on the side of the road or is collected with catch basin networks discharging to depressed areas on the side of the road within the groundwater of Barnstable Harbor. Both pervious and impervious areas pertaining to the urban portion of Route 6A within the groundwater of Barnstable Harbor are considered contributing to Barnstable Harbor (MA96-01). In addition, sections of Route 6A (Figure 2g) that were outside the groundwater boundary

⁴ Walter, D.A., Masterson, J.P., and Hess, K.M., 2004, Ground-Water Recharge Areas and Traveltimes to Pumped Wells, Ponds, Streams, and Coastal Water Bodies, Cape Cod, Massachusetts, Scientific Investigations Map I-2857, 1 sheet. Available at: <http://pubs.water.usgs.gov/sim20042857>

⁵ U.S. Geological Survey (USGS). (2009). Groundwater contributing areas for Cape Cod and Plymouth-Carver Regions of Massachusetts. Data Series 451 (1 of 3).

were considered contributing due to their proximity to the groundwater boundary and continuity of the road.

Route 132 crosses the groundwater in a north-south direction, and is located south of Barnstable Harbor (MA96-01) (Figures 2d, 2j, 2o). Runoff from Route 132 between Route 6A and Old Strawberry Hill Road is collected with catch basins and discharges to depressed area along the road where it infiltrates into the ground and travels to Barnstable Harbor via groundwater flow. A catch basin network collecting runoff from the southern end of this section discharges to an unnamed pond at the intersection of Route 132 with Shootflying Hill Road, within the groundwater of Barnstable Harbor (Figure 2d). A 950 foot section of Route 132 between Phinneys Lane and Bearses Way is also contributing to Barnstable Harbor (MA96-01). Runoff from this section of road is collected with catch basins which discharge in depressed areas next to Route 132 and infiltrate within the groundwater of Barnstable Harbor (Figure 2o). Both pervious and impervious areas pertaining to Route 132 are considered contributing to Barnstable Harbor (MA96-01).

Phinneys Lane is a two lane road crossing Route 6 (Figure 2e). Approximately 0.65 miles of Phinneys Lane is MassDOT-owned property within the urban area. Runoff from this section of road is collected with catch basins and discharges along the road where it infiltrates into the ground and travels to Barnstable Harbor (MA96-01) via groundwater flow. Both pervious and impervious areas pertaining to Phinneys Lane are considered as contributing to Barnstable Harbor (MA96-01).

Barnstable Harbor is an Outstanding Resource Water that is part of the Sandy Neck Barrier Beach System Area of Environmental Concern (ACEC), which is located in the northern portion of the groundwater. Portions of Route 6A are located within the ACEC. In addition, portions of Routes 6 and 132 are located within a Zone II Well Protection Area.

Existing BMPs

MassDOT did not identify any existing BMPs in place to treat roadway runoff from the discharging area before reaching the impaired water segment.

Assessment

In cases where a TMDL has been approved, MassDOT assesses the water body for the impairments covered by the TMDL under the BMP 7R methodology.⁶ MassDOT separately assesses the water body for any stormwater-related impairments that are not covered by the TMDL under the BMP 7U methodology.⁷ MassDOT assessed Barnstable Harbor (MA96-01) using the methodologies described below.

This assessment has been completed based on the *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*.¹ MassDEP has released a proposed *Massachusetts Year 2014*

⁶ MassDOT, July 2010. BMP 7R: TMDL Watershed Review. Available at:

http://www.massdot.state.ma.us/Portals/8/docs/environmental/npdes/BMP_7R_TMDL_WatershedReview.pdf

⁷ MassDOT, April 2010. BMP 7U: Water Quality Impaired Waters Assessment and Mitigation Plan. Available at:

http://www.massdot.state.ma.us/Portals/8/docs/environmental/npdes/BMP_7U_ImpairedWaterbodiesAssessment.pdf

Integrated List of Waters, which has been reviewed for any proposed changes to the condition of the water bodies.⁸ The condition of Barnstable Harbor (MA96-01) is not proposed to change.

BMP 7U for Nitrogen

MassDOT assessed the contribution of nitrogen from MassDOT properties to this water body using the approach described in BMP 7U⁷ of MassDOT's Storm Water Management Plan (Water Quality Impaired Waters Assessment and Mitigation Plan), which applies to impairments that have not been addressed by a TMDL, and MassDOT's application of BMP 7U to nitrogen in groundwater-controlled watersheds.⁹ Barnstable Harbor (MA96-01) is impaired for estuarine bioassessments, which is typically related to eutrophication processes caused by excess nitrogen.¹⁰ Nitrogen loading was determined using a mass accounting approach as described in the BMP 7U for nitrogen methodology.⁹

For the nitrogen assessment under BMP 7R, MassDOT used USGS modeling¹¹ to estimate annual pollutant loads from its property. Based on the USGS SELDM, which was run using precipitation data from a site in Hyannis and an average of water quality data from Harwich and Marion, MassDOT estimates the nitrogen loading from impervious areas as 6.2 lbs/acre/yr and from pervious areas as 2.5 lbs/acre/yr.⁹ The nitrogen loading for MassDOT property in the contributing area is summarized below:

- MassDOT Impervious Area: 152.0 acres
- MassDOT Pervious Area: 340.6 acres
- Estimated Existing MassDOT Load: 1,794.0 lbs/yr
- Total Existing Groundwatershed Nitrogen Load: 96,029 lbs/yr
- MassDOT Existing Load as a Percentage of Total Groundwatershed Nitrogen Load: 1.87 %

The MassDOT existing load compared to the total groundwatershed nitrogen load is very small and considered negligible based on MassDOT's Nitrogen TMDL Method because it is less than 3.5% of the total nitrogen groundwatershed load.⁹ In general, in areas where the MassDOT load is determined to be negligible, MassDOT does not implement BMPs because of their minimal impact on the overall groundwatershed load.

BMP 7R for Pathogen TMDL (CN 252.0)

MassDOT assessed the indicator bacteria (fecal coliform) impairment using the approach described in BMP 7R⁶ of MassDOT's Storm Water Management Plan (SWMP), which applies to impairments that have been assigned to a water body covered by a final TMDL. Barnstable Harbor (MA96-01) is covered by the *Final Pathogen TMDL for the Cape Cod Watershed*.²

Pathogen concentrations in stormwater vary widely and concentrations can vary by an order of magnitude within a given storm event at a single location making it difficult to predict pathogen

⁸ MassDOT, June 2014. Massachusetts Year 2014 Integrated List of Waters – Proposed Listing of the Condition of Massachusetts' Waters Pursuant to Sections 305(b), 314 and 303(d) of the Clean Water Act. Massachusetts. Available at: <http://www.mass.gov/eea/docs/dep/water/resources/07v5/14iwlstp.pdf>

⁹ MassDOT, June 2015. Application of BMP 7U to Nitrogen in Groundwater-Controlled Massachusetts Watersheds. Available in attachment 9.

¹⁰ CWP, 2003. Impacts of Impervious Cover on Aquatic Systems. Watershed Protection Research Monograph No. 1. Ellicott, Md.

¹¹ Granato, G.E., 2013, Stochastic empirical loading and dilution model (SELDM) version 1.0.0: U.S. Geological Survey Techniques and Methods, book 4, chap. C3, 112 p. Available at: <http://pubs.usgs.gov/tm/04/c03>

concentrations in stormwater with accuracy. MassDOT generally will not conduct site specific assessments of pathogen loading for each water body impaired for pathogens but instead developed an iterative adaptive management approach to be consistent with relevant TMDLs and permit condition requirements and an approach to stormwater management. Greater detail of the assessment methodology is provided in MassDOT's BMP 7R Pathogen Methodology.¹²

According to the Final TMDL, sources of indicator bacteria are believed to be primarily from boat wastes; failing septic systems; pets, wildlife, and birds; and stormwater. It should be noted that bacteria from wildlife would be considered a natural condition unless some form of human inducement, such as feeding, is causing congregation of wild birds or animals. Additionally, the TMDL states that implementation to achieve the TMDL goals should be an iterative process with selection and implementation of mitigation measures followed by monitoring to determine the extent of water quality improvement realized. Recommended TMDL implementation measures include identification and elimination of prohibited sources such as leaky or improperly connected sanitary sewer flows and best management practices to mitigate stormwater runoff volume.

The TMDL states that several impaired segments carry a higher priority due to their location, use, and risk to human health. These segments tend to be located nearest to sensitive areas such as Outstanding Resource Waters or designated uses that require higher water quality standards than Class B. Barnstable Harbor (MA96-01) is listed as a high priority due to its designation as an Outstanding Resource Water.²

In addition to the generic recommendations provided in the draft MS4 permit for Massachusetts, the Cape Cod Watershed TMDL report² (Section 8.0) recommends the following specific BMPs to address elevated fecal coliform levels in the watershed:

- Correction of failing septic systems
- Public education regarding illicit sewer connection and failing infrastructure, as well as stormwater runoff and boat wastes
- Identification and elimination of prohibited sources such as leaky or improperly connected sanitary sewer flows
- Best management practices to mitigate stormwater runoff volume

The TMDL report also indicates that structural BMPs may be appropriate if less costly non-structural BMPs are not effective. Many non-structural BMPs are in place, including public education and outreach, street sweeping, and catch basin cleanouts. In addition to practices like these, many communities have formed advisory committees to help resolve existing stormwater issues. Many of the communities on Cape Cod practice their own stormwater BMPs. Additionally, the TMDL states that implementation to achieve the TMDL goals should be an iterative process with selection and implementation of mitigation measures followed by monitoring to determine the extent of water quality improvement realized.

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

- Septic tank controls
- Documentation of storm drain outfall locations

¹² MassDOT, December 2014. Description of MassDOT's Application of BMP 7R for Pathogen Related Impairments. Available at: <http://www.massdot.state.ma.us/Portals/8/docs/environmental/impairedWaters/Year5/Attachment4.pdf>

- Resident education
- Additional water quality monitoring
- Designation of “No Discharge” areas in high priority coastal waters
- Annual street sweeping and catch basin cleaning

Proposed Mitigation Plan

As described above, MassDOT’s nitrogen contribution to the receiving water is negligible. Therefore, MassDOT has no plans to implement structural BMPs to control nitrogen in stormwater runoff from their property under the Impaired Waters Program.

With respect to the fecal coliform impairment, 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. As discussed in MassDOT’s BMP 7R Pathogen Methodology, MassDOT believes that existing efforts are consistent with the current and draft MS4 permit requirements and TMDL recommendations in regard to pathogens.

In accordance with the BMPs identified in the TMDL report as planned measures to reach compliance with the Cape Cod Pathogen TMDL report, MassDOT has documented the locations of its stormwater outfalls. In addition, as part of its pet waste management program, MassDOT has determined that two MassDOT targeted rest areas are located within the watershed of this water body. One rest area is located on the westbound of Route 6, at the intersection with Route 132 (Figures 1, 2d) and the second rest area is located on the eastbound of Route 6, near the intersection of Route 6 with Mary Dunn Road (Figures 1, 2f). MassDOT will be installing signs at rest areas within the subwatersheds of pathogen impaired waterbodies. The signs will inform the public of the need to remove pet waste, which can minimize contributions of pathogens to stormwater runoff. Pet waste removal bags and disposal cans will be provided.

Although the TMDL report also identifies the benefits of structural BMPs to address pathogens in runoff from impervious areas in some instances, MassDOT feels that it is not a beneficial approach to implement these BMPs in advance of other ongoing BMP efforts identified in the groundwatershed, 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 stormwater controls.

Furthermore, MassDOT has an ongoing inspection and monitoring program aimed at identifying and addressing illicit discharges to MassDOT’s stormwater management system. 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 groundwatershed of this water body that could be contributing pathogens to the impaired water body.

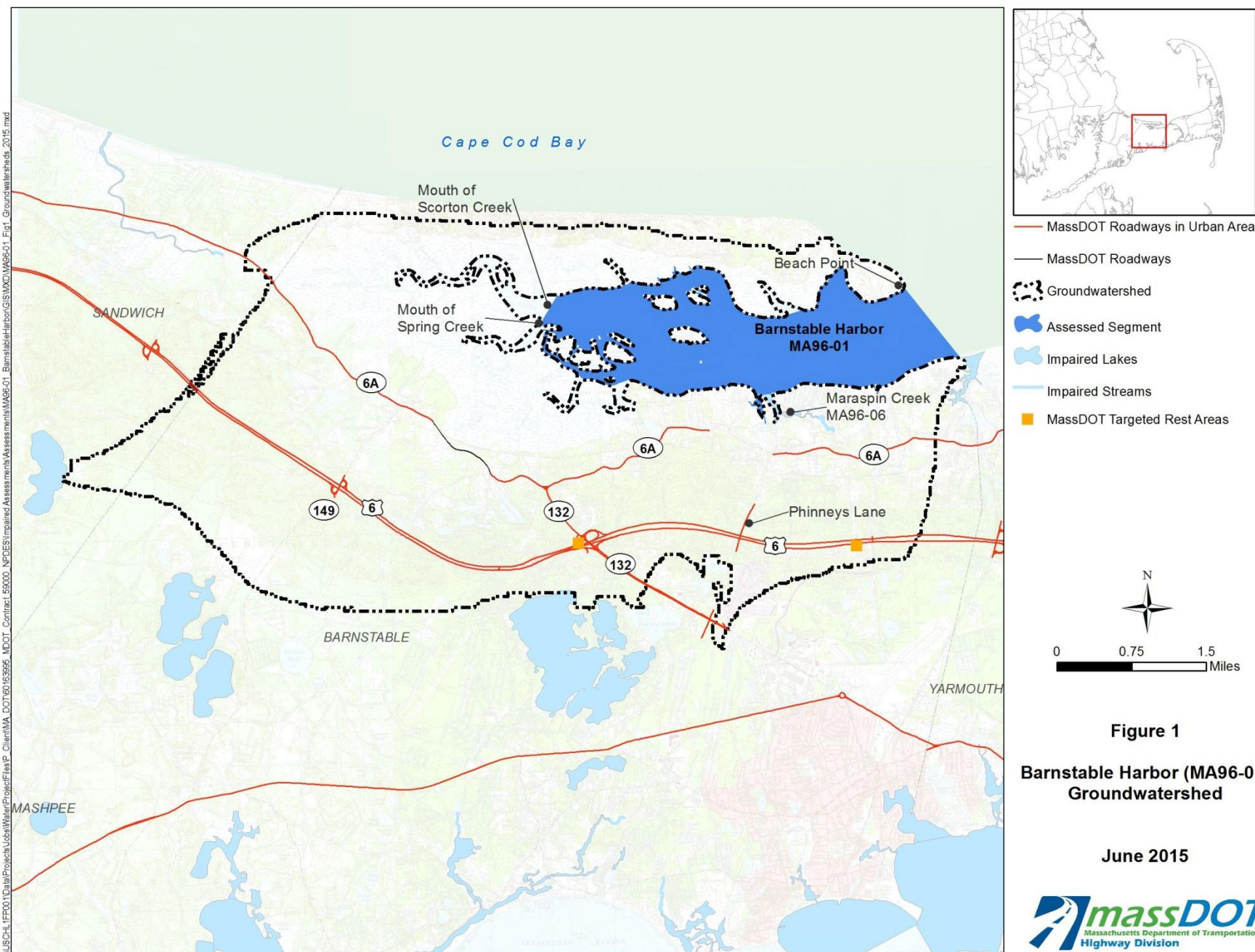
MassDOT has concluded that the BMPs outlined in the SWMP are consistent with its existing permit requirements for Barnstable Harbor. These measures achieve pathogen reductions (including fecal coliform) to the maximum extent practicable and are consistent with the intent of its existing stormwater permit and the applicable Pathogen TMDLs. As stated previously, pathogen loadings are highly variable and although there is potential for stormwater runoff from MassDOT

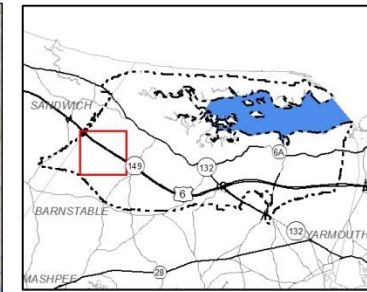
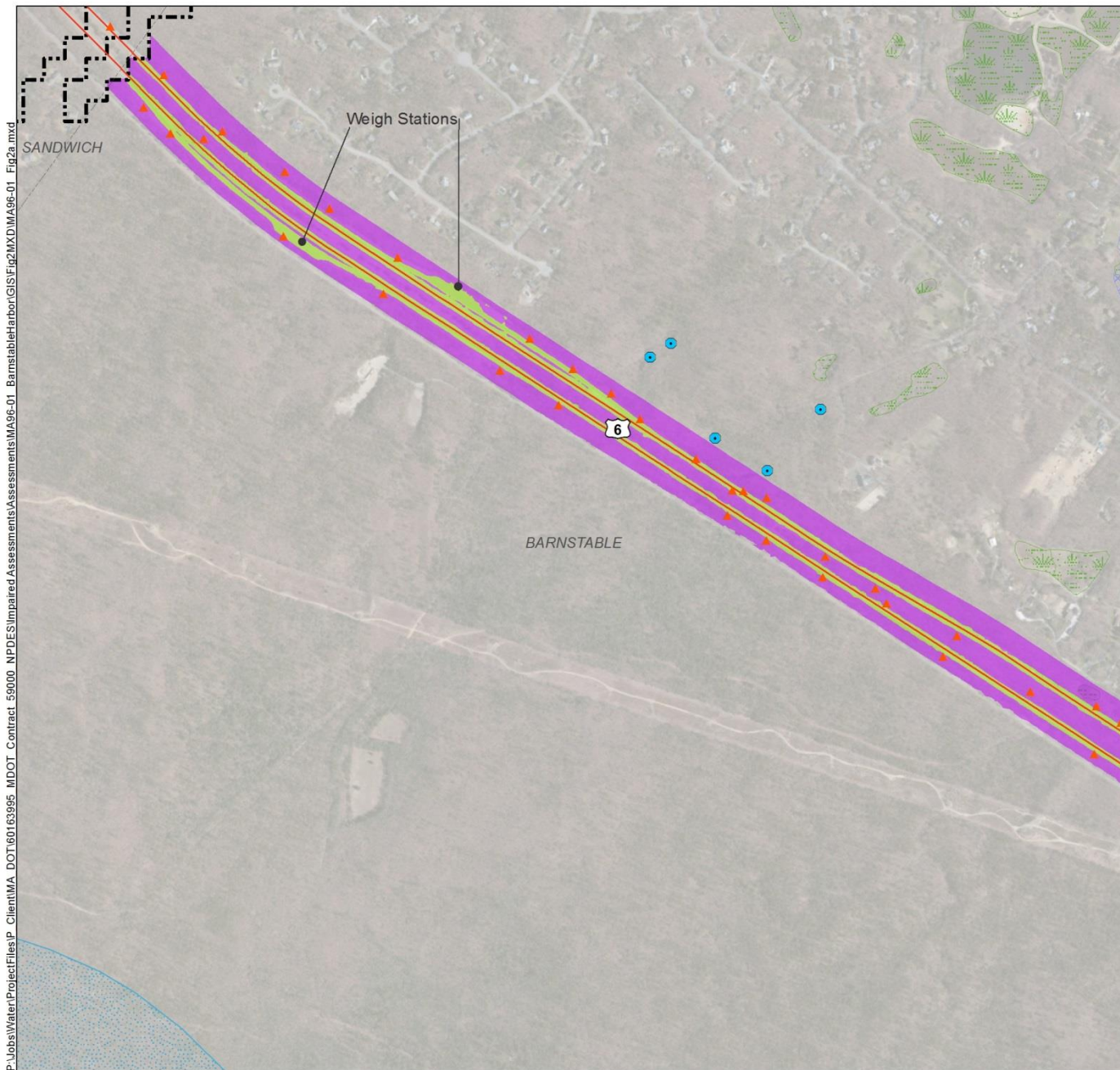
roadways to be a contributing source it is unlikely to warrant action relative to other sources of pathogens in the groundwatershed.

MassDOT will continue to ensure proper non-structural BMPs are being implemented within the groundwatershed of the Barnstable Harbor, including regular roadway and drainage system maintenance, erosion and sedimentation control, and outreach and education. As described in MassDOT's Stormwater Handbook,¹³ MassDOT does not use nitrogen based fertilizers as part of normal operations and maintenance procedures. In the rare circumstance where fertilizers are used, it is for the occasional vegetation establishment associated with recent ground disturbance. Further work by MassDOT on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to address impairments. MassDOT will include an update in NPDES permit annual reports to EPA regarding proposed BMP design either through retrofit or programmed projects, plans for construction of BMPs, reduction achieved by finalized BMP designs and progress made towards meeting target reductions.

¹³ MassDOT, May 2004. The MassHighway Storm Water Handbook for Highways and Bridges. Available at: http://www.massdot.state.ma.us/Portals/8/docs/environmental/wetlands/Stormwater_Handbook.pdf

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- ▲ MassDOT Outfalls
- MassDOT Roadways in Urban Area
- ⬜ Groundwatershed
- Assessed Segment
- MassDOT Impervious Area
- MassDOT Pervious Area
- DEP Wetlands
- ⬜ Areas of Critical Environmental Concern
- ⬜ Zone II Wellhead Protection Areas
- Certified Vernal Pools

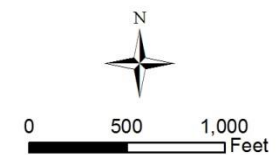


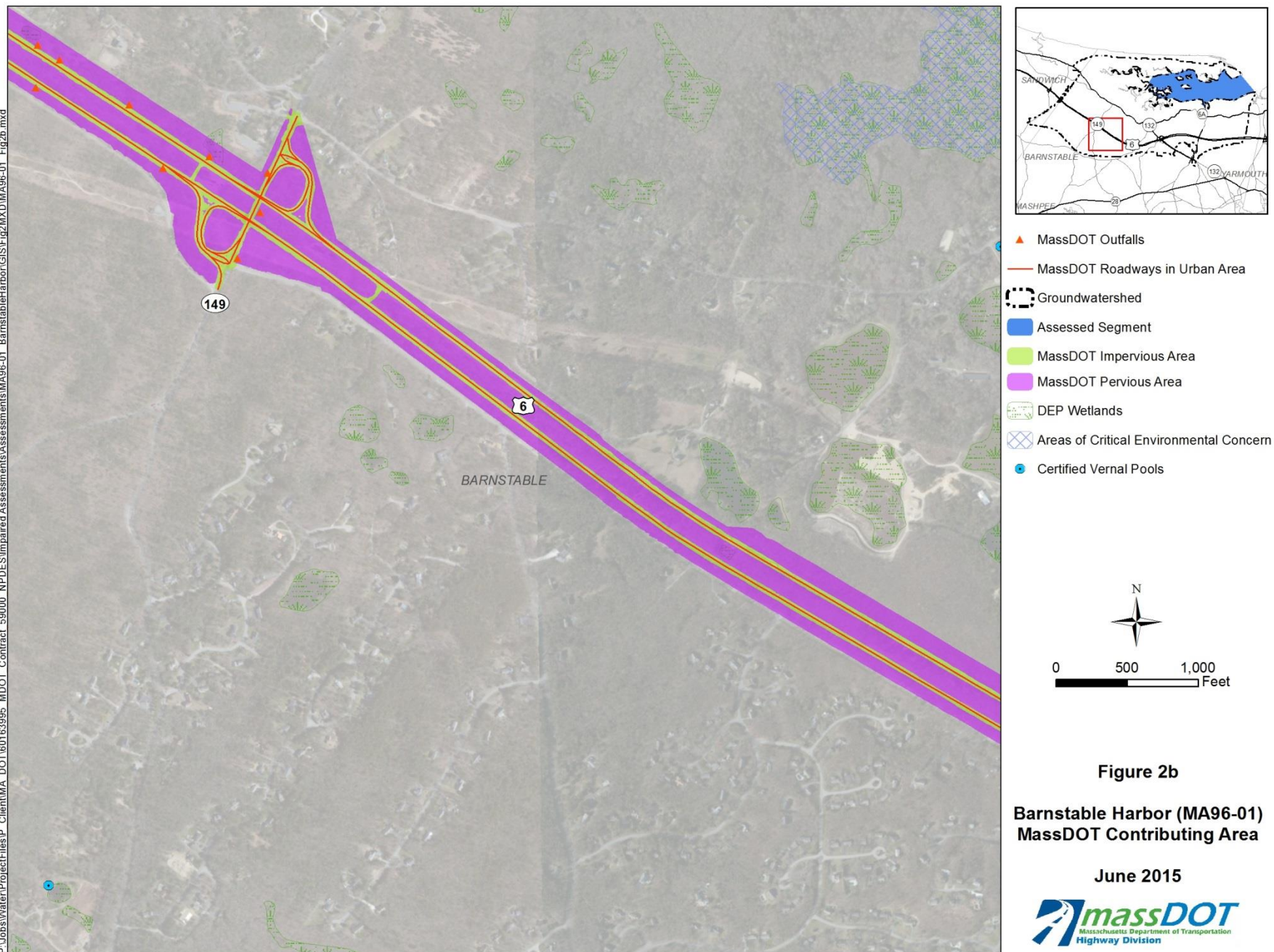
Figure 2a

**Barnstable Harbor (MA96-01)
MassDOT Contributing Area**

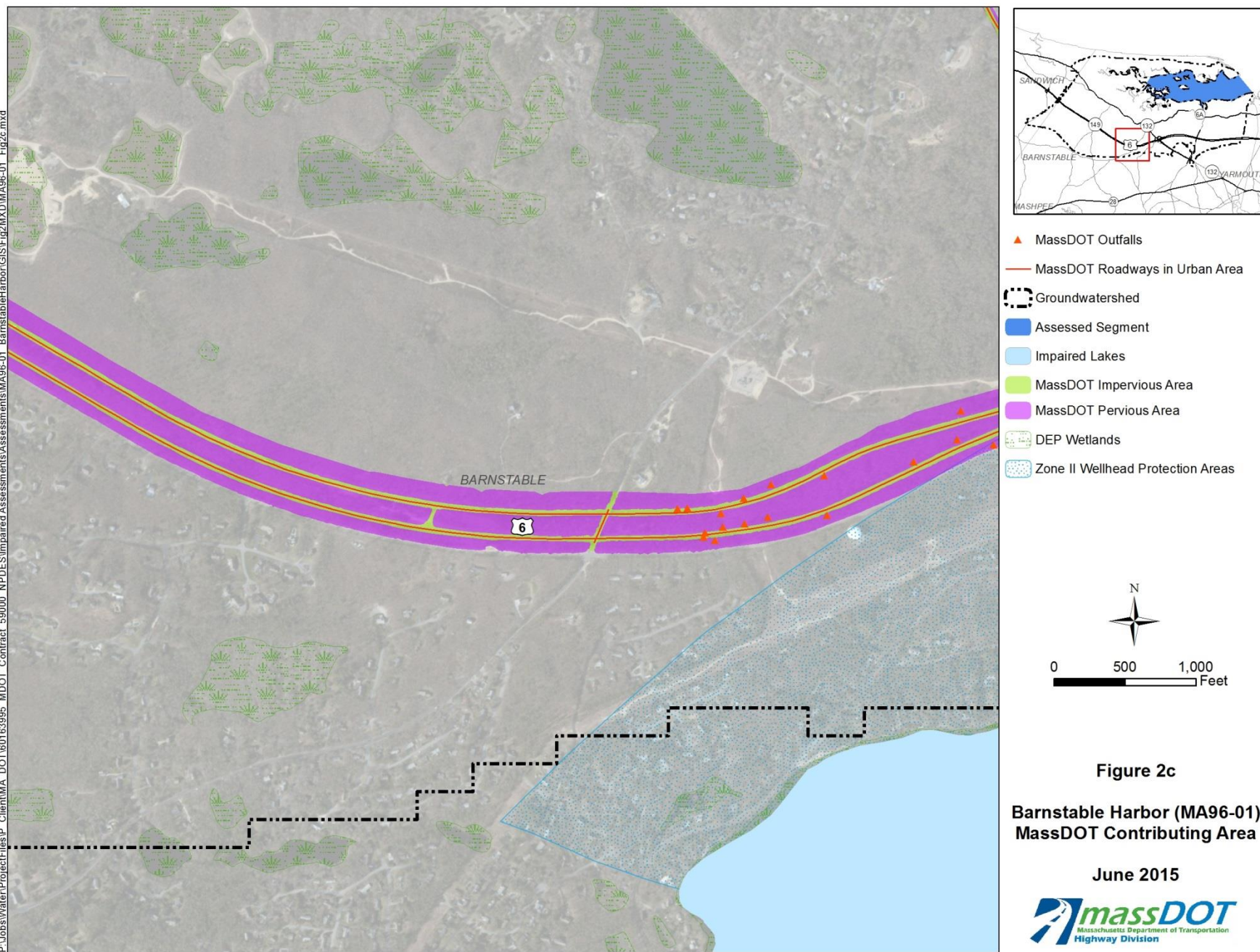
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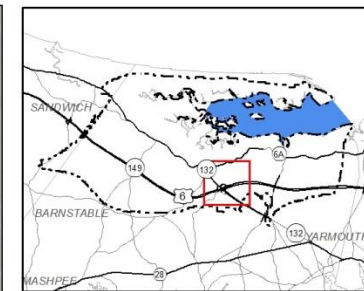
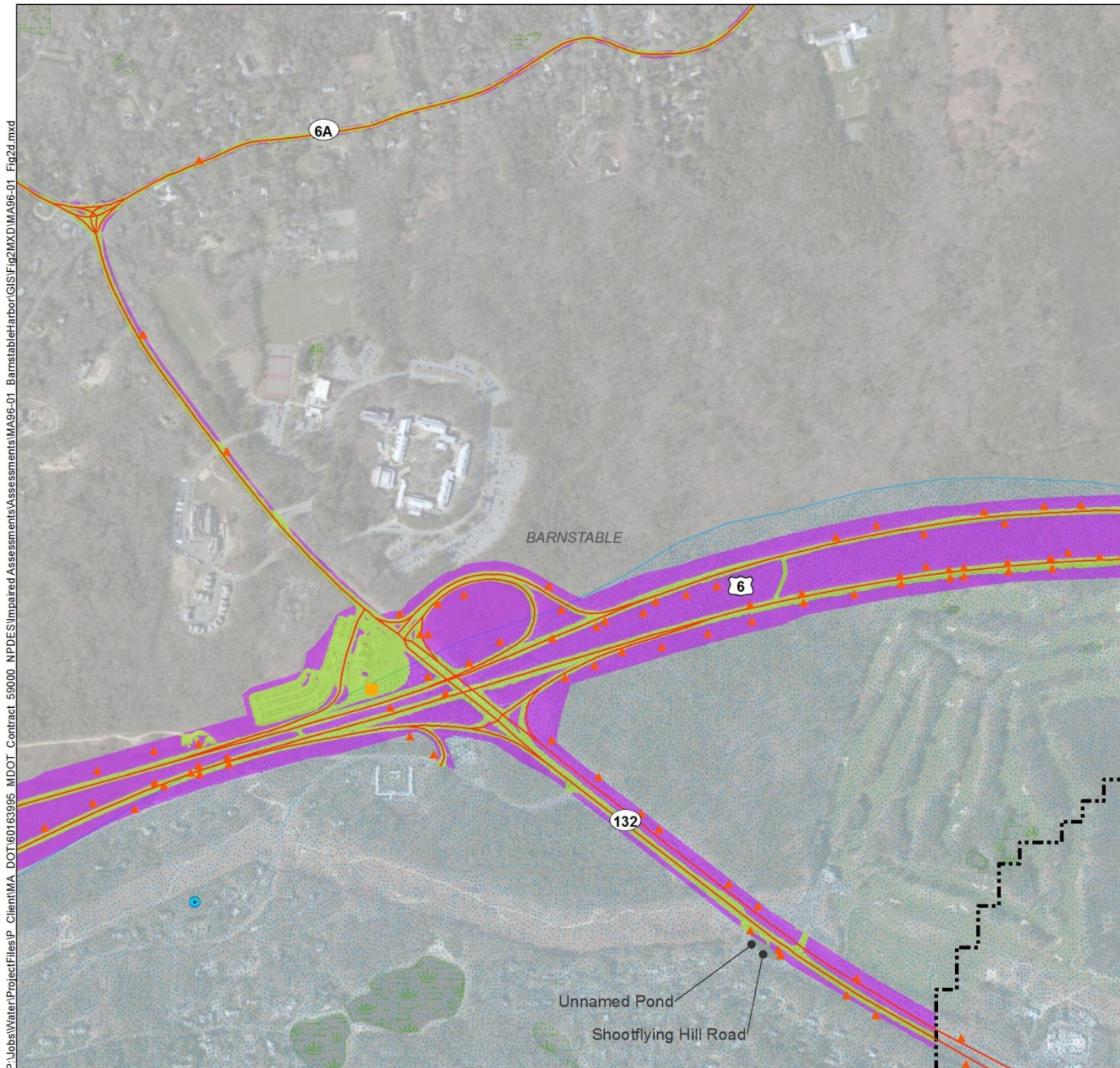


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- ▲ MassDOT Outfalls
- MassDOT Roadways in Urban Area
- ⬡ Groundwatershed
- Assessed Segment
- MassDOT Impervious Area
- MassDOT Pervious Area
- MassDOT Targeted Rest Areas
- DEP Wetlands
- Zone II Wellhead Protection Areas
- Certified Vernal Pools

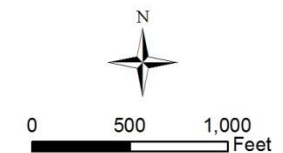
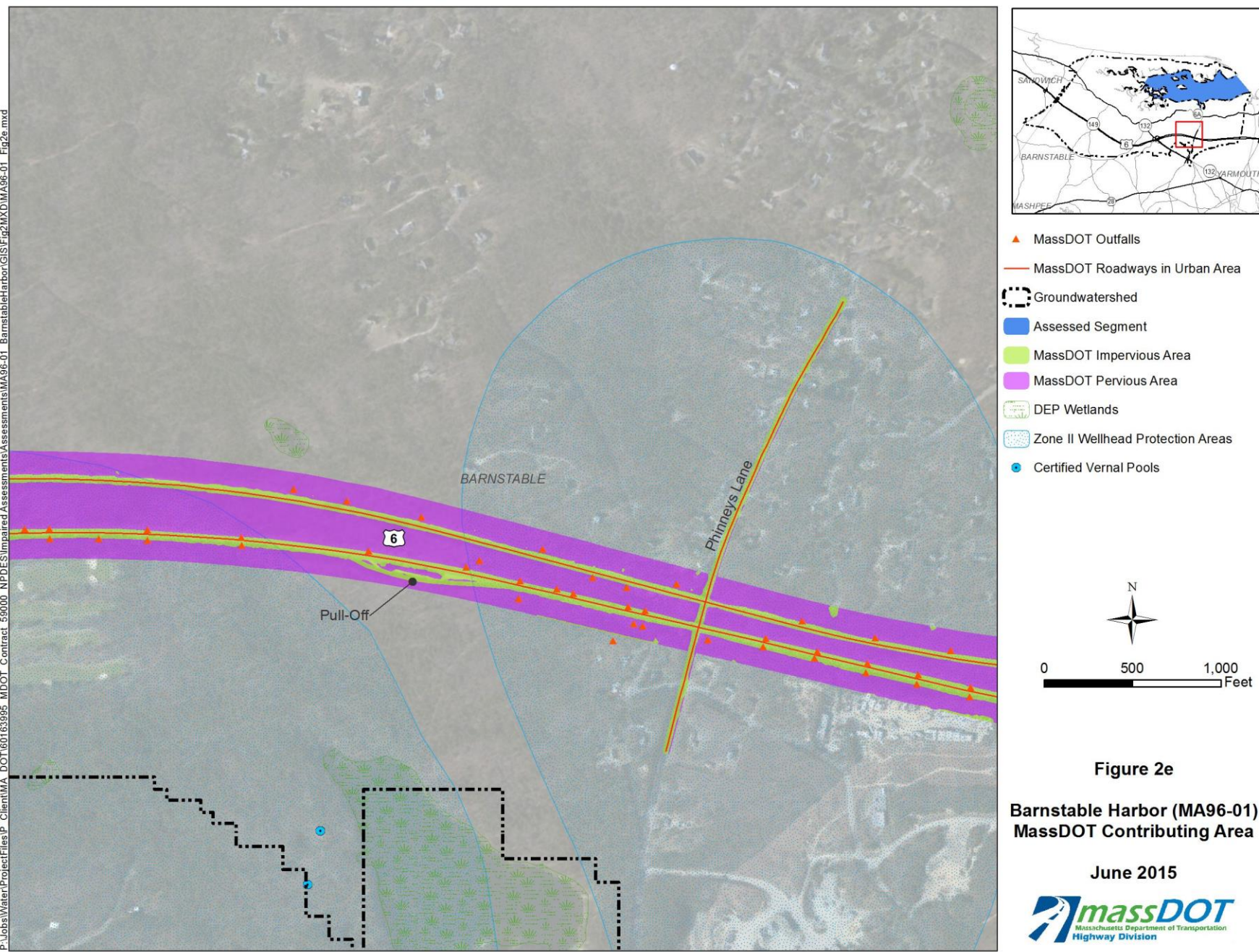
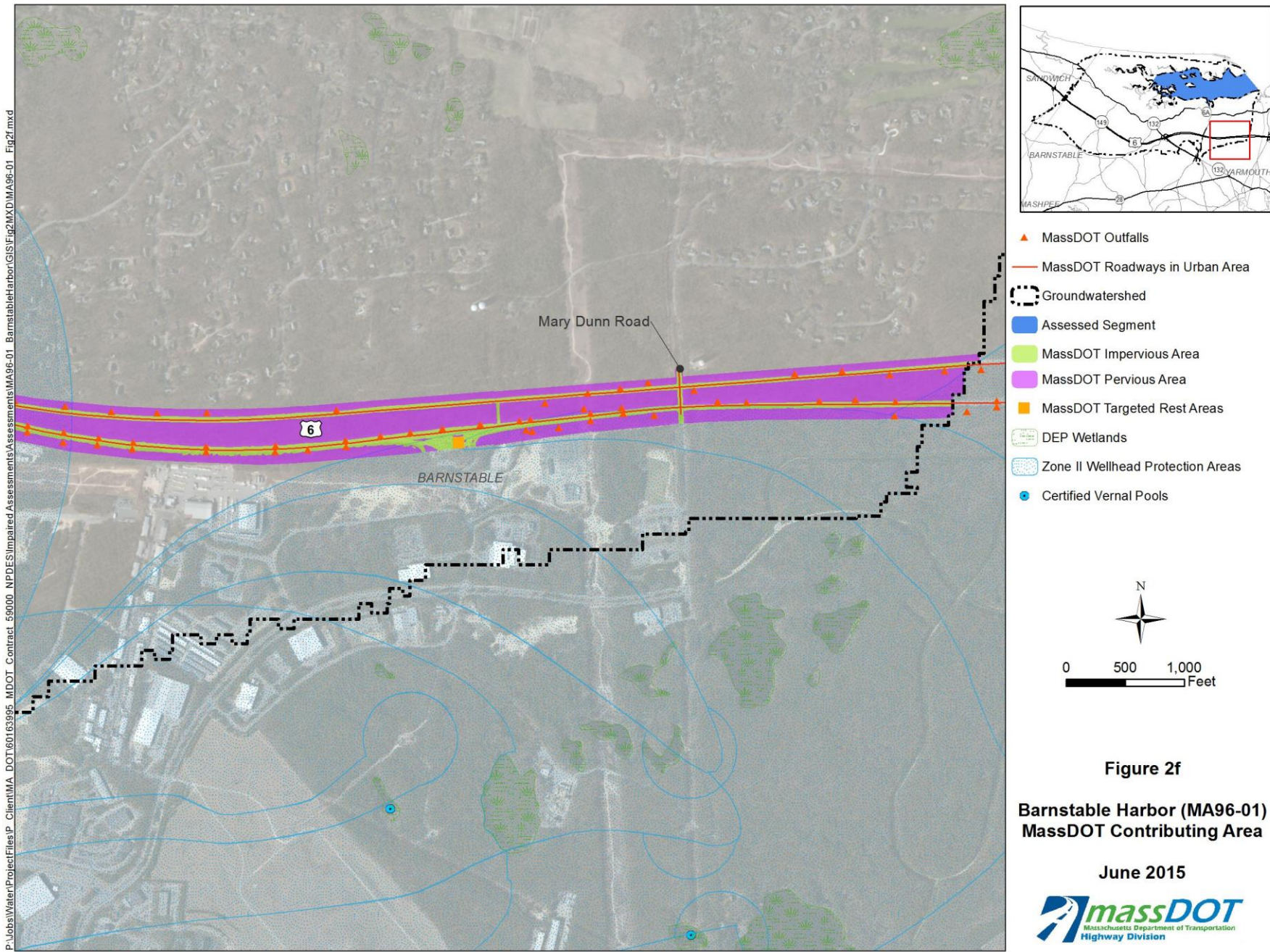


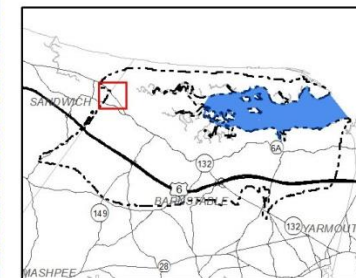
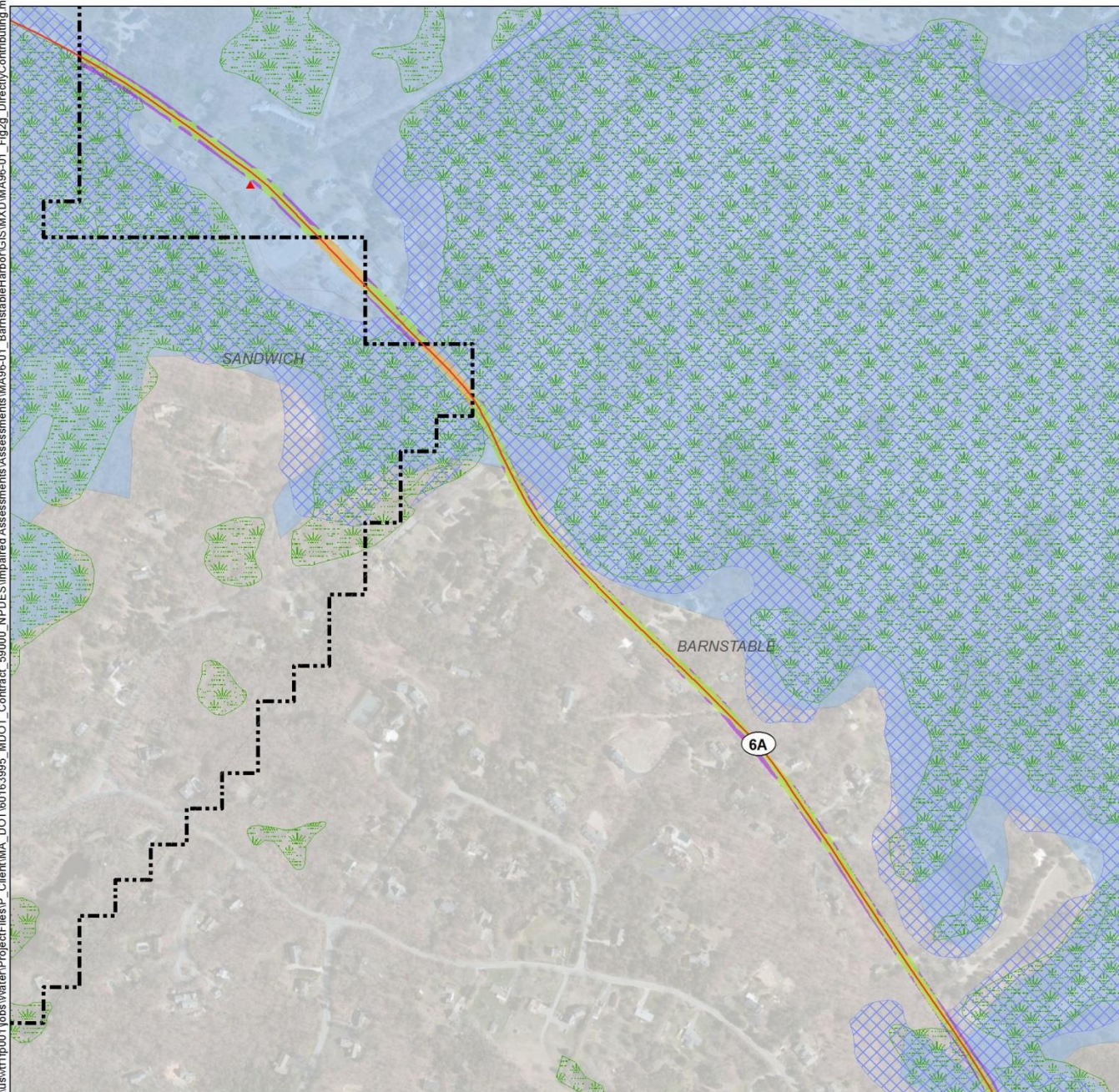
Figure 2d
Barnstable Harbor (MA96-01)
MassDOT Contributing Area

June 2015









- ▲ MassDOT Outfalls
- MassDOT Roadways in Urban Area
- Groundwatershed
- Assessed Segment
- MassDOT Impervious Area
- MassDOT Pervious Area
- MassDOT Supplemental Contributing Area
- DEP Wetlands
- Outstanding Resource Waters
- Areas of Critical Environmental Concern

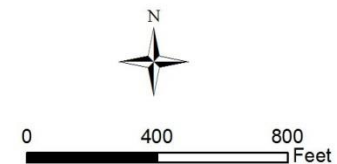
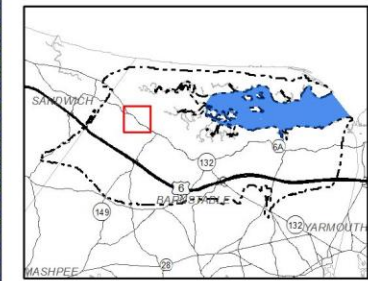


Figure 2g

**Barnstable Harbor (MA96-01)
MassDOT Contributing Area**

June 2015





- MassDOT Roadways in Urban Area
- ⬡ Groundwatershed
- Assessed Segment
- MassDOT Impervious Area
- MassDOT Pervious Area
- ▨ DEP Wetlands
- Outstanding Resource Waters
- ▨ Areas of Critical Environmental Concern

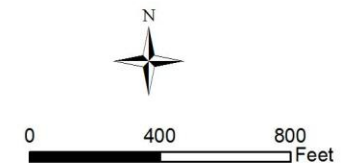
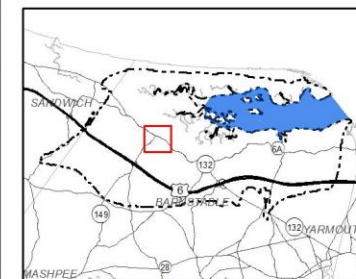


Figure 2h

**Barnstable Harbor (MA96-01)
MassDOT Contributing Area**

June 2015





- MassDOT Roadways in Urban Area
- MassDOT Roadways
- ⬜ Groundwatershed
- Assessed Segment
- MassDOT Impervious Area
- MassDOT Pervious Area
- DEP Wetlands
- Outstanding Resource Waters
- ⬜ Areas of Critical Environmental Concern

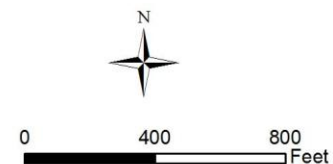
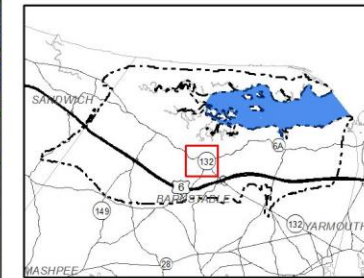


Figure 2i

**Barnstable Harbor (MA96-01)
MassDOT Contributing Area**

June 2015





- ▲ MassDOT Outfalls
- MassDOT Roadways in Urban Area
- MassDOT Roadways
- ⬜ Groundwatershed
- Assessed Segment
- MassDOT Impervious Area
- MassDOT Pervious Area
- DEP Wetlands
- Outstanding Resource Waters
- ⬜ Areas of Critical Environmental Concern
- Certified Vernal Pools

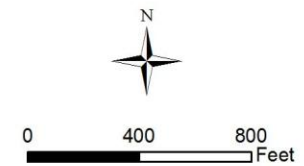


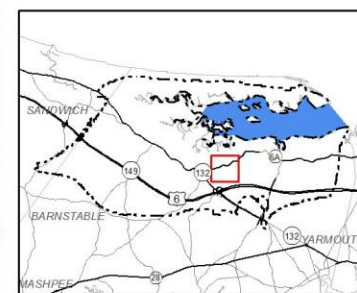
Figure 2j

**Barnstable Harbor (MA96-01)
MassDOT Contributing Area**

June 2015



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- ▲ MassDOT Outfalls
- MassDOT Roadways in Urban Area
- ⬡ Groundwatershed
- Assessed Segment
- MassDOT Impervious Area
- MassDOT Pervious Area
- DEP Wetlands
- Outstanding Resource Waters
- Areas of Critical Environmental Concern

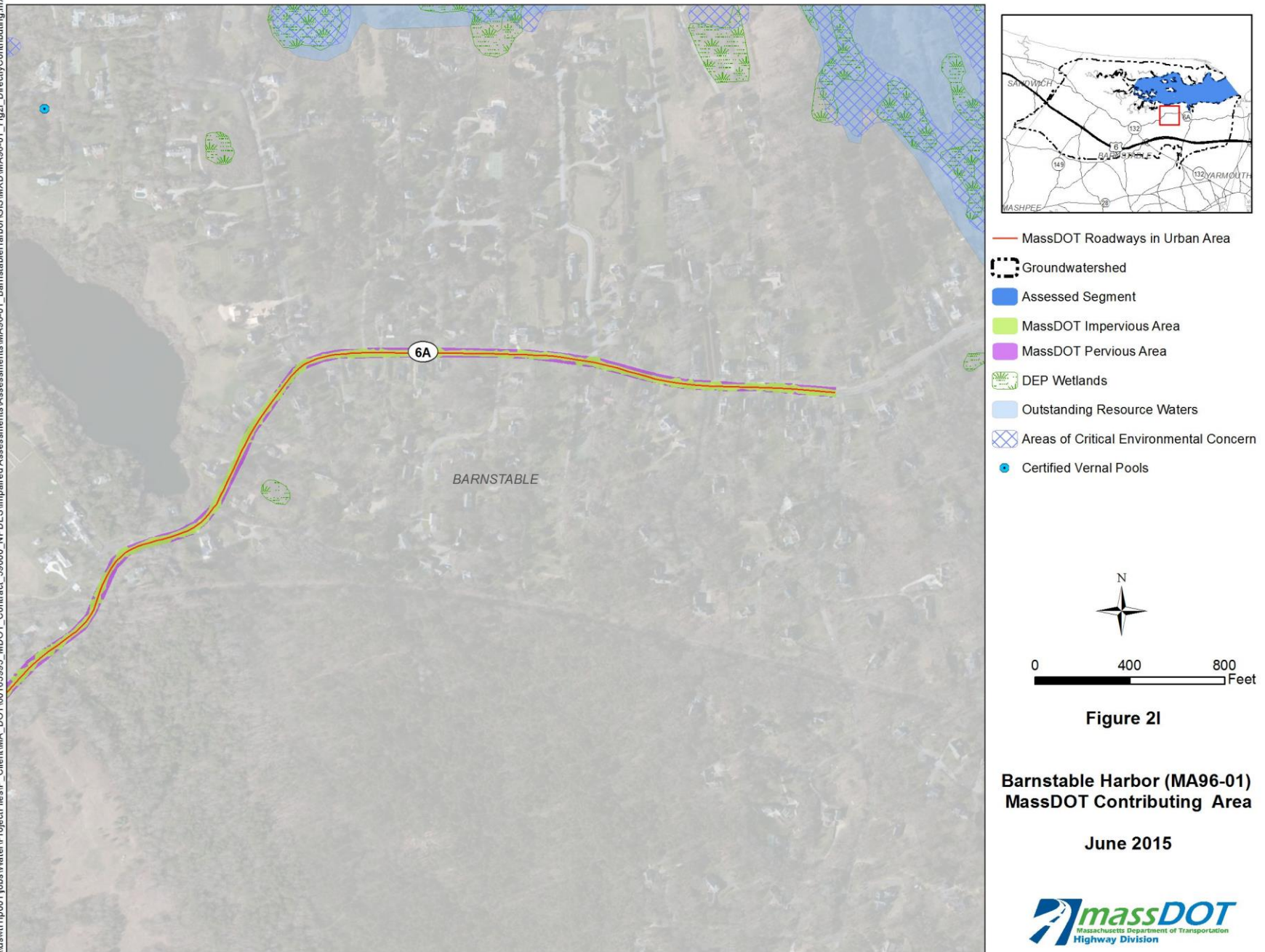


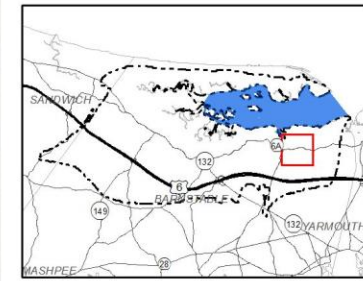
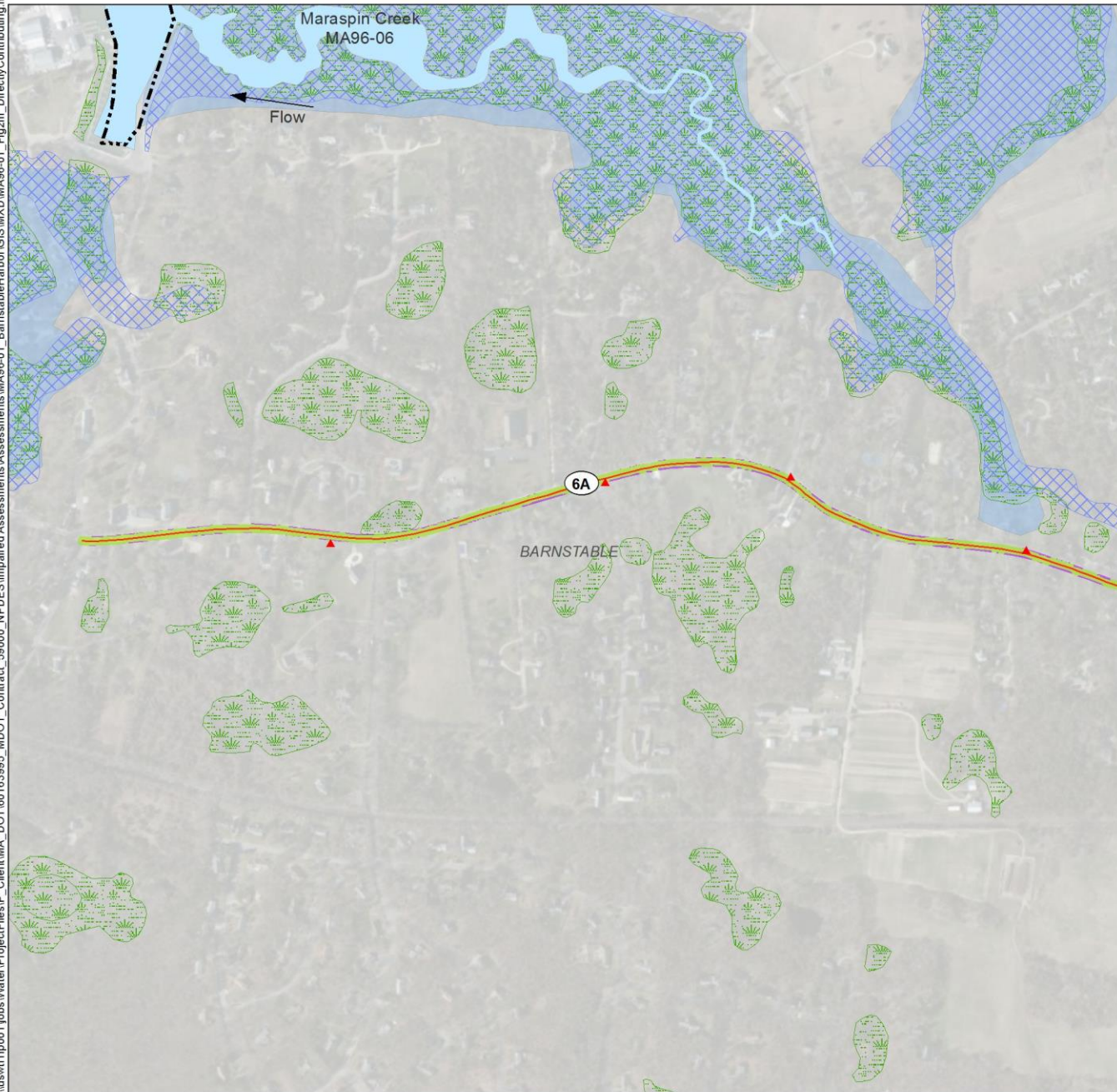
Figure 2k

Barnstable Harbor (MA96-01)
MassDOT Contributing Area

June 2015







- ▲ MassDOT Outfalls
- MassDOT Roadways in Urban Area
- ⬜ Groundwatershed
- Assessed Segment
- Impaired Streams
- Impaired Lakes
- MassDOT Impervious Area
- MassDOT Pervious Area
- DEP Wetlands
- Outstanding Resource Waters
- ⬜ Areas of Critical Environmental Concern

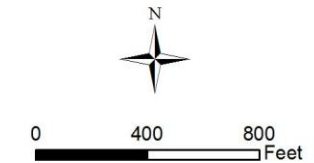
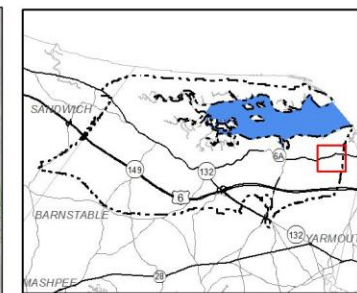
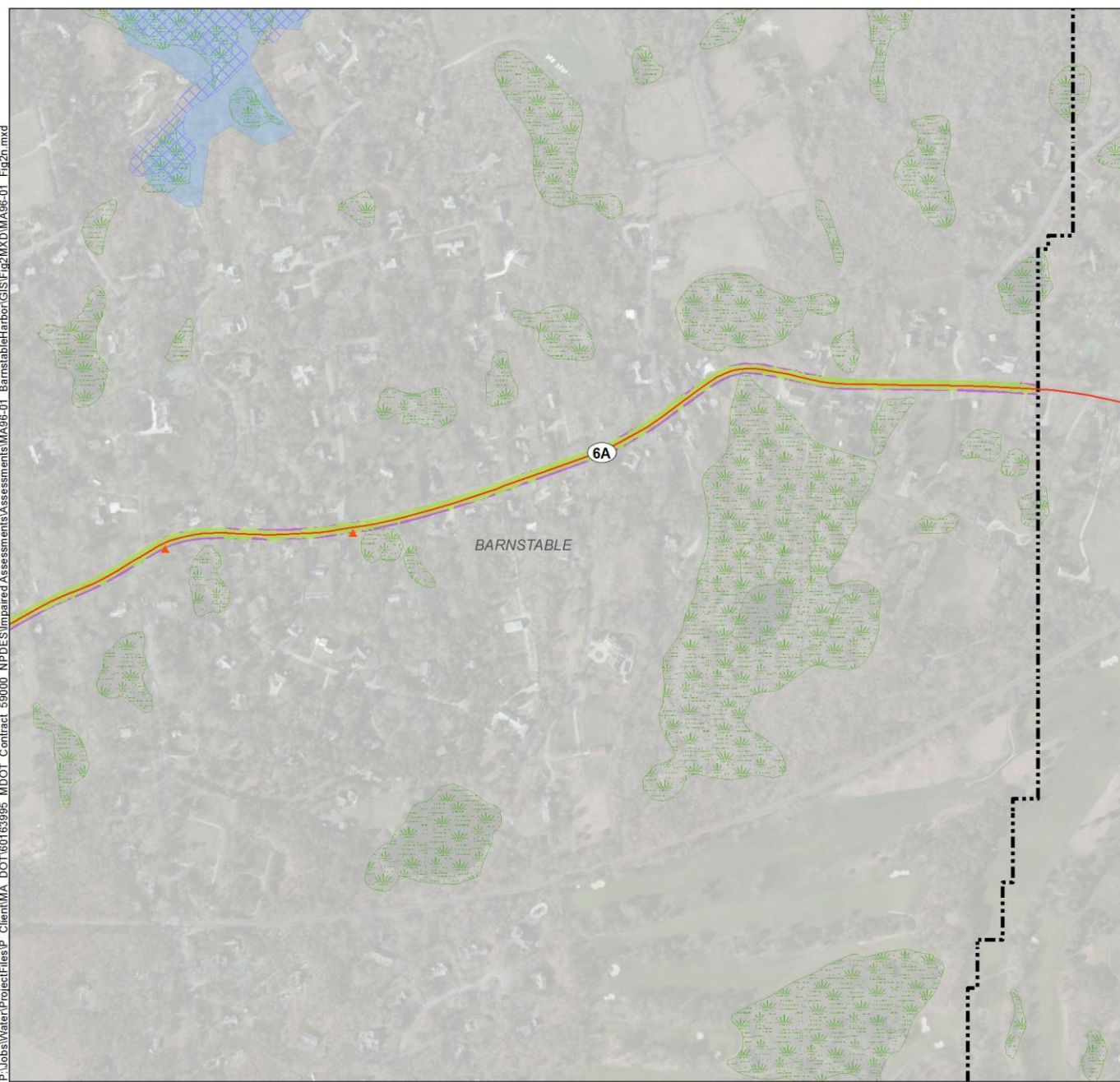


Figure 2m

**Barnstable Harbor (MA96-01)
MassDOT Contributing Area**

June 2015





- ▲ MassDOT Outfalls
- MassDOT Roadways in Urban Area
- Groundwatershed
- Assessed Segment
- MassDOT Impervious Area
- MassDOT Pervious Area
- DEP Wetlands
- Outstanding Resource Waters
- Areas of Critical Environmental Concern

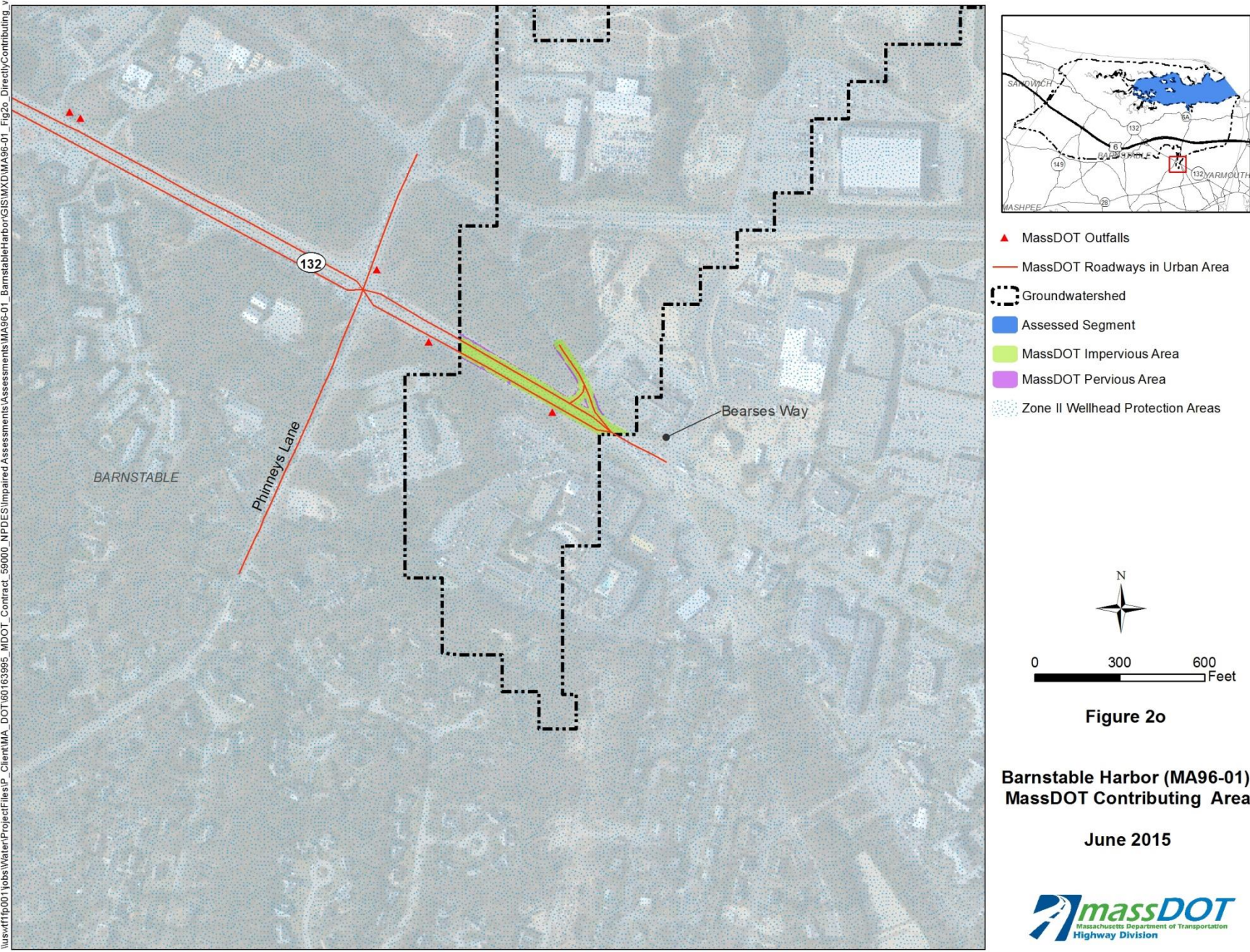


Figure 2n

**Barnstable Harbor (MA96-01)
MassDOT Contributing Area**

June 2015





Impaired Waters Assessment for Boat Meadow River (MA96-15)

Summary

Impaired Water¹	Stormwater Impairments:	<i>Estuarine Bioassessments; Fecal Coliform</i>
	Category:	<i>5 (Waters requiring a TMDL)</i>
	Final TMDLs:	<i>Final Pathogen TMDL for the Cape Cod Watershed (CN 252.0)²</i>
	WQ Assessment:	<i>Cape Cod Coastal Drainage Areas 2004-2008 Surface Water Quality Assessment Report³</i>
Location	Towns:	<i>Eastham and Orleans</i>
	MassDOT Roads:	<i>Route 6</i>
Assessment Method(s)	7R (TMDL Method) <input checked="" type="checkbox"/>	7U (Non-TMDL Method) <input checked="" type="checkbox"/>
BMPs	Existing:	<i>None</i>
MassDOT Area and Targets		Nitrogen
	Estimated MassDOT Load:	<i>8.5 lbs/yr</i>
	Existing Load to Water Body:	<i>5,294 lbs/yr</i>
	MassDOT Contribution to Existing Load:	<i>0.16 %</i>

Site Description

Boat Meadow River (MA96-15) is a 0.05 square mile water body with headwaters located east of the old railway grade in Eastham and flows west to the mouth at Cape Cod Bay in Eastham, Massachusetts. Figure 1 illustrates the groundwatershed for Boat Meadow River (MA96-15). The groundwatersheds for Cape Cod and adjacent Southeastern Massachusetts Communities were

¹ MassDEP, March 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. Massachusetts. Available at: <http://www.mass.gov/eea/docs/dep/water/resources/07v5/12list2.pdf>

² MassDEP, 2009. Final Pathogen TMDL for the Cape Cod Watershed. Available at: <http://www.mass.gov/eea/docs/dep/water/resources/a-thru-m/capecod1.pdf>

³ MassDEP, May 2011. Cape Cod Coastal Drainage Areas 2004-2008 Surface Water Quality Assessment Report. Available at: <http://www.mass.gov/eea/docs/dep/water/resources/71wqar09/96wqar12.pdf>

provided by USGS based on groundwater modeling developed under the Massachusetts Estuary Program (MEP) and contributing groundwater areas as delineated and published in the USGS 451 groundwater contributing areas data.^{4,5} The watersheds for Cape Cod and adjacent Southeastern Massachusetts Communities are based on groundwater delineations and not ground surface topography.⁴ For groundwater assessments with impairments related to nitrogen, if a discharge occurs inside the groundwater boundary, it is considered to be a discharge that contributes to the impaired segment. If the discharge point is outside of the groundwater boundary, it is not considered to contribute to the impaired segment. MassDOT property in the urban area that contributes runoff or infiltration within the groundwater area is considered in this assessment as contributing to Boat Meadow River (MA96-15).

MassDEP's Water Quality Assessment Report titled *Cape Cod Coastal Drainage Areas 2004-2008 Surface Water Quality Assessment Report*³ lists the Shellfish Harvesting Use as "impaired". The report states that the known cause of the impairments is elevated fecal coliform bacteria and the suspected sources include water fowl and discharges from municipal separate storm sewer systems (MS4). Additionally, Eastham and Orleans are Phase II communities that have NPDES MS4 permit coverage (EPA NPDES permit numbers: MAR041110 and MAR041146, respectively). These permits require that the towns develop, implement and enforce a stormwater management program and reduce the discharge of pollutants from their system. The Primary and Secondary Contact Recreational Uses were also assessed and given a status of "support". The other uses were not assessed.

Figure 2 shows the MassDOT-owned property within urban area that is contributing to the groundwater of Boat Meadow River. Route 6 extends in an east west direction through the southern tip of the groundwater. Approximately 1-acre of impervious area along Route 6 is considered to be contributing area to Boat Meadow River. Stormwater runoff from this section of roadway is collected by catch basins and discharged to the adjacent areas where it infiltrates into the ground. In addition, the pervious area within the MassDOT right-of-way is also considered contributing area to the Boat Meadow River groundwater.

Approximately 4,200 square feet of impervious area related to an on-ramp to the Route 6/Route 6A rotary located within the groundwater, is considered contributing area to Boat Meadow River. However, the adjacent off-ramp of the rotary located within the groundwater (Figure 2) is collected with a catch basin which discharges outside of the groundwater. Therefore, this section of the ramp is not considered contributing property.

It should be noted in Figure 2, that an Outstanding Resource Water and the Inner Cape Cod Area of Environmental Concern are located near these roadways within the groundwater.

Existing BMPs

MassDOT did not identify any existing BMPs in place to treat roadway runoff from the discharging area before reaching the impaired water segment.

⁴ Walter, D.A., Masterson, J.P., and Hess, K.M., 2004, Ground-Water Recharge Areas and Traveltimes to Pumped Wells, Ponds, Streams, and Coastal Water Bodies, Cape Cod, Massachusetts, Scientific Investigations Map I-2857, 1 sheet. Available at: <http://pubs.water.usgs.gov/sim20042857>

⁵ U.S. Geological Survey (USGS). (2009). Groundwater contributing areas for Cape Cod and Plymouth-Carver Regions of Massachusetts. Data Series 451 (1 of 3).

Assessment

In cases where a TMDL has been approved, MassDOT assesses the water body for the impairments covered by the TMDL under the BMP 7R methodology.⁶ MassDOT separately assesses the water body for any stormwater-related impairments that are not covered by the TMDL under the BMP 7U methodology.⁷ MassDOT assessed Boat Meadow River (MA96-15) using the methodologies described below.

This assessment has been completed based on the *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*.¹ MassDEP has released a proposed *Massachusetts Year 2014 Integrated List of Waters*, which has been reviewed for any proposed changes to the condition of the water bodies.⁸ The condition of Boat Meadow River is not proposed to change.

BMP 7U for Nitrogen

MassDOT assessed the contribution of nitrogen from MassDOT properties to this water body using the approach described in BMP 7U⁷ of MassDOT's Storm Water Management Plan (Water Quality Impaired Waters Assessment and Mitigation Plan), which applies to impairments that have not been addressed by a TMDL, and MassDOT's application of BMP 7U to nitrogen in groundwater-controlled watersheds.⁹ Boat Meadow River (MA96-15) is impaired for estuarine bioassessments, which is typically related to eutrophication processes caused by excess nitrogen.¹⁰ Nitrogen loading was determined using a mass accounting approach as described in the BMP 7U for nitrogen methodology.⁹

For the nitrogen assessment under BMP 7U, MassDOT used USGS modeling¹¹ to estimate annual pollutant loads from its property. Based on the USGS SELDM model, which was run using precipitation data from an average of sites in Hyannis and Provincetown and an average of water quality data from Harwich and Marion, MassDOT estimates the nitrogen loading from impervious areas as 5.8 lbs/acre/yr and from pervious areas as 2.5 lbs/acre/yr.⁹ The nitrogen loading for MassDOT property in the contributing area is summarized below:

- MassDOT Impervious Area: 1.1 acres
- MassDOT Pervious Area: 0.9 acres
- Estimated Existing MassDOT Load: 8.5 lbs/yr
- Total Existing Groundwatershed Nitrogen Load: 5,294 lbs/yr

⁶ MassDOT, July 2010. BMP 7R: TMDL Watershed Review. Available at:
http://www.massdot.state.ma.us/Portals/8/docs/environmental/npdes/BMP_7R_TMDL_WatershedReview.pdf

⁷ MassDOT, April 2010. BMP 7U: Water Quality Impaired Waters Assessment and Mitigation Plan. Available at:
http://www.massdot.state.ma.us/Portals/8/docs/environmental/npdes/BMP_7U_ImpairedWaterbodiesAssessment.pdf

⁸ MassDOT, June 2014. Massachusetts Year 2014 Integrated List of Waters – Proposed Listing of the Condition of Massachusetts' Waters Pursuant to Sections 305(b), 314 and 303(d) of the Clean Water Act. Massachusetts. Available at: <http://www.mass.gov/eea/docs/dep/water/resources/07v5/14iwlstp.pdf>

⁹ MassDOT, June 2015. Application of BMP 7U to Nitrogen in Groundwater-Controlled Massachusetts Watersheds: Attachment 9.

¹⁰ CWP, 2003. Impacts of Impervious Cover on Aquatic Systems. Watershed Protection Research Monograph No. 1. Ellicott, Md.

¹¹ Granato, G.E., 2013. Stochastic empirical loading and dilution model (SELDM) version 1.0.0: U.S. Geological Survey Techniques and Methods, book 4, chap. C3, 112 p. Available at: <http://pubs.usgs.gov/tm/04/c03>

- MassDOT Existing Load as a Percentage of Total Groundwatershed
Nitrogen Load: 0.16 %

The MassDOT existing load compared to the total groundwatershed nitrogen load is very small and considered negligible based on MassDOT's Nitrogen TMDL Method because it is less than 3.5% of the total nitrogen groundwatershed load.⁹ In general, in areas where the MassDOT load is determined to be negligible, MassDOT does not implement BMPs because of their minimal impact on the overall groundwatershed load.

BMP 7R for Pathogen TMDL (CN 252.0)

MassDOT assessed the indicator bacteria (fecal coliform) impairment using the approach described in BMP 7R⁶ of MassDOT's Storm Water Management Plan (SWMP), which applies to impairments that have been assigned to a water body covered by a final TMDL. Boat Meadow River (MA96-15) is covered by the *Final Pathogen TMDL for the Cape Cod Watershed*.²

Pathogen concentrations in stormwater vary widely and concentrations can vary by an order of magnitude within a given storm event at a single location making it difficult to predict pathogen concentrations in stormwater with accuracy. MassDOT generally will not conduct site specific assessments of pathogen loading for each water body impaired for pathogens but instead developed an iterative adaptive management approach to be consistent with relevant TMDLs and permit condition requirements and an approach to stormwater management. Greater detail of the assessment methodology is provided in MassDOT's BMP 7R Pathogen Methodology.¹²

According to the Final TMDL, sources of indicator bacteria are believed to be primarily from boat wastes; failing septic systems; pets, wildlife, and birds; and stormwater. It should be noted that bacteria from wildlife would be considered a natural condition unless some form of human inducement, such as feeding, is causing congregation of wild birds or animals. Additionally, the TMDL states that implementation to achieve the TMDL goals should be an iterative process with selection and implementation of mitigation measures followed by monitoring to determine the extent of water quality improvement realized. Recommended TMDL implementation measures include identification and elimination of prohibited sources such as leaky or improperly connected sanitary sewer flows and best management practices to mitigate stormwater runoff volume.

The TMDL states that several impaired segments carry a higher priority due to their location, use, and risk to human health. The higher priority areas in the Cape Cod Watershed stand out as likely priority areas to address bacteria pollution sources. These segments tend to be located nearest to sensitive areas such as Outstanding Resource Waters or designated uses that require higher water quality standards than Class B. Boat Meadow River (MA96-15) is listed as a medium priority due to its designation as a Class SA, as well as its use for shellfishing.

In addition to the generic recommendations provided in the draft MS4 permit for Massachusetts, the Cape Cod Watershed TMDL report (Section 8.0) recommends the following specific BMPs to address elevated fecal coliform levels in the watershed:

- Correction of failing septic systems
- Public education regarding illicit sewer connection and failing infrastructure, as well as stormwater runoff and boat wastes

¹² MassDOT, December 2014. Description of MassDOT's Application of BMP 7R for Pathogen Related Impairments. Available at:
<http://www.massdot.state.ma.us/Portals/8/docs/environmental/impairedWaters/Year5/Attachment4.pdf>

- Identification and elimination of prohibited sources such as leaky or improperly connected sanitary sewer flows
- Best management practices to mitigate stormwater runoff volume

The TMDL report also indicates that structural BMPs may be appropriate if less costly non-structural BMPs are not effective. Many non-structural BMPs are in place, including public education and outreach, street sweeping, and catch basin cleanouts. In addition to practices like these, many communities have formed advisory committees to help resolve existing stormwater issues. Many of the communities on Cape Cod practice their own stormwater BMPs. Additionally, the TMDL states that implementation to achieve the TMDL goals should be an iterative process with selection and implementation of mitigation measures followed by monitoring to determine the extent of water quality improvement realized.

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

- Septic tank controls
- Documentation of storm drain outfall locations
- Resident education
- Additional water quality monitoring
- Designation of "No Discharge" areas in high priority coastal waters
- Annual street sweeping and catch basin cleaning

Proposed Mitigation Plan

As described above, MassDOT's nitrogen contribution to the receiving water is negligible. Therefore, MassDOT has no plans to implement structural BMPs to control nitrogen in stormwater runoff from their property under the Impaired Waters Program.

With respect to the fecal coliform impairment, MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing SWMP including educational programs, illicit connection review and source control. As discussed in MassDOT's BMP 7R Pathogen Methodology, MassDOT believes that existing efforts are consistent with the current and draft MS4 permit requirements and TMDL recommendations in regard to pathogens.

In accordance with the BMPs identified in the TMDL report as planned measures to reach compliance with the Cape Cod Pathogen TMDL report, 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 targeted rest stops are located within the groundwatershed of this water body. MassDOT will be installing signs at rest stops within the groundwatershed of pathogen impaired water bodies. The signs will inform the public of the need to remove pet waste, which can minimize contributions of pathogens to stormwater runoff. Pet waste removal bags and disposal cans will be provided.

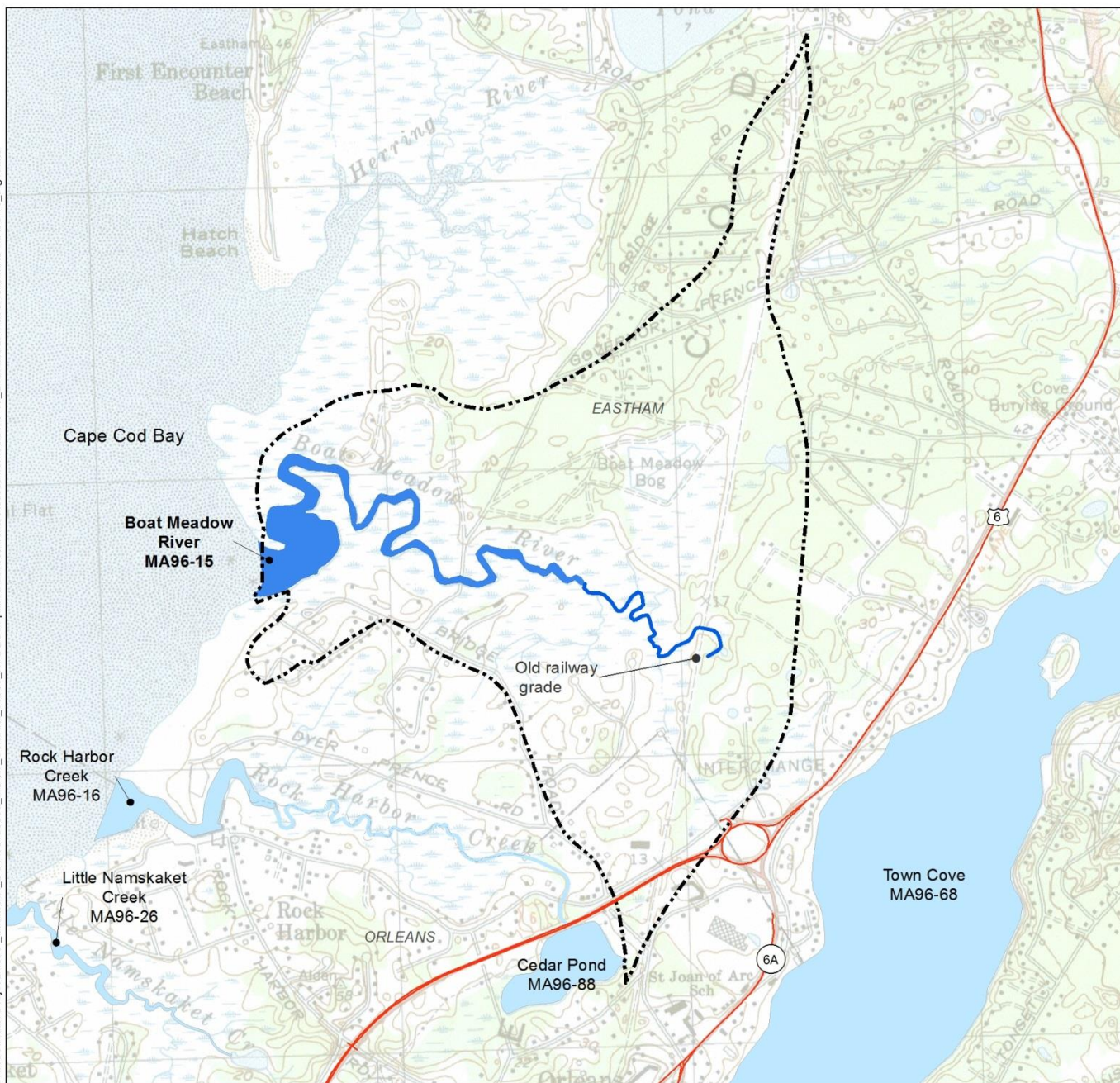
Although the TMDL report also identifies the benefits of structural BMPs to address pathogens in runoff from impervious areas in some instances, MassDOT feels that it is not a beneficial approach to implement these BMPs in advance of other ongoing BMP efforts identified in the groundwatershed, given the documented variability of pathogen concentrations in highway runoff, and the low probability of achieving substantial gains towards meeting the TMDL with solely implementing stormwater controls.

Furthermore, MassDOT has an ongoing inspection and monitoring program aimed at identifying and addressing illicit discharges to MassDOT's stormwater management system. 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 groundwatershed of this water body that could be contributing pathogens to the impaired water body.

MassDOT has concluded that the BMPs outlined in the SWMP are consistent with its existing permit requirements for Boat Meadow River. 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 MassDOT roadways to be a contributing source it is unlikely to warrant action relative to other sources of pathogens in the groundwatershed.

MassDOT will continue to ensure proper non-structural BMPs are being implemented within the groundwatershed of Boat Meadow River, including regular roadway and drainage system maintenance, erosion and sedimentation control, and outreach and education. As described in MassDOT's Stormwater Handbook,¹³ MassDOT does not use nitrogen based fertilizers as part of normal operations and maintenance procedures. In the rare circumstance where fertilizers are used, it is for the occasional vegetation establishment associated with recent ground disturbance. Further work by MassDOT on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to address impairments. MassDOT will include an update in NPDES permit annual reports to EPA regarding proposed BMP design either through retrofit or programmed projects, plans for construction of BMPs, reduction achieved by finalized BMP designs and progress made towards meeting target reductions.

¹³ MassDOT, May 2004. The MassHighway Storm Water Handbook for Highways and Bridges. Available at: http://www.massdot.state.ma.us/Portals/8/docs/environmental/wetlands/Stormwater_Handbook.pdf



- MassDOT Roadways in Urban Area
- ⋯ Groundwatershed
- Assessed Segment
- ⬮ Assessed Segment
- ⬮ Impaired Lakes
- Impaired Streams

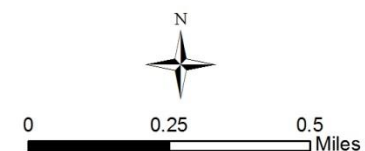
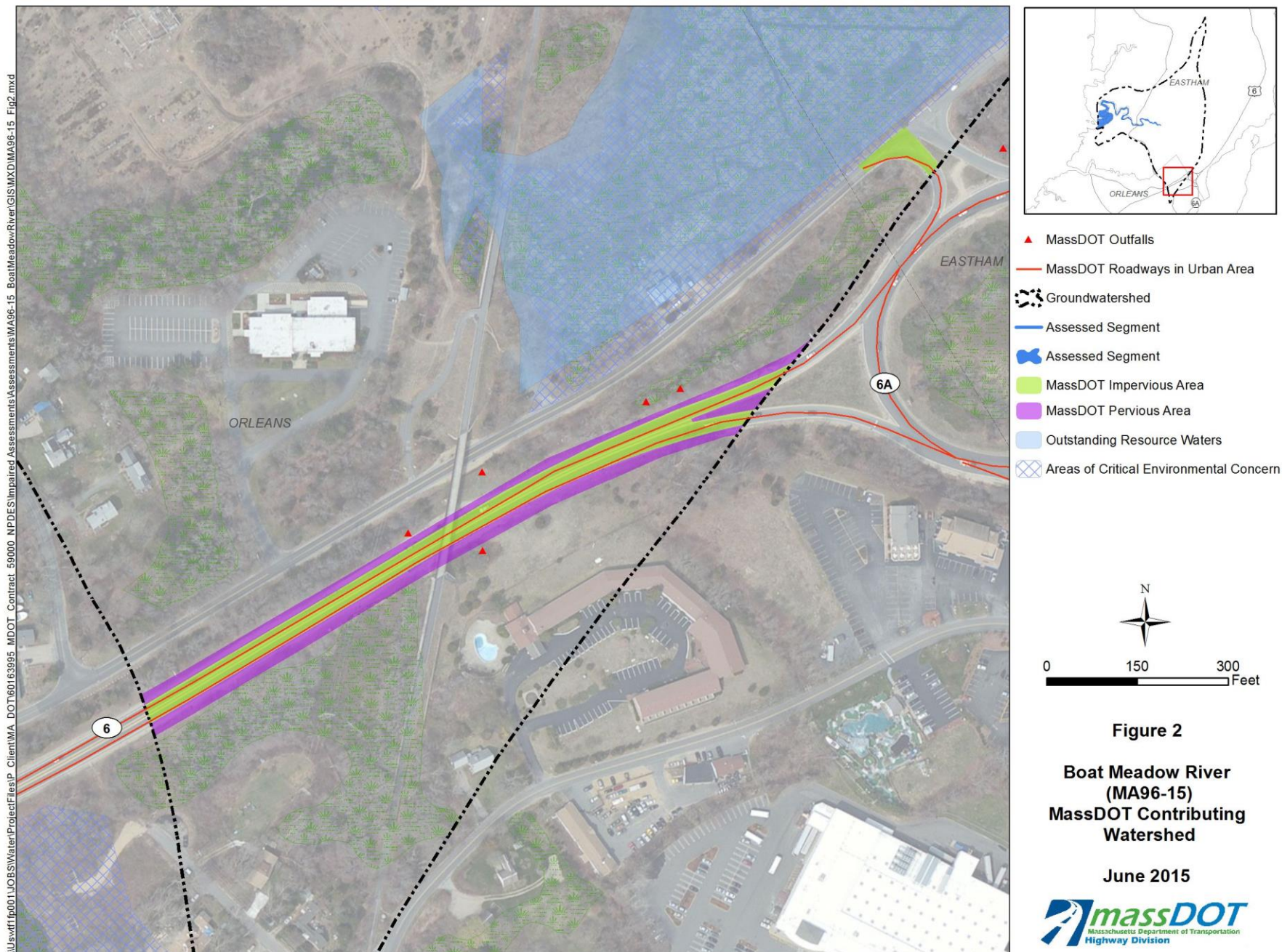


Figure 1
Boat Meadow River
(MA96-15)
Groundwatershed

June 2015





Impaired Waters Assessment for Herring River (MA96-33)

Summary

Impaired Water¹	Stormwater Impairments:	<i>Aluminum; Estuarine Bioassessments; Fecal Coliform; pH, Low</i>
	Non - Stormwater Impairments:	<i>Fish-Passage Barrier; Other flow regime alterations</i>
	Category:	<i>5 (Waters requiring a TMDL)</i>
	Final TMDLs:	<i>Final Pathogen TMDL for the Cape Cod Watershed (CN 252.0)²</i>
	WQ Assessment:	<i>Cape Cod Coastal Drainage Areas 2004-2008 Surface Water Quality Assessment Report³</i>
Location	Towns:	<i>Truro and Wellfleet</i>
	MassDOT Roads:	<i>Route 6</i>
Assessment Method(s)	7R (TMDL Method) <input checked="" type="checkbox"/>	7U (Non-TMDL Method) <input checked="" type="checkbox"/>
BMPs	Existing:	<i>None</i>
MassDOT Area and Targets		Nitrogen
	Estimated MassDOT Load:	<i>91.1 lbs/yr</i>
	Existing Load to Water Body:	<i>37,824 lbs/yr</i>
	MassDOT Contribution to Existing Load:	<i>0.24 %</i>

Site Description

Herring River (MA96-33) is a 0.40 square mile water body which extends from Griffin Island to Wellfleet Harbor in Wellfleet, Massachusetts. Figure 1 illustrates the groundwatershed for Herring

¹ MassDEP, March 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. Massachusetts. Available at: <http://www.mass.gov/eea/docs/dep/water/resources/07v5/12list2.pdf>

² MassDEP, 2009. Final Pathogen TMDL for the Cape Cod Watershed. Available at: <http://www.mass.gov/eea/docs/dep/water/resources/a-thru-m/capecod1.pdf>

³ MassDEP, May 2011. Cape Cod Coastal Drainage Areas 2004-2008 Surface Water Quality Assessment Report. Available at: <http://www.mass.gov/eea/docs/dep/water/resources/71wqar09/96wqar12.pdf>

River (MA96-33). The groundwatersheds for Cape Cod and adjacent Southeastern Massachusetts Communities were provided by USGS based on groundwater modeling developed under the Massachusetts Estuary Program (MEP) and contributing groundwater areas as delineated and published in the USGS 451 groundwater contributing areas data.^{4,5} The watersheds in Cape Cod and adjacent Southeastern Massachusetts Communities are based on groundwater delineations and not ground surface topography.⁴ For groundwatershed assessments with impairments related to nitrogen, if a discharge occurs inside the groundwatershed boundary, it is considered to be a discharge that contributes to the impaired segment. If the discharge point is outside of the groundwatershed boundary, it is not considered to contribute to the impaired segment. MassDOT property in the urban area that contributes runoff or infiltration within the groundwatershed area is considered in this assessment as contributing to Herring River (MA96-33).

MassDEP's Water Quality Assessment Report titled *Cape Cod Coastal Drainage Areas 2004-2008 Surface Water Quality Assessment Report*³ lists the Aquatic Life Use as "impaired" for the upper 0.071 mi² due to low PH, aluminum, other flow regime alterations, and fish passage barrier. Aquatic Life Use is listed as "impaired" for the lower 0.324 mi² due to loss of eelgrass bed habitat. Shellfish Harvesting Use for Herring River is listed as "impaired" due to elevated fecal coliform bacteria from marina/boating pump-out releases, waterfowl, waste from pets, on-site (septic) systems, and unspecified urban stormwater. The Fish Consumption Use, Primary and Secondary Recreational Uses and Aesthetics are listed as "not assessed".

Figure 2 shows the MassDOT-owned property within urban area that is contributing to the groundwatershed of Herring River. Route 6 extends in a north-west direction through the eastern side of the groundwatershed. Approximately 8.7 acres of impervious area along Route 6 from Cranberry Hollow Road to Lecount Hollow Road is considered to be contributing stormwater runoff to Herring River. Stormwater runoff from this section of roadway is collected with catch basin and discharged to the adjacent areas within the groundwatershed to infiltrate into the ground. Based on field observations, drainage from the high point of Route 6 at Lecount Hollow Road to the southern groundwatershed boundary discharges outside the groundwatershed boundary. Runoff from the impervious surface for this section of road is collected with a catch basin network which discharges to Blackfish Creek, outside of the groundwatershed boundary. This section of Route 6 is not considered contributing property to Herring River. The pervious area within the MassDOT right-of-way of Route 6 within the groundwatershed boundaries is considered contributing area to the Herring River groundwatershed. Way 112, with approximately 0.86 acres of impervious area, is also considered contributing area to Herring River, along with the impervious area within its right-of-way.

It should be noted in Figure 2, that the Inner Cape Cod Area of Environmental Concern is located near these roadways within the groundwatershed.

Existing BMPs

MassDOT did not identify any existing BMPs in place to treat roadway runoff from the discharging area before reaching the impaired water segment.

⁴ Walter, D.A., Masterson, J.P., and Hess, K.M., 2004, Ground-Water Recharge Areas and Traveltimes to Pumped Wells, Ponds, Streams, and Coastal Water Bodies, Cape Cod, Massachusetts, Scientific Investigations Map I-2857, 1 sheet. Available at: <http://pubs.water.usgs.gov/sim20042857>

⁵ U.S. Geological Survey (USGS). (2009). Groundwater contributing areas for Cape Cod and Plymouth-Carver Regions of Massachusetts. Data Series 451 (1 of 3).

Assessment

In cases where a TMDL has been approved, MassDOT assesses the water body for the impairments covered by the TMDL under the BMP 7R methodology.⁶ MassDOT separately assesses the water body for any stormwater-related impairments that are not covered by the TMDL under the BMP 7U methodology.⁷ MassDOT assessed Herring River (MA96-33) using the methodologies described below.

MassDOT has identified a subset of water body impairments in the Herring River watershed that are not related to stormwater runoff. These impairments include fish-passage barrier and other flow regime alterations not related to stormwater. In accordance with MassDOT's *Impaired Waters Assessment for Impaired Waters with Impairments Unrelated to Stormwater* in the December 8, 2012 EPA submittal, the non-stormwater related impairments are not specifically addressed as part of the Impaired Waters Program.⁸

This assessment has been completed based on the *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*.¹ MassDEP has released a proposed *Massachusetts Year 2014 Integrated List of Waters*, which has been reviewed for any proposed changes to the condition of the water bodies.⁹ The condition of Herring River is not proposed to change.

BMP 7U for Nitrogen

MassDOT assessed the contribution of nitrogen from MassDOT properties to this water body using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (Water Quality Impaired Waters Assessment and Mitigation Plan), which applies to impairments that have not been addressed by a TMDL, and MassDOT's application of BMP 7U to nitrogen in groundwater-controlled watersheds.¹⁰ Herring River (MA96-33) is impaired for estuarine bioassessments, which is typically related to eutrophication processes caused by excess nitrogen.¹¹ Nitrogen loading was determined using a mass accounting as described in the BMP 7U for nitrogen methodology.

For the nitrogen assessment under BMP 7U, MassDOT used USGS modeling¹² to estimate annual pollutant loads from its property. Based on the USGS SELDM, which was run using precipitation data from an average of sites in Hyannis and Provincetown and an average of water quality data from Harwich and Marion, MassDOT estimates the nitrogen loading from impervious areas as 5.8

⁶ MassDOT, July 2010. BMP 7R: TMDL Watershed Review. Available at:

http://www.massdot.state.ma.us/Portals/8/docs/environmental/npdes/BMP_7R_TMDL_WatershedReview.pdf

⁷ MassDOT, April 2010. BMP 7U: Water Quality Impaired Waters Assessment and Mitigation Plan. Available at:

http://www.massdot.state.ma.us/Portals/8/docs/environmental/npdes/BMP_7U_ImpairedWaterbodiesAssessment.pdf

⁸ MassDOT, December 2012. Impaired Waters Assessment for Impaired Waters with Impairments Unrelated to Stormwater. Available at:

http://www.massdot.state.ma.us/Portals/8/docs/environmental/impairedWaters/Year3/Year3_ImpairedWatersAssessment_1.pdf#page=308

⁹ MassDEP, June 2014. Massachusetts Year 2014 Integrated List of Waters – Proposed Listing of the Condition of Massachusetts' Waters Pursuant to Sections 305(b), 314 and 303(d) of the Clean Water Act. Massachusetts. Available at: <http://www.mass.gov/eea/docs/dep/water/resources/07v5/14iwlisp.pdf>

¹⁰ MassDOT, June 2015. Application of BMP 7U to Nitrogen in Groundwater-Controlled Massachusetts Watersheds: Attachment 9.

¹¹ CWP, 2003. Impacts of Impervious Cover on Aquatic Systems. Watershed Protection Research Monograph No. 1. Ellicott, Md.

¹² Granato, G.E., 2013. Stochastic empirical loading and dilution model (SELDM) version 1.0.0: U.S. Geological Survey Techniques and Methods, book 4, chap. C3, 112 p. Available at: <http://pubs.usgs.gov/tm/04/c03>

lbs/acre/yr and from pervious areas as 2.5 lbs/acre/yr.¹⁰ The nitrogen loading for MassDOT property in the contributing area is summarized below:

- MassDOT Impervious Area: 9.6 acres
- MassDOT Pervious Area: 14.2 acres
- Estimated Existing MassDOT Load: 91.1 lbs/yr
- Total Existing Groundwatershed Nitrogen Load: 37,824 lbs/yr
- MassDOT Existing Load as a Percentage of Total Groundwatershed Nitrogen Load: 0.24 %

The MassDOT existing load compared to the total groundwatershed nitrogen load is very small and considered negligible based on MassDOT's Nitrogen TMDL Method because it is less than 3.5% of the total nitrogen groundwatershed load.¹⁰ In general, in areas where the MassDOT load is determined to be negligible, MassDOT does not implement BMPs under the Impaired Waters Program because of their minimal impact on the overall groundwatershed load.

BMP 7R for Pathogen TMDL (CN 252.0)

MassDOT assessed the indicator bacteria (fecal coliform) impairment using the approach described in BMP 7R of MassDOT's Storm Water Management Plan (SWMP), which applies to impairments that have been assigned to a water body covered by a final TMDL. Herring River (MA96-33) is covered by the *Final Pathogen TMDL for the Cape Cod Watershed*.²

Pathogen concentrations in stormwater vary widely and concentrations can vary by an order of magnitude within a given storm event at a single location making it difficult to predict pathogen concentrations in stormwater with accuracy. MassDOT generally will not conduct site specific assessments of pathogen loading for each water body impaired for pathogens but instead developed an iterative adaptive management approach to be consistent with relevant TMDLs and permit condition requirements and an approach to stormwater management. Greater detail of the assessment methodology is provided in MassDOT's BMP 7R Pathogen Methodology.¹³

According to the final TMDL, sources of indicator bacteria are believed to be primarily from boat wastes, failing septic systems, pets, wildlife, birds, and stormwater. It should be noted that bacteria from wildlife would be considered a natural condition unless some form of human inducement, such as feeding, is causing congregation of wild birds or animals. Additionally, the TMDL states that implementation to achieve the TMDL goals should be an iterative process with selection and implementation of mitigation measures followed by monitoring to determine the extent of water quality improvement realized. Recommended TMDL implementation measures include identification and elimination of prohibited sources such as leaky or improperly connected sanitary sewer flows and best management practices to mitigate stormwater runoff volume.

The TMDL states that several impaired segments carry a higher priority due to their location, use, and risk to human health. These segments tend to be located nearest to sensitive areas such as Outstanding Resource Waters or designated uses that require higher water quality standards than Class B. Herring River (MA96-33) is listed as a high priority due to its designation as an Outstanding Resource Water.

¹³ MassDOT, December 2014. Description of MassDOT's Application of BMP 7R for Pathogen Related Impairments. Available at:
<http://www.massdot.state.ma.us/Portals/8/docs/environmental/impairedWaters/Year5/Attachment4.pdf>

In addition to the generic recommendations provided in the draft MS4 permit for Massachusetts, the Cape Cod Watershed TMDL report (Section 8.0) recommends the following specific BMPs to address elevated fecal coliform levels in the watershed:

- Correction of failing septic systems
- Public education regarding illicit sewer connection and failing infrastructure, as well as stormwater runoff and boat wastes
- Identification and elimination of prohibited sources such as leaky or improperly connected sanitary sewer flows
- Best management practices to mitigate stormwater runoff volume

The TMDL report also indicates that structural BMPs may be appropriate if less costly non-structural BMPs are not effective. Many non-structural BMPs are in place, including public education and outreach, street sweeping, and catch basin cleanouts. In addition to practices like these, many communities have formed advisory committees to help resolve existing stormwater issues. Many of the communities on Cape Cod practice their own stormwater BMPs. Additionally, the TMDL states that implementation to achieve the TMDL goals should be an iterative process with selection and implementation of mitigation measures followed by monitoring to determine the extent of water quality improvement realized.

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

- Septic tank controls
- Documentation of storm drain outfall locations
- Resident education
- Additional water quality monitoring
- Designation of "No Discharge" areas in high priority coastal waters
- Annual street sweeping and catch basin cleaning

Proposed Mitigation Plan

As described above, MassDOT's nitrogen contribution to the receiving water is negligible. Therefore, MassDOT has no plans to implement structural BMPs to control nitrogen in stormwater runoff from their property under the Impaired Waters Program.

With respect to the fecal coliform impairment, MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing SWMP including educational programs, illicit connection review and source control. As discussed in MassDOT's BMP 7R Pathogen Methodology, MassDOT believes that existing efforts are consistent with the current and draft MS4 permit requirements and TMDL recommendations in regard to pathogens.

In accordance with the BMPs identified in the TMDL report as planned measures to reach compliance with the Cape Cod Pathogen TMDL report, 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 targeted rest stops are located within the groundwatershed of this water body. MassDOT will be installing signs at rest stops within the groundwatershed of pathogen impaired water bodies. The signs will inform the public of the need to remove pet waste, which can minimize contributions of pathogens to stormwater runoff. Pet waste removal bags and disposal cans will be provided.

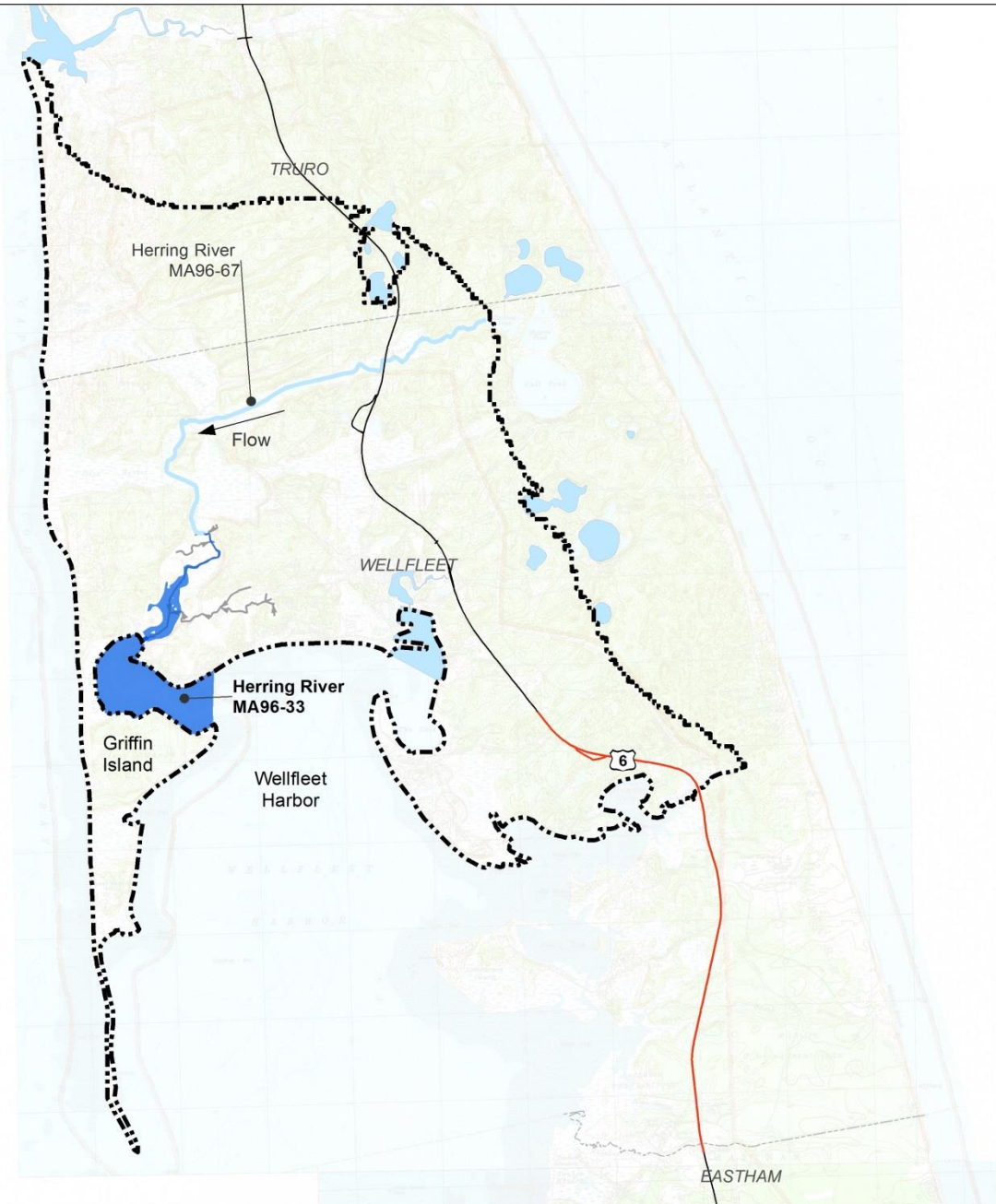
Although the TMDL report also identifies the benefits of structural BMPs to address pathogens in runoff from impervious areas in some instances, MassDOT feels that it is not a beneficial approach to implement these BMPs in advance of other ongoing BMP efforts identified in the groundwatershed, given the documented variability of pathogen concentrations in highway runoff, and the low probability of achieving substantial gains towards meeting the TMDL with solely implementing stormwater controls.

Furthermore, MassDOT has an ongoing inspection and monitoring program aimed at identifying and addressing illicit discharges to MassDOT's stormwater management system. 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 groundwatershed of this water body that could be contributing pathogens to the impaired water body.

MassDOT has concluded that the BMPs outlined in the SWMP are consistent with its existing permit requirements for Herring River. 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 MassDOT roadways to be a contributing source it is unlikely to warrant action relative to other sources of pathogens in the groundwatershed.

MassDOT will continue to ensure proper non-structural BMPs are being implemented within the groundwatershed of Herring River, including regular roadway and drainage system maintenance, erosion and sedimentation control, and outreach and education. As described in MassDOT's Stormwater Handbook,¹⁴ MassDOT does not use nitrogen based fertilizers as part of normal operations and maintenance procedures. In the rare circumstance where fertilizers are used, it is for the occasional vegetation establishment associated with recent ground disturbance. Further work by MassDOT on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to address impairments. MassDOT will include an update in NPDES permit annual reports to EPA regarding proposed BMP design either through retrofit or programmed projects, plans for construction of BMPs, reduction achieved by finalized BMP designs and progress made towards meeting target reductions.

¹⁴ MassDOT, May 2004. The MassHighway Storm Water Handbook for Highways and Bridges. Available at: http://www.massdot.state.ma.us/Portals/8/docs/environmental/wetlands/Stormwater_Handbook.pdf



- MassDOT Roadways in Urban Area
- MassDOT Roadways
- - - Groundwatershed
- Assessed Segment
- Assessed Segment
- Impaired Lakes
- Impaired Streams
- Non-Impaired Streams

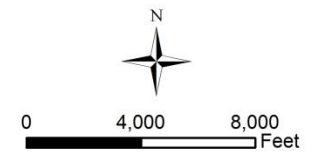
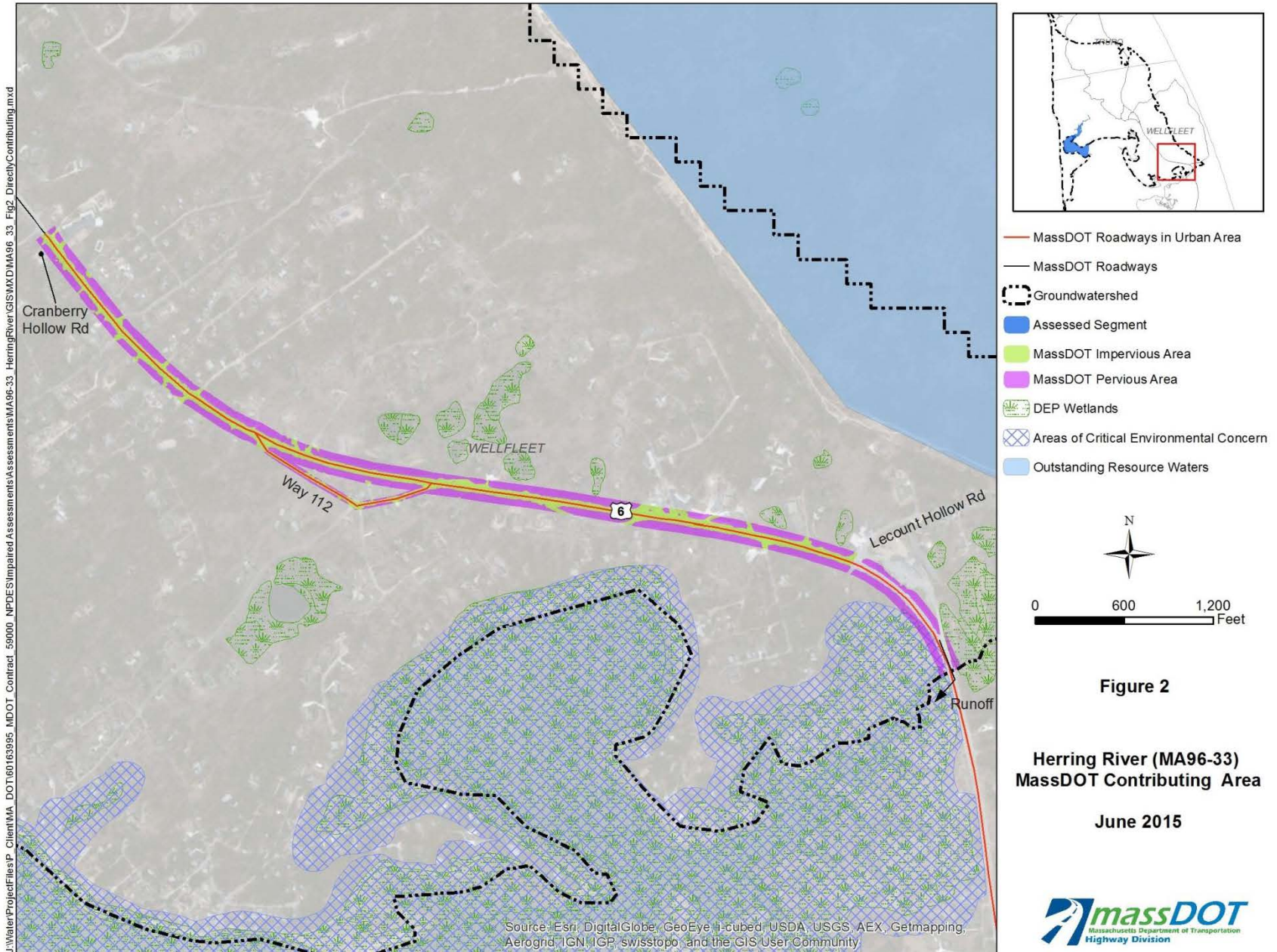


Figure 1
Herring River (MA96-33)
Groundwatershed

June 2015





Impaired Waters Assessment for Cedar Pond (MA96-88)

Summary

Impaired Water¹	Stormwater Impairments:	<i>Chlorophyll-a; Dissolved Oxygen; Dissolved Oxygen Saturation</i>
	Category:	<i>5 (Waters requiring a TMDL)</i>
	Final TMDLs:	<i>None</i>
	WQ Assessment:	<i>Cape Cod Coastal Drainage Areas 2004-2008 Water Quality Assessment Report²</i>
Location	Towns:	<i>Orleans</i>
	MassDOT Roads:	<i>Route 6A</i>
Assessment Method(s)	7R (TMDL Method) <input type="checkbox"/>	7U (Non-TMDL Method) <input checked="" type="checkbox"/>
BMPs	Existing:	<i>None</i>
MassDOT Area and Targets		Nitrogen
	Estimated MassDOT Load:	<i>8.7 lbs/yr</i>
	Existing Load to Water Body:	<i>875 lbs/yr</i>
	MassDOT Contribution to Existing Load:	<i>1.0 %</i>

Site Description

Cedar Pond (MA96-88) is a 0.03 square mile water body located south of Route 6 in Orleans, Massachusetts. The outlet of Cedar Pond is the headwaters for Rock Harbor Creek (MA96-16) which flows north beneath Route 6 and continues to Cape Cod Bay. Figure 1 illustrates the groundwatershed for Cedar Pond. The groundwatershed for this segment is based on technical

¹ MassDEP, March 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. Massachusetts. Available at: <http://www.mass.gov/eea/docs/dep/water/resources/07v5/12list2.pdf>

² MassDEP, May 2011. Cape Cod Coastal Drainage Areas 2004-2008 Surface Water Quality Assessment Report. Available at: <http://www.mass.gov/eea/docs/dep/water/resources/71wqar09/96wqar12.pdf>

reports³ developed by the Massachusetts Estuaries Project (MEP). The MEP team includes technical staff from USGS and the Cape Cod Commission and works collaboratively with MassDEP and the University of Massachusetts Dartmouth School of Marine Science and Technology to refine USGS groundwatersheds boundaries for receiving waters on Cape Cod. For groundwatershed assessments with impairments related to nitrogen, if a discharge occurs inside the groundwatershed boundary, it is considered to be a discharge that contributes to the impaired segment. If the discharge point is outside of the groundwatershed boundary, it is not considered to contribute to the impaired segment. MassDOT property within the urban area that contributes runoff or infiltration within the groundwatershed area is considered in this assessment as contributing to Cedar Pond (MA96-88).

MassDEP's Water Quality Assessment Report titled *Cape Cod Coastal Drainage Areas 2004-2008 Surface Water Quality Assessment Report*² lists the Aquatic Life Use as "impaired". The report states that the known cause of the impaired status is due to low dissolved oxygen, elevated chlorophyll-a and supersaturation of dissolved oxygen. The suspected sources are changes in ordinary stratification and bottom water hypoxia/anoxia, changes in tidal circulation/flushing, and internal nutrient recycling. No other uses are assessed; however, it is also noted that there is no shellfish harvesting area associated with Cedar Pond. Additionally, the Town of Orleans is a Phase II community that has NPDES permit coverage for their municipal separate storm sewer system (MAR041146). The permit requires that the town of Orleans develop, implement and enforce a stormwater management program and reduce the discharge of pollutants from their system. Land use within the groundwatershed of Cedar Pond is primarily residential, with commercial land uses in the vicinity of Route 6A.

Figure 2 illustrates the MassDOT-owned property within urban area that is contributing to the groundwatershed of Cedar Pond. Route 6A extends in a northeast and southwest direction through the middle of the groundwatershed (Figure 2). Roadway runoff that discharges within the groundwatershed boundary and infiltrates into the ground is considered contributing to Cedar Pond. Runoff from approximately 500 linear feet of Route 6A is collected in a local catch basin network that discharges inside the boundary of the groundwatershed north of Route 6A. In addition, approximately 350 linear feet of impervious cover along Route 6A extending beyond the groundwatershed boundary to the southwest flows into the same drainage system that discharges within the groundwatershed boundary and is considered "Supplemental Contributing Area". Any impervious area located outside of the groundwatershed boundary that flows back into the groundwatershed via sheet flow, drainage pipes, or other means is considered "Supplemental". The northern portion of Route 6A within the groundwatershed boundary is not considered contributing to Cedar Pond, as the runoff from this portion of the roadway flows to a catch basin network that discharges to Boland Pond which is located outside of the groundwatershed. Although there is a second outfall that appears to discharge runoff from Route 6A within the groundwatershed (Figure 2), based on field verification, this outfall was identified to be a paved spillway collecting runoff from a private property, and not MassDOT property. However, the pervious areas within the groundwatershed are considered contributing to Cedar Pond as any runoff via sheetflow would infiltrate into the ground within the groundwatershed boundary.

Existing BMPs

MassDOT did not identify any existing BMPs in place to treat roadway runoff from the discharging area before reaching the impaired water segment.

³ MassDEP, December 2008. Massachusetts Estuaries Project Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Threshold for the Rock Harbor Embayment System, Orleans, Massachusetts. Available at: http://www.oceanscience.net/estuaries/report/Orleans/Rock_Harbor_MEPrpt_final.pdf

Assessment

In cases where a TMDL has been approved, MassDOT assesses the water body for the impairments covered by the TMDL under the BMP 7R methodology.⁴ MassDOT separately assesses the water body for any stormwater-related impairments that are not covered by the TMDL under the BMP 7U methodology.⁵ MassDOT assessed Cedar Pond (MA96-88) using the methodologies described below.

This assessment has been completed based on the *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*.¹ MassDEP has released a proposed *Massachusetts Year 2014 Integrated List of Waters*, which has been reviewed for any proposed changes to the condition of the water bodies.⁶ The condition of Cedar Pond is not proposed to change.

BMP 7U for Nitrogen

MassDOT assessed the contribution of nitrogen from MassDOT properties to this water body using the approach described in BMP 7U⁵ of MassDOT's Storm Water Management Plan (Water Quality Impaired Waters Assessment and Mitigation Plan), which applies to impairments that have not been addressed by a TMDL, and MassDOT's application of BMP 7U to nitrogen in groundwater-controlled watersheds.⁷ The MEP technical report identifies the total nitrogen loading from the groundwatershed for this water body, and attributes the level of oxygen depletion and high organic matter loads from phytoplankton production (chlorophyll-a levels) to excess nitrogen loading from the groundwatershed and eutrophication of these estuarine systems.⁸ Therefore, MassDOT considers the following impairments to Cedar Pond (MA96-88) to be linked to elevated nitrogen: dissolved oxygen, dissolved oxygen supersaturation and chlorophyll-a.

For the nitrogen assessment under BMP 7U, MassDOT used USGS modeling⁹ to estimate annual pollutant loads from its property. Based on the USGS SELDM model, which was run using precipitation data from an average of sites in Hyannis and Provincetown and an average of water quality data from Harwich and Marion, MassDOT estimates the nitrogen loading from impervious areas as 5.8 lbs/acre/yr and from pervious areas as 2.5 lbs/acre/yr.⁷ The nitrogen loading for MassDOT property in the contributing area is summarized below:

- MassDOT Impervious Area: 1.1 acres
- MassDOT Pervious Area: 0.8 acres
- Estimated Existing MassDOT Load: 8.4 lbs/yr

⁴ MassDOT, July 2010. BMP 7R: TMDL Watershed Review. Available at:
http://www.massdot.state.ma.us/Portals/8/docs/environmental/npdes/BMP_7R_TMDL_WatershedReview.pdf

⁵ MassDOT, April 2010. BMP 7U: Water Quality Impaired Waters Assessment and Mitigation Plan. Available at:
http://www.massdot.state.ma.us/Portals/8/docs/environmental/npdes/BMP_7U_ImpairedWaterbodiesAssessment.pdf

⁶ MassDOT, June 2014. Massachusetts Year 2014 Integrated List of Waters – Proposed Listing of the Condition of Massachusetts' Waters Pursuant to Sections 305(b), 314 and 303(d) of the Clean Water Act. Massachusetts. Available at: <http://www.mass.gov/eea/docs/dep/water/resources/07v5/14iwlstp.pdf>

⁷ MassDOT, June 2015. Application of BMP 7U to Nitrogen in Groundwater-Controlled Massachusetts Watersheds: Attachment 9

⁸ Massachusetts Estuaries Project, December 2008. Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Threshold for the Rock Harbor Embayment System, Orleans, Massachusetts. Available at: http://www.oceanscience.net/estuaries/report/Orleans/Rock_Harbor_MEPrpt_final.pdf

⁹ Granato, G.E., 2013. Stochastic empirical loading and dilution model (SELDM) version 1.0.0: U.S. Geological Survey Techniques and Methods, book 4, chap. C3, 112 p. Available at: <http://pubs.usgs.gov/tm/04/c03>

- Total Existing Groundwatershed Nitrogen Load: 875 lbs/yr
- MassDOT Existing Load as a Percentage of Total Groundwatershed Nitrogen Load: 1.0%

The MassDOT existing load compared to the total groundwatershed nitrogen load is very small and considered negligible based on MassDOT's Nitrogen TMDL Method because it is less than 3.5% of the total nitrogen groundwatershed load.⁷ In general, in areas where the MassDOT load is determined to be negligible, MassDOT does not implement BMPs because of their minimal impact on the overall groundwatershed load under the Impaired Waters Program.

Proposed Mitigation Plan

As described above, MassDOT's nitrogen contribution to the receiving water is negligible. Therefore, MassDOT has no plans to implement structural BMPs to control nitrogen in stormwater runoff from their property under the Impaired Waters Program.

MassDOT will continue to ensure proper non-structural BMPs are being implemented within the groundwatershed of Cedar Pond, including regular roadway and drainage system maintenance, erosion and sedimentation control, and outreach and education. As described in MassDOT's Stormwater Handbook,¹⁰ MassDOT does not use nitrogen based fertilizers as part of normal operations and maintenance procedures. In the rare circumstance where fertilizers are used, it is for the occasional vegetation establishment associated with recent ground disturbance.

Further work by MassDOT on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to address impairments. MassDOT will include an update in NPDES permit annual reports to EPA regarding proposed BMP design either through retrofit or programmed projects, plans for construction of BMPs, reduction achieved by finalized BMP designs and progress made towards meeting target reductions.

¹⁰ MassDOT, May 2004. The MassHighway Storm Water Handbook for Highways and Bridges. Available at: http://www.massdot.state.ma.us/Portals/8/docs/environmental/wetlands/Stormwater_Handbook.pdf

