MASSACHUSETTS watershed·based plans

WATERSHED-BASED PLAN

Malden River (MA71-05)

September 2022

Prepared By:

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Prepared For:

MassDEP
Commonwealth of Massachusetts
Department of Environmental Protection

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Contents

Executive Summary

Introduction: The purpose of a Massachusetts Watershed-Based Plan (WBP) is to organize information about Massachusetts' watersheds and present the information in a format that will enhance the development and implementation of projects that will restore water quality and beneficial uses in the Commonwealth. The Massachusetts WBP follows the United States Environmental Protection Agency's (EPA's) recommended format for "nine-element" watershed plans. This WBP was developed by Geosyntec Consultants (Geosyntec) under the direction of the Mystic River Watershed Association (MyRWA), with funding, input, and collaboration from the Massachusetts Department of Environmental Protection (MassDEP).

This WBP was prepared for the Malden River watershed, which is located just north of Boston in the cities and towns of Malden, Everett, Melrose, Stoneham, Medford, and Wakefield, Massachusetts. The watershed is highly urbanized and within municipal separate storm sewer (MS4) areas. Spot Pond is located in the headwaters of the watershed and discharges into Spot Pond Brook, which flows into channelized and piped conveyances throughout areas of Melrose and Malden. Ell Pond is also located in the headwaters of the watershed and discharges into piped conveyances in Melrose, Massachusetts. The Malden River daylights from two sets of stormwater culverts south of Malden Center and flows for approximately 2 miles through Malden and along the border between the cities of Medford and Everett before its confluence with the Mystic River, directly upstream of the Amelia Earhart Dam. The Malden River watershed is located within the Mystic River basin and is approximately 7,000 acres (11 square miles).

Impairments and Pollution Sources: The Malden River (MA71-05) is identified as a category 5 waterbody on the MassDEP 2018/2020 Massachusetts Integrated List of Waters (303(d) List) due to numerous impairments including debris, flocculant masses, oil and grease, scum/ foam, transparency/ clarify, trash, chlordane in fish tissue, DDT in fish tissue, PCBs in fish tissue, dissolved oxygen (DO), DO supersaturation, high pH, total phosphorus (TP), sediment bioassay, temperature, total suspended solids (TSS), water chestnut, *Escherichia coli (E. coli)*, and fecal coliform due to discharges from municipal separate storm sewers (MS4s), illegal dumps, introduction of non-native organisms, combined sewer overflows, contaminated sediments, impervious surface/ parking lot runoff, and unknown sources. Additionally, the Malden River watershed is included in the Final Pathogen total maximum daily load (TMDL) for the Boston Harbor, Weymouth-Weir, and Mystic Watersheds (MassDEP et al., 2018) and in the TP "Alternative" TMDL for the Mystic River watershed (ERG et al., 2020).

Goals, Management Measures, and Funding: Water quality goals for this WBP are focused on addressing the pathogen TMDL and the listed TP, bacteria and DO impairments. The pollutant load reductions needed to achieve water quality goals are focused on TP. It is expected that efforts to reduce TP loading will also result in improvements to *E. coli* and DO in the Malden River watershed. This WBP includes an adaptive sequence to establish and track specific water quality goals. First, an interim goal has been established to reduce TP loading by 290 pounds/year in the next ten years. From there, the focus will be shifted to the long-term goal of delisting all assessment units within the study area based on adaptively adjusting goals based on ongoing monitoring results.

It is expected that goals will be accomplished primarily through the installation of structural best management practices (BMPs) to capture runoff and reduce loading as well as implementation of non-structural BMPs (e.g., street sweeping, catch basin cleaning), and watershed education and outreach. A desktop analysis identified

twenty structural BMP opportunity locations and a subsequent field investigation identified the top six locations; BMP concept sheets were developed for these six locations and the concepts were prioritized.

It is expected that funding for management measures will be obtained from a variety of sources including Clean Water Act (CWA) Section 319 Nonpoint Source Pollution Grant Program, city/town capital funds, state grants such as Coastal Pollution Remediation grants, Municipal Vulnerability Preparedness, or other grant programs such as hazard mitigation funding.

Public Education and Outreach: Goals of public education and outreach include providing information about proposed stormwater improvements and their anticipated benefits and promoting watershed stewardship. MyRWA and the City of Malden aim to engage watershed residents and businesses through interpretive signage, education mailing, online resources, and a variety of other means. It is expected that these programs will be evaluated by tracking coverage from local media, number of mailers distributed, activity on online resources, and other tools applicable to the type of outreach performed. Past public education and outreach events included watershed public outreach events such as "Trash Free Mystic," educational kiosks such as those at the Park at Rivers Edge, and educational curriculums at Malden High School.

Implementation Schedule and Evaluation Criteria: Project activities will be implemented based on the information outlined in the following elements for monitoring, implementation of structural BMPs, public education and outreach activities, and periodic updates to the WBP. The WBP implementation schedule includes milestones for BMP implementation, monitoring, public education and outreach, and periodic updates to the WBP.

Water quality monitoring is conducted in the Malden River at three different sampling stations by the Mystic River Watershed Association (MyRWA) and the Massachusetts Water Resources Authority (MWRA). Other evaluation criteria include indirect indicators of load reduction, project-specific indicators, and criteria from the Pathogen TMDL (MassDEP, et al., 2018) and the TP Alternative TMDL (ERG, et al., 2020). The monitoring programs and evaluation criteria will help to identify if the implemented and proposed management measures (identified in Element C) are resulting in improvements to water quality. This will support continued understanding of water quality trends in the Malden River including determining sources of pollution, evaluating the effectiveness of implemented BMPs, and tracking compliance with the water quality goals identified in this WBP.

This WBP is meant to be a living document, re-evaluated at least once every three years and adjusted as needed based on ongoing efforts (e.g., based on monitoring results, 319 funding, etc.). It is recommended that a working group of watershed stakeholders be established to meet at least biannually to implement and update this WBP, and track progress.

Introduction

What is a Watershed-Based Plan?

Purpose & Need

The purpose of a Massachusetts Watershed-Based Plan (WBP) is to organize information about Massachusetts' watersheds and present the information in a format that will enhance the development and implementation of projects that will restore water quality and beneficial uses in the Commonwealth. The Massachusetts WBP follows the United States Environmental Protection Agency's (EPA's) recommended format for "nine-element" watershed plans, as described below.

All states are required to develop WBPs in order to be eligible for federal watershed implementation grant funds under Section 319 of the Clean Water Act (CWA), but not all states have taken the same approach. Most states develop WBPs only for selected watersheds. Massachusetts Department of Environmental Protection's (MassDEP's) approach has been to develop a tool to support statewide development of WBPs so **that good projects in all areas of the state may be eligible for CWA Section 319 implementation grant funds** under Section 319 of the Clean Water Act.

EPA guidelines promote the use of Section 319 funding for developing and implementing WBPs. WBPs are required for all projects implemented with Section 319 funds and are recommended for all watershed projects, whether they are designed to protect unimpaired waters, restore impaired waters, or both.

Watershed-Based Plan Outline

This WBP includes nine elements (a through i) in accordance with EPA Guidelines:

a) An **identification of the causes and sources** or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this WBP and to achieve any other watershed goals identified in the WBP, as discussed in item (b) immediately below.

b) An **estimate of the load reductions** expected for the management measures described under paragraph (c) below, recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time.

c) A **description of the nonpoint source (NPS) management measures** needed to achieve the load reductions estimated under paragraph (b) above as well as to achieve other watershed goals identified in this WBP and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan.

d) An **estimate of the amounts of technical and financial assistance needed**, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan. As sources of funding, States should consider the use of their Section 319 programs, State Revolving Funds, United States Department of Agriculture's (USDA's) Environmental Quality Incentives Program and Conservation Reserve Program,

and other relevant federal, state, local, and private funds that may be available to assist in implementing this plan.

e) An **information/education component** that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented.

f) A **schedule for implementing the NPS management measures** identified in this plan that is reasonably expeditious.

g) A description of **interim, measurable milestones** for determining whether NPS management measures or other control actions are being implemented.

h) A set of **criteria to determine if loading reductions are being achieved** over time and substantial progress is being made toward attaining water quality standards and, if not, the criteria for determining whether this WBP needs to be revised or, if a NPS total maximum daily load (TMDL) has been established, whether the TMDL needs to be revised.

i) A **monitoring component** to evaluate the effectiveness of the implementation efforts over time measured against the criteria established under item (h) immediately above.

Project Partners and Stakeholder Input

This WBP was developed by Geosyntec under the direction of the Mystic River Watershed Association (MyRWA), with funding, input, and collaboration from MassDEP. This WBP was developed using funds from the CWA Section 319 program to assist municipalities and watershed associations in developing technically robust WBPs using MassDEP's Watershed-Based Planning Tool (WBP Tool). The stakeholder coordination for this WBP was focused on the Malden River watershed.

The following are core project stakeholders:

- Catherine Pedemonti –MyRWA
- Amber Christofferson – MyRWA
- Yem Lip – City of Malden
- Michelle Romero – City of Malden
- Mark Jacobson – PaddleBoston

This WBP was developed as part of an iterative process:

- First, the Geosyntec project team collected and reviewed existing data and reports for the Malden River watershed received from the MyRWA and the City of Malden.
- Next, a core stakeholder conference call was facilitated on July 11, 2022, to solicit input and gain consensus on elements included in the plan (identifying problem areas, BMP projects, water quality goals, public outreach activities, etc.). The meeting minutes from the stakeholder conference call are included in **Appendix A**.
- Next, the Geosyntec project team reviewed additional data and reports received from stakeholders and conducted a watershed investigation on July 28, 2022.
- Finally, the preliminary WBP was drafted and reviewed by MassDEP and finalized based on MassDEP input.

This WBP is meant to be a living document and reevaluated at least once every three years and adjusted as needed based on ongoing efforts (e.g., based on monitoring results, project updates, grant funding, etc.). It is recommended that stakeholders meet at least biannually to track progress and update this WBP.

Data Sources

This WBP was developed using the framework and data sources provided by MassDEP's WBP Tool and supplemented by information provided in the CWA Section 604b application for "Mystic Infiltration Trench Siting and Design Project" (City of Everett, 2020). Additional data sources were reviewed and are included in subsequent sections of this WBP.

Element A: Identify Causes of Impairment & Pollution Sources

Element A: Identify the causes and sources or groups of similar sources that need to be controlled to achieve the necessary pollutant load reductions estimated in the watershed based plan (WBP).

General Watershed Information

the Malden River watershed is located just north of Boston in the cities and towns of Malden, Everett, Melrose, Stoneham, Medford, and Wakefield, Massachusetts. The watershed is highly urbanized and within municipal separate storm sewer (MS4) areas. Spot Pond is located in the headwaters of the watershed and discharges into Spot Pond Brook, which flows into channelized and piped conveyances throughout areas of Melrose and Malden. Ell Pond is also located in the headwaters of the watershed and discharges into piped conveyances in Melrose, Massachusetts. The Malden River daylights from two sets of stormwater culverts (Lower Spot Pond Brook Culvert) south of Malden Center and flows for approximately 2 miles through Malden and along the border between the cities of Medford and Everett before it's confluence with the Mystic River, directly upstream of the Amelia Earhart Dam. The Malden River watershed is located within the Mystic River basin and is approximately 7,000 acres (11 square miles).

Table A-1 presents the general watershed information for the Malden River watershed[1] and **Figure A-1** includes a map of the watershed boundary.

Table A-1: General Watershed Information

Watershed Name (Assessment Unit ID):	Malden River (MA71-05); Spot Pond Brook
Major Basin:	Mystic River
Watershed Area:	6944.5 (acres)

[1] Watersheds are defined by the WBP-tool by utilizing MassGIS drainage sub-basins.

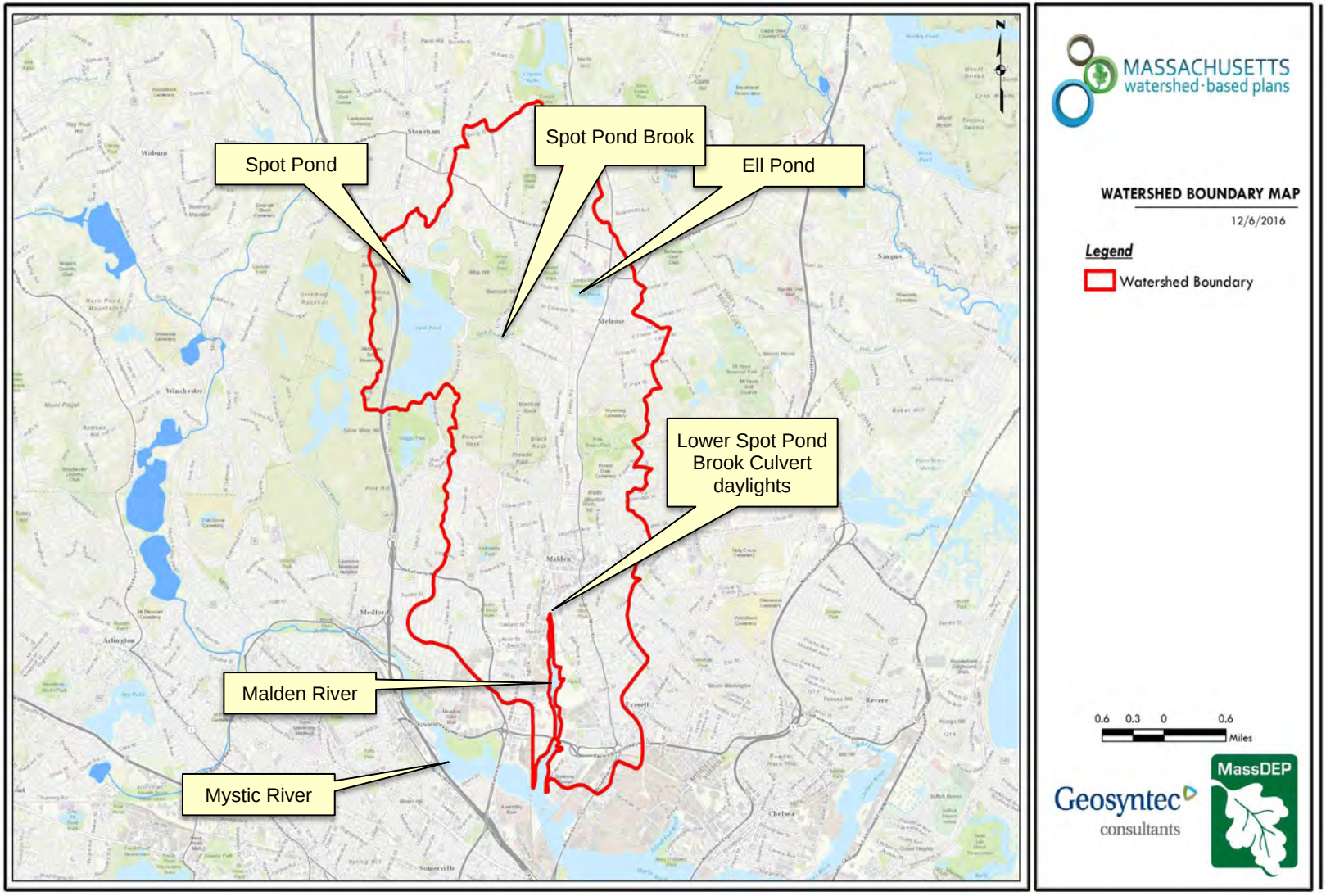

Figure A-1: Watershed Boundary Map (MassGIS, 2007; MassGIS, 1999; MassGIS, 2001; USGS, 2016)

Ctrl + Click on the map to view a full-sized image in your web browser.

MassDEP Water Quality Assessment Report and TMDL Review

The Malden River is included in a TMDL assessment for pathogens, which is listed below:

- Final Pathogen TMDL for the Boston Harbor, Weymouth-Weir, and Mystic Watersheds (MassDEP, et al., 2018)

An "Alternative" TMDL for the Mystic River watershed (includes the Malden River) was also completed in 2020 and is listed below:

- Mystic River Watershed Alternative TMDL Development for Phosphorus Management (ERG et al., 2020)

A water quality assessment report was developed for the Mystic River watershed and is listed below:

- Mystic River Watershed and Coastal Drainage Area 2004-2008 Water Quality Assessment Report (MassDEP, 2010)

Select excerpts from the water quality assessment report (MassDEP, 2010) relating to the water quality in the Malden River watershed are included in **Appendix B** (note: relevant information is included directly from this document for informational purposes and has not been modified).

Additional Water Quality Data

Monitoring Programs in the Malden River

There are four main monitoring programs conducted in the Mystic River watershed by MyRWA and the Massachusetts Water Resources Authority (MWRA), which are summarized below. More detailed information on the monitoring programs can be found in the Malden River Exploratory Water Quality Data Analysis (Walker, 2016) and the Mystic River Watershed TMDL Alternative Development Final Report (ERG, 2020).

- MyRWA's Baseline Water Quality Monitoring Program: The baseline monitoring program has been in operation since 2000 and is used to monitor a variety of trends in watershed water quality. Collected constituents include pathogen indicators, nutrients, and physical-chemical water quality parameters (e.g., total suspended solids, pH, etc.).
- MyRWA's Phosphorus Loading Monitoring Program: The phosphorus loading monitoring program has been conducted since 2015 and is used to collect information on parameters that contribute to eutrophication impairments (e.g., Total Phosphorus (TP)) and response parameters (e.g., dissolved oxygen (DO), Chlorophyll-a), which could potentially be used as indicators of nutrient over enrichment.
- MWRA's Combined Sewer Overflow (CSO) Event Monitoring Program: CSO monitoring is conducted to evaluate water quality risks associated with the discharge of untreated sewages and stormwater runoff into the watershed during CSO events. Monitoring is conducted on an ongoing basis in Alewife Brook, Chelsea River, Little River, and the Mystic River. Note that monitoring is not restricted to CSO discharge events. The CSO monitoring program collects data on pathogen indicators and on physical-chemical water quality parameters.

- MWRA's Water Quality Monitoring Program: The MWRA water quality monitoring in general started in 1989, with the beginning of the CSO monitoring program. The Boston Harbor monitoring in the Harbor proper began in 1993, and in the rivers in 1995. This program was created to establish long-term water quality trends in the Harbor and tributary watersheds for pathogen indicators, nutrients, and physical-chemical water quality parameters. This program has not been implemented in the Malden River watershed.

Figure A-2 identifies the locations of the three monitoring stations (two MyRWA and one MWRA) in the Malden River and **Table A-2** identifies which programs are (or have been) implemented at the monitoring stations (three out of the four monitoring programs listed above are included in the Malden River.

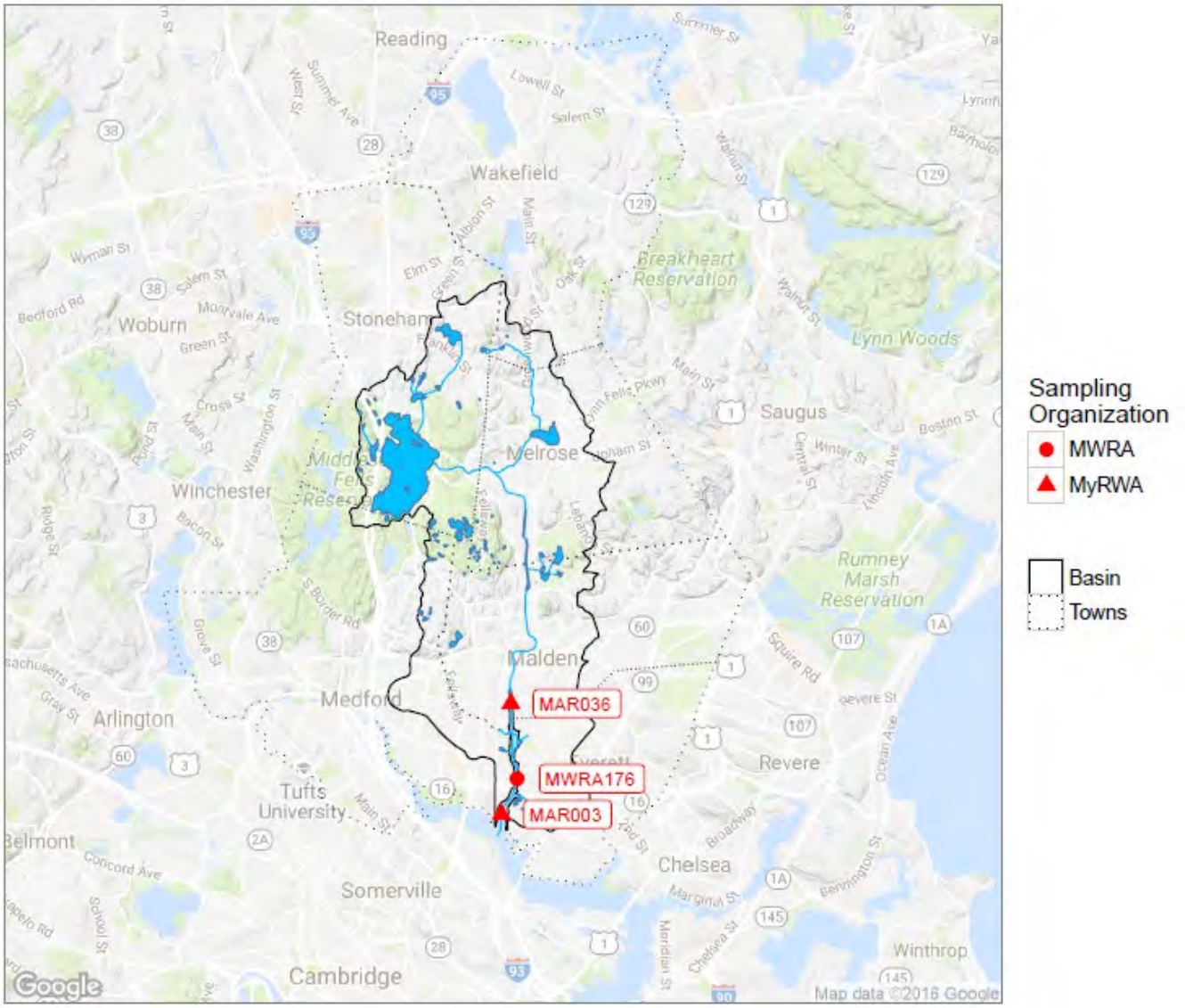

Figure A-2: Map of MWRA and MyRWA Water Quality Monitoring Locations in the Malden River watershed (Walker, 2016)

Table A-2: Water Quality Monitoring Stations and Corresponding Monitoring Programs in the Malden River (Walker, 2016)

Station ID	Organization	Monitoring Program
MAR003	MyRWA	Phosphorus
MAR036	MyRWA	Baseline, Phosphorus
MWRA176	MWRA	CSO

MassDEP Water Quality Monitoring Program Data

Historical and current Technical Memoranda (TM) produced by the MassDEP Watershed Planning Program (WPP) are available here: Water Quality Technical Memoranda | Mass.gov[2] and are organized by major watersheds in Massachusetts. Most of these TMs present the water chemistry and biological sampling results of WPP monitoring surveys. The TMs pertaining primarily to biological information (e.g., benthic macroinvertebrates, periphyton, fish populations) contain biological data and metrics that are currently not reported elsewhere. The data contained in the water quality TMs are also provided on the "Data" page (Water Quality Monitoring Program Data | Mass.gov[3]). Many of these TMs have helped inform CWA 305(b) assessment and 303(d) listing decisions.

Water quality monitoring data is available for the Malden River (station MAR036; see **Figure A-2**) from 2009 for *Escherichia coli* (*E. Coli)*, TP, Total Nitrogen (TN), and suspended solids and is presented in **Table A-3**, **Table A-4**, **Table A-5**, and **Table A-6** (MassDEP, 2020). The *E. Coli* data range from 10 to 8,700 most probable number per 100 milliliters (MPN/100mL), the TN data range from 0.61 to 1.2 milligrams per liter (mg/L), and the suspended solids data range from 3.9 to 14 mg/L. All of the TP data exceeded the Mystic River Watershed Alternative TMDL Development for Phosphorus Management (ERG et al., 2020) standard of 30 micrograms per liter (µg/L).

Table A-3: Water Quality (*E. Coli*) Data in Malden River Watershed (MassDEP, 2020)

Waterbody	Sampling Station ID	Sampling Location Description	Date	*E. Coli* (MPN/100mL)
Malden River	MAR036	[Medford Street, Malden]	4/21/2009	1200
			5/26/2009	63
			6/30/2009	8700
			7/23/2009	350
			8/4/2009	200
			9/8/2009	10

"MPN/100 ml"= most probable number per 100 milliliters

[2] https://www.mass.gov/guides/water-quality-technical-memoranda
[3] https://www.mass.gov/water-quality-monitoring-program-data

Table A-4: Water Quality (TP) Data in Malden River Watershed (MassDEP, 2020)

Waterbody	Sampling Station ID	Sampling Location Description	Date	TP (µg/L)
Malden River	MAR036	[Medford Street, Malden]	4/21/2009	62
			5/26/2009	75
			6/30/2009	80
			8/4/2009	53
			9/8/2009	49

"µg/L" = micrograms per Liter

Table A-5: Water Quality (TN) Data in Malden River Watershed (MassDEP, 2020)

Waterbody	Sampling Station ID	Sampling Location Description	Date	TN (mg/L)
Malden River	MAR036	[Medford Street, Malden]	4/21/2009	0.61
			5/26/2009	1.2
			6/30/2009	1.2
			8/4/2009	0.87
			9/8/2009	0.86

"mg/L" = milligrams per Liter

Table A-6: Water Quality (Suspended Solids) Data in Malden River Watershed (MassDEP, 2020)

Waterbody	Sampling Station ID	Sampling Location Description	Date	Suspended Solids (mg/L)
Malden River	MAR036	[Medford Street, Malden]	4/21/2009	14
			5/26/2009	6.1
			6/30/2009	5.6
			8/4/2009	5.1
			9/8/2009	3.9

"mg/L" = milligrams per Liter

Final Pathogen TMDL for the Boston Harbor, Weymouth-Weir, and Mystic Watersheds

The Malden River watershed is included in the Final Pathogen TMDL (MassDEP, 2018) which provides a framework for addressing the bacterial pathogens and other fecal-related pollution in surface waters. The TMDL will be used to set permit limits and provide stakeholders a document to identify bacterial sources and take appropriate actions to reduce their efforts. The TMDL includes water quality sampling data for the Malden River watershed which is summarized in **Table A-7** and **Table A-8**. Overall, the geometric mean of the enterococcus and fecal coliform sampling has decreased over time, although the minimum and maximum *E. Coli* results do not show any trend.

Table A-7: Malden River Indicator Bacteria Data Summary (MassDEP, 2018)[4]

Station ID	Data Source	Minimum *E. Coli* (cfu/100 mL)	Maximum *E. Coli* (cfu/100 mL)	Number of Samples
MAR036 (Medford St. Bridge)	MyRWA, 2010	20	7,270	11
	MyRWA, 2011	203	9,210	12
	MyRWA, 2012	41	24,200	11
	MyRWA, 2013	169	3,650	10
	MyRWA, 2014	98	8,160	11

"CFU/100 mL"= colony forming units per 100 milliliters**.**

Table A-8: Malden River Bacterial Water Quality Summary (MassDEP, 2018)

Station ID	Year Range	Enterococcus (CFU/100mL) (Geometric mean of minimum of 5 samples)			Fecal Coliform (CFU/100mL)		
		Geometric Mean	Range	Number of Samples	Geometric Mean	Range	Number of Samples
MWRA176 (Malden River at Rt 16 Bridge, MWRA Site 176)	2003 – 2007	23.8	0 – 9000	103	60.7	0 – 24200	102
	2008 – 2009	12.2	0 – 1990	42	111	0 – 4350	42
	2010 – 2014	10.3	1 - 5480	106	0.4	1 – 17300	36

"CFU/100 mL"= colony forming units per 100 milliliters

"MWRA" = Massachusetts Water Resources Authority

Malden River: Exploring Water Quality Data Analysis

This report analyzed water quality data collected by the MyRWA and the MWRA from 2000 through 2015 at all three monitoring stations in the Malden River (MAR003, MAR036 and MWRA176; see **Figure A-2**). **Figure A-3** shows theDO levels and saturation levels by station and sample depth over time. Super-saturated conditions (when DO saturation exceeds 100%) occasionally occurs in late spring or late spring at the MAR036 station, which may indicate excessive production due to algae or aquatic vegetation. At the MWRA176 station, the surface DO saturation exceeds 100% frequently in the summer, indicating algae or vegetation growth occurring. The bottom depth samples are both stations indicate high sediment oxygen demand (Walker Environmental Research LLC., 2016).

[4] This data is also included in the analysis presented in **Figure A-5** from Walker (2016).

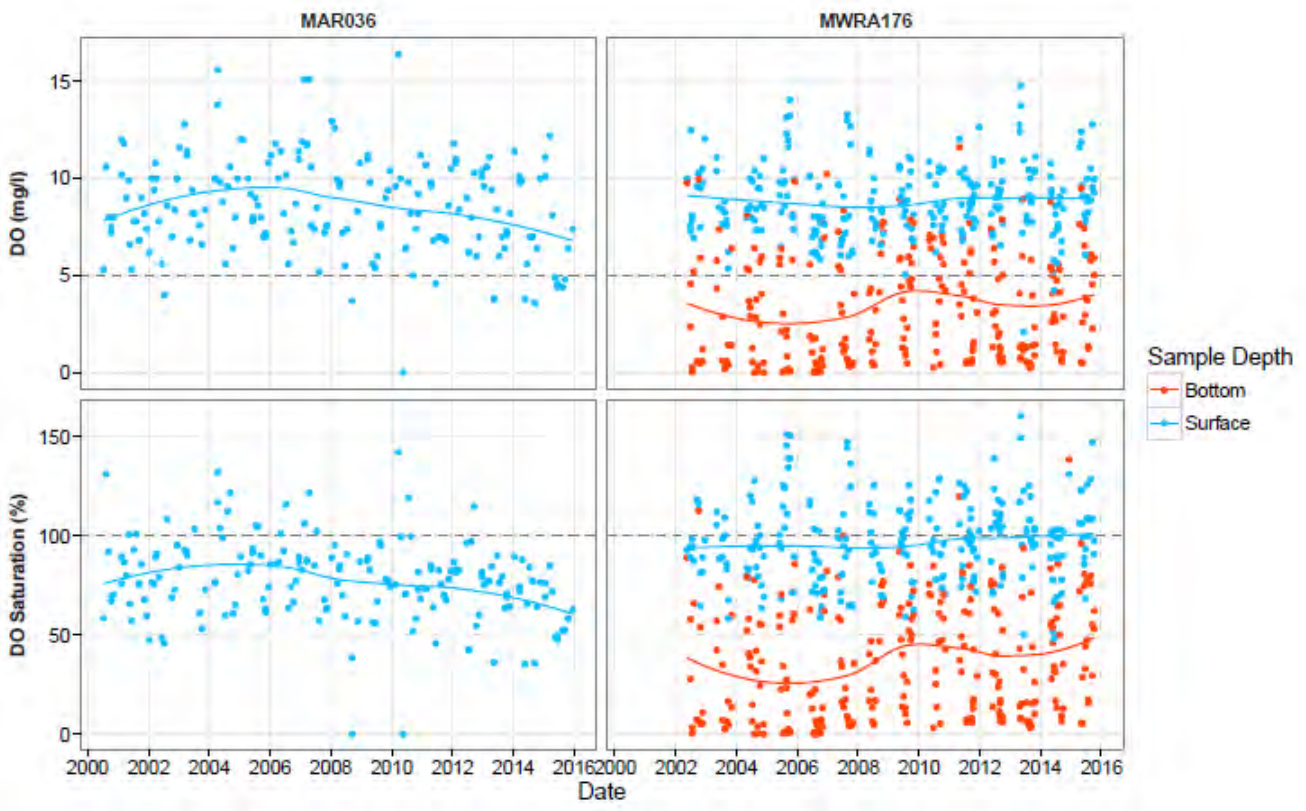

Figure A-3: Dissolved Oxygen Results for MAR036 and MWRA176 (Walker, 2016)

Figure A-4 shows TP monitoring results at MAR036 between 2000—2016 and the horizontal line shows the 0.025 mg/L target concentration from USEPA's 1986 Water Quality Criteria ("Gold Book")[5]. In 2000 through 2005 there was a significant decrease in TP concentration and since then the concentrations have remained steady. All samples exceeded the presented target concentration (Walker, 2016).

[5] The "Gold Book" recommends a maximum TP concentration of 0.025 mg/L in lakes and reservoirs and 0.050 mg/L in streams. Because the main channel of the Malden River is an impoundment, a target level of 0.025 mg/L was presented in the analysis (Walker, 2016).

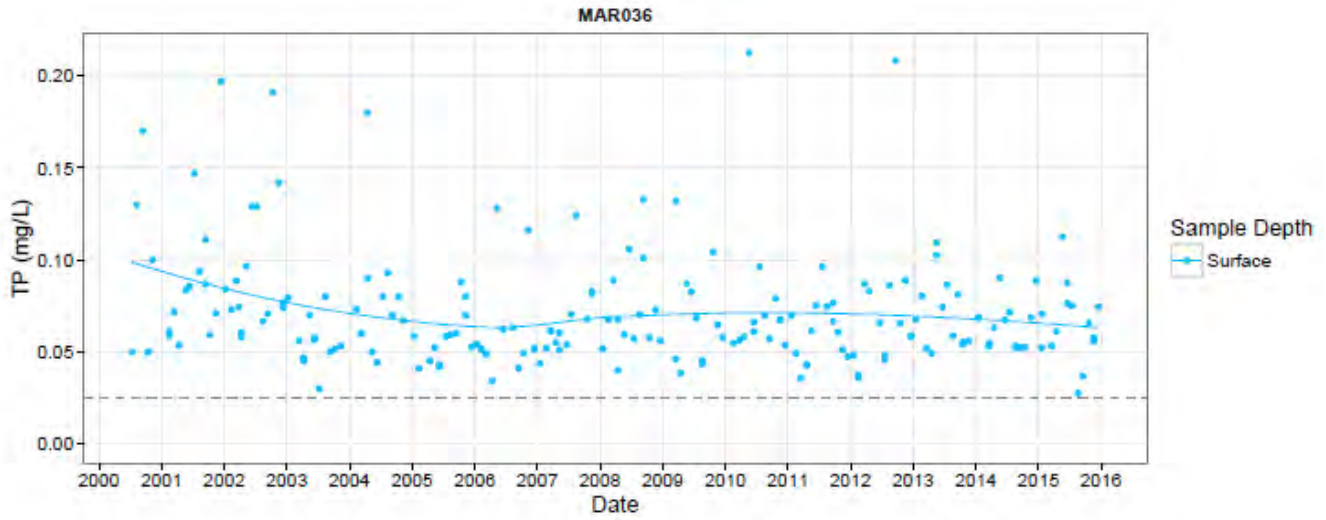

Figure A-4: Total Phosphorus Results for MAR036 (Walker, 2016)

In year 2015, TP samples were also taken at MAR003 as well as MAR036 as part of the MyRWA Phosphorus Sampling Program. **Figure A-5** shows the TP concentrations measured at both MyRWA stations in 2015 for both the Baseline and Phosphorus Sampling Programs. While both stations are included in the Phosphorus Program, only MAR036 is included in the Baseline Program. This figure reveals a major discrepancy between the two sampling programs at MAR036: TP concentrations were generally higher for the Baseline program relative to the Phosphorus program. However, data from the Phosphorus program still show that the majority of samples were above the presented target TP concentration of 0.025 mg/L.

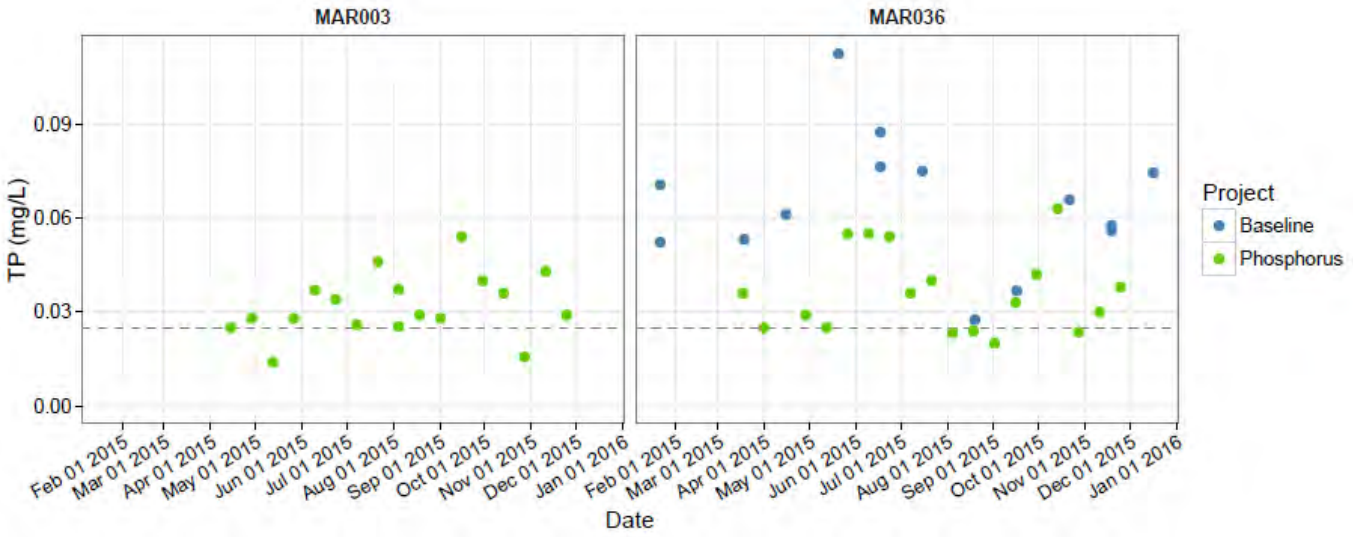

Figure A-5: Total Phosphorus Measurements in 2015 Comparing MyRWA's Baseline and Phosphorus Sampling Programs (Walker, 2016)

Figure A-6 shows the percent of samples at MAR036 and MWRA176 exceeding the single sample maximum (235 CFU/100mL based on the Massachusetts Surface Water Quality Standards (MassDEP, 2013)) for *E. Coli* by year, station, and weather condition. There is typically a higher percentage of exceedances of the MAR036 than MWRA176 in both wet and dry weather conditions. Samples at MAR036 almost always exceed the single sample maximum in wet weather conditions.

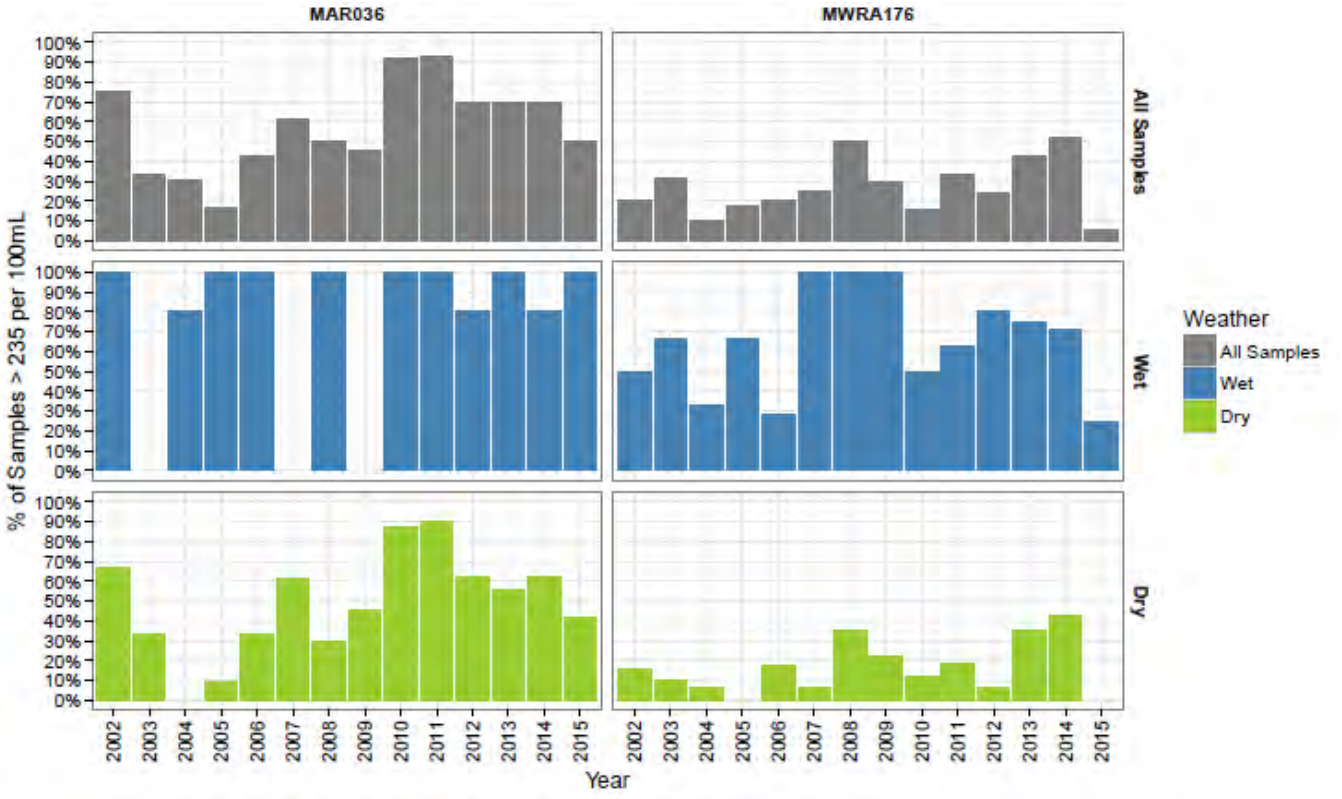

Figure A-6: Percent of Samples Exceeding the Single Sample Maximum for *E. Coli*[6] (Walker, 2016)

Overall, the water quality sampling results analysis by Walker (2016) generally did not show improvements or trends towards improvements in water quality, with the exception of improvements in TP levels between 2000 and 2005.

Mystic River Watershed Alternative TMDL Development for Phosphorus Management Final Report

Annual watershed TP and TN loading estimates from sanitary sewer overflows (SSOs) were developed using measured SSO discharge volumes (data from MWRA) and TP and TN estimated concentrations[7]. **Table A-9** summarizes SSO TP and TN loading estimates for the Malden River. Overall, the estimated SSO nutrient loading decreased over time between 2006 through 2017 (ERG, et al., 2020).

[6] 235 CFU/ 100ml based on the Massachusetts Surface Water Quality Standards (MassDEP, 2013)

[7] SSO TP and TN concentrations were based on the average annual influent wastewater concentrations for 2016 sampled at the Deer Island Sewage Treatment Plant of 5.23 mg/L and 41.8 mg/L.

Table A-9: Estimated Nutrient SSO Loads for Malden River (ERG, et al., 2020)

Year	Estimated Annual TP SSO Loads (lbs./year)	Estimated Annual TN SSO Loads (lbs./year)
2006	25.7	205.2
2007	19.6	157.0
2008	0.9	7.3
2009	0.8	6.3
2010	25.7	205.2
2011	0.0	0.1
2012	0.0	0.2
2013	0.0	0.1
2014	0.4	3.5
2015	0.0	0.0
2016	0.0	0.0
2017	0.0	0.1

"TP" = Total Phosphorus

"TN" = Total Nitrogen

"SSO" = Sanitary Sewer Overflow

City of Malden Stormwater Management Program Plan

The City of Malden's Stormwater Management Program Plan does not include water quality sampling results; however, it does list the number of outfalls that discharge into each waterbody segment. Stormwater runoff, especially stormwater runoff from highly urbanized areas, may contain pollutants and high levels of nutrients that may degrade the water quality of receiving waterbodies. There are 23 outfalls in the City of Malden that discharge to the Malden River (MA71-05), 14 outfalls that discharge to Lower Spot Pond Brook Channel, and 41 outfalls that discharge to Lower Spot Pond Brook Culvert (City of Malden, 2019).

Water Quality Impairments and Pollution Sources

Impairment categories from the MassDEP 2018/2020 Massachusetts Integrated List of Waters (303(d) List) are listed in **Table A-10**. Known water quality impairments for stream segments in the Malden watershed, as documented in the 2018/2020 303(d) List, are listed in **Table A-11**.

The Malden River (MA71-05) is identified as a category 5 waterbody on the Massachusetts Year 2018 Integrated List of Waters (303(d)) list due to numerous impairments including debris, flocculant masses, oil and grease, scum/ foam, transparency/ clarify, trash, chlordane in fish tissue, DDT in fish tissue, PCBs in fish tissue, DO, DO supersaturation, high pH, total phosphorus (TP), sediment bioassay, temperature, total suspended solids (TSS), water chestnut, *E. coli*, and fecal coliform due to discharges from MS4s, illegal dumps, introduction of non-native organisms, combined sewer overflows, contaminated sediments, impervious surface/ parking lot runoff, and unknown sources.

Table A-10: 2018/2020 MA Integrated List of Waters Categories (MassDEP, 2021)

Integrated List Category	Description
1	Unimpaired and not threatened for all designated uses.
2	Unimpaired for some uses and not assessed for others.
3	Insufficient information to make assessments for any uses.
4	Impaired or threatened for one or more uses, but not requiring calculation of a Total Maximum Daily Load (TMDL), including: 4a: TMDL is completed 4b: Impairment controlled by alternative pollution control requirements 4c: Impairment not caused by a pollutant - TMDL not required
5	Impaired or threatened for one or more uses and requiring preparation of a TMDL.

Table A-11: Water Quality Impairments (MassDEP, 2021)

Assessment Unit ID	Waterbody	Integrated List Category	Designated Use	Impairment Cause	Impairment Source
MA71-05	Malden River	5	Aesthetic	Debris	Illegal Dumps or Other Inappropriate Waste Disposal
MA71-05	Malden River	5	Aesthetic	Flocculant Masses	Discharges from Municipal Separate Storm Sewer Systems
MA71-05	Malden River	5	Aesthetic	Odor	Discharges from Municipal Separate Storm Sewer Systems
MA71-05	Malden River	5	Aesthetic	Oil and Grease	Discharges from Municipal Separate Storm Sewer Systems
MA71-05	Malden River	5	Aesthetic	Scum/Foam	Discharges from Municipal Separate Storm Sewer Systems
MA71-05	Malden River	5	Aesthetic	Transparency/Clarity	Discharges from Municipal Separate Storm Sewer Systems
MA71-05	Malden River	5	Aesthetic	Trash	Illegal Dumps or Other Inappropriate Waste Disposal
MA71-05	Malden River	5	Fish Consumption	Chlordane in Fish Tissue	Source Unknown
MA71-05	Malden River	5	Fish Consumption	DDT in Fish Tissue	Source Unknown
MA71-05	Malden River	5	Fish Consumption	PCBs in Fish Tissue	Source Unknown
MA71-05	Malden River	5	Fish, other Aquatic Life and Wildlife	Dissolved Oxygen	Combined Sewer Overflows
MA71-05	Malden River	5	Fish, other Aquatic Life and Wildlife	Dissolved Oxygen	Discharges from Municipal Separate Storm Sewer Systems

Assessment Unit ID	Waterbody	Integrated List Category	Designated Use	Impairment Cause	Impairment Source
MA71-05	**Malden River**	**5**	Fish, other Aquatic Life and Wildlife	Dissolved Oxygen Supersaturation	Discharges from Municipal Separate Storm Sewer Systems
MA71-05	**Malden River**	**5**	Fish, other Aquatic Life and Wildlife	High pH	Discharges from Municipal Separate Storm Sewer Systems
MA71-05	**Malden River**	**5**	Fish, other Aquatic Life and Wildlife	Total Phosphorus	Contaminated Sediments
MA71-05	**Malden River**	**5**	Fish, other Aquatic Life and Wildlife	Total Phosphorus	Discharges from Municipal Separate Storm Sewer Systems
MA71-05	**Malden River**	**5**	Fish, other Aquatic Life and Wildlife	Sediment Bioassay (Chronic Toxicity Freshwater)	Contaminated Sediments
MA71-05	**Malden River**	**5**	Fish, other Aquatic Life and Wildlife	Sediment Bioassay (Chronic Toxicity Freshwater)	Discharges from Municipal Separate Storm Sewer Systems
MA71-05	**Malden River**	**5**	Fish, other Aquatic Life and Wildlife	Temperature	Impervious Surface/ Parking Lot Runoff
MA71-05	**Malden River**	**5**	Fish, other Aquatic Life and Wildlife	Temperature	Source Unknown
MA71-05	**Malden River**	**5**	Fish, other Aquatic Life and Wildlife	Total Suspended Solids (TSS)	Combined Sewer Overflows
MA71-05	**Malden River**	**5**	Fish, other Aquatic Life and Wildlife	Total Suspended Solids (TSS)	Discharges from Municipal Separate Storm Sewer Systems
MA71-05	**Malden River**	**5**	Fish, other Aquatic Life and Wildlife	Water Chestnut	Introduction of Non-Native Organisms (Accidental or Intentional)
MA71-05	**Malden River**	**5**	Primary Contact Recreation	Debris	Illegal Dumps or Other Inappropriate Waste Disposal
MA71-05	**Malden River**	**5**	Primary Contact Recreation	Escherichia Coli (*E. Coli*)	Discharges from Municipal Separate Storm Sewer Systems
MA71-05	**Malden River**	**5**	Primary Contact Recreation	Fecal Coliform	Commercial Districts (Industrial Parks)
MA71-05	**Malden River**	**5**	Primary Contact Recreation	Fecal Coliform	Discharges from Municipal Separate Storm Sewer Systems
MA71-05	**Malden River**	**5**	Primary Contact Recreation	Flocculant Masses	Discharges from Municipal Separate Storm Sewer Systems
MA71-05	**Malden River**	**5**	Primary Contact Recreation	Odor	Discharges from Municipal Separate Storm Sewer Systems

Assessment Unit ID	Waterbody	Integrated List Category	Designated Use	Impairment Cause	Impairment Source
MA71-05	**Malden River**	**5**	Primary Contact Recreation	Oil and Grease	Discharges from Municipal Separate Storm Sewer Systems
MA71-05	**Malden River**	**5**	Primary Contact Recreation	Scum/Foam	Discharges from Municipal Separate Storm Sewer Systems
MA71-05	**Malden River**	**5**	Primary Contact Recreation	Transparency/Clarity	Discharges from Municipal Separate Storm Sewer Systems
MA71-05	**Malden River**	**5**	Primary Contact Recreation	Trash	Illegal Dumps or Other Inappropriate Waste Disposal
MA71-05	**Malden River**	**5**	Secondary Contact Recreation	Debris	Illegal Dumps or Other Inappropriate Waste Disposal
MA71-05	**Malden River**	**5**	Secondary Contact Recreation	Flocculant Masses	Discharges from Municipal Separate Storm Sewer Systems
MA71-05	**Malden River**	**5**	Secondary Contact Recreation	Odor	Discharges from Municipal Separate Storm Sewer Systems
MA71-05	**Malden River**	**5**	Secondary Contact Recreation	Oil and Grease	Discharges from Municipal Separate Storm Sewer Systems
MA71-05	**Malden River**	**5**	Secondary Contact Recreation	Scum/Foam	Discharges from Municipal Separate Storm Sewer Systems
MA71-05	**Malden River**	**5**	Secondary Contact Recreation	Transparency/Clarity	Discharges from Municipal Separate Storm Sewer Systems
MA71-05	**Malden River**	**5**	Secondary Contact Recreation	Trash	Illegal Dumps or Other Inappropriate Waste Disposal

Water Quality Goals

Based on the impairments and water quality data identified above, the long-term water quality goal in the Malden River watershed is to reduce TP and bacteria loading to the Malden River so it meets its designated uses for fish, other aquatic life, and wildlife; aesthetics; fish consumption; and primary and secondary contact recreation. There are multiple listed impairments for the Malden River; however, water quality goals are focused on reducing TP and bacteria because it is expected that efforts to reduce these pollutant loads will also result in improvements to the other listed impairments for the waterbody (e.g., DO and Secchi disk transparency). **Table A-12** includes the TP, bacteria, and DO water quality goals.

The water quality goal for TP is based on the Mystic River Watershed TMDL Alternative Development (ERG, et al., 2020).

Massachusetts Surface Water Quality Standards (MassDEP, 2013) prescribe the minimum water quality criteria required to sustain a waterbody's designated uses; the Malden River is classified as a Class 'B' waterbody. The water quality goal for bacteria is based on the goal for Class 'B' waterbodies under the Massachusetts Surface Water Quality Standards (MassDEP, 2013), which is also presented in the Final Pathogen TMDL for the Boston Harbor, Weymouth-Weir, and Mystic Watersheds (MassDEP, et al., 2018).

Element C of this WBP includes proposed management measures to address these water quality goals.

Table A-12: Malden River Water Quality Goals

Pollutant	Goal	Source
Total Phosphorus (TP)	TP should not exceed: 30 µg/L	Mystic River Watershed TMDL Alternative Development – Final Report (ERG, et al., 2020)
Bacteria	**Class B Standards** Public Bathing Beaches: For *E. coli*, geometric mean of 5 most recent samples shall not exceed 126 colonies/ 100 ml and no single sample during the bathing season shall exceed 235 colonies/100 ml. For enterococci, geometric mean of 5 most recent samples shall not exceed 33 colonies/100 ml and no single sample during bathing season shall exceed 61 colonies/100 ml; Other Waters and Non-bathing Season at Bathing Beaches: For *E. coli*, geometric mean of samples from most recent 6 months shall not exceed 126 colonies/100 ml (typically based on min. 5 samples) and no single sample shall exceed 235 colonies/100 ml. For enterococci, geometric mean of samples from most recent 6 months shall not exceed 33 colonies/100 ml, and no single sample shall exceed 61 colonies/100 ml.	Final Pathogen TMDL for the Boston Harbor, Weymouth-Weir, and Mystic Watersheds) (MassDEP, et al. 2018) Massachusetts Surface Water Quality Standards (MassDEP, 2013)
Dissolved Oxygen (DO)	Dissolved oxygen saturation should not be less than 5 mg/L in warm water fisheries or less than 6 mg/L in cold water fisheries.	Massachusetts Surface Water Quality Standards (MassDEP, 2013)

Land Use and Impervious Cover Information

Land use information and impervious cover is presented in the tables and figures below. Land use source data is from 2005 and was obtained from MassGIS (2009b).

Watershed Land Uses

Land use in the Malden River watershed is approximately 42 percent high density residential, 22 percent forested, 10 percent commercial, 6 percent open land, 5 percent water, 5 percent medium density residential, 5 percent industrial, 4 percent highway, and less 1 one percent is low density residential; there is almost no agricultural land use in the watershed (**Table A-13** and **Figure A-7**).

Table A-13: Watershed Land Uses

Land Use	Area (acres)	% of Watershed
High Density Residential	2942.35	42.4
Forest	1545.2	22.3
Commercial	708.93	10.2
Open Land	412.04	5.9
Water	370.14	5.3
Medium Density Residential	364.48	5.2
Industrial	345.82	5
Highway	245.38	3.5
Low Density Residential	8.93	0.1
Agriculture	1.19	0

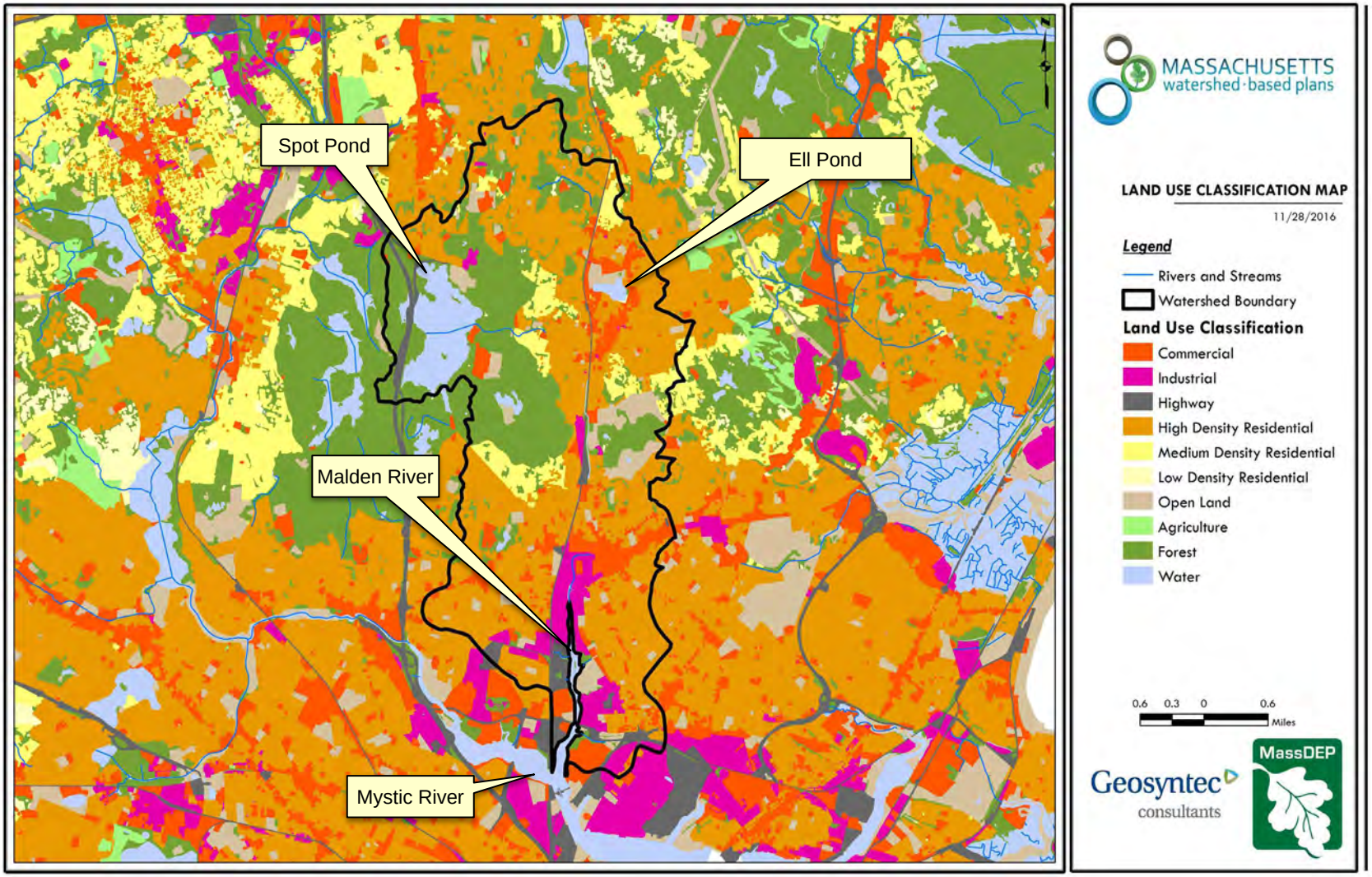

Figure A-7: Watershed Land Use Map (MassGIS, 2007; MassGIS, 2009b; MassGIS, 1999; MassGIS, 2001; USGS, 2016)

Ctrl + Click on the map to view a full-sized image in your web browser.

Watershed Impervious Cover

There is a strong link between impervious land cover and stream water quality. Impervious cover includes land surfaces that prevent the infiltration of water into the ground, such as paved roads and parking lots, roofs, basketball courts, etc. As a large percentage of the Malden River watershed is high density residential, there is a large amount of impervious cover within the watershed. Impervious cover is most concentrated in the downstream area of the watershed (**Figure A-8**).

Impervious areas that are directly connected (DCIA) to receiving waters (via storm sewers, gutters, or other impervious drainage pathways) produce higher runoff volumes and transport stormwater pollutants with greater efficiency than disconnected impervious cover areas which are surrounded by vegetated, pervious land. Runoff volumes from disconnected impervious cover areas are reduced as stormwater infiltrates when it flows across adjacent pervious surfaces.

An estimate of DCIA for the watershed was calculated based on the Sutherland equations. USEPA provides guidance (USEPA, 2010) on the use of the Sutherland equations to predict relative levels of connection and disconnection based on the type of stormwater infrastructure within the total impervious area (TIA) of a watershed. The estimated TIA and DCIA for the Malden River watershed is 39.1 percent and 35.2 percent, respectively. The relationship between TIA and water quality can generally be categorized as shown in **Table A-14** (Schueler et al. 2009):

Table A-14: Relationship between Total Impervious Area (TIA) and water quality (Schueler et al. 2009)

% Watershed Impervious Cover	Stream Water Quality
0-10%	Typically high quality, and typified by stable channels, excellent habitat structure, good to excellent water quality, and diverse communities of both fish and aquatic insects.
11-25%	These streams show clear signs of degradation. Elevated storm flows begin to alter stream geometry, with evident erosion and channel widening. Streams banks become unstable, and physical stream habitat is degraded. Stream water quality shifts into the fair/good category during both storms and dry weather periods. Stream biodiversity declines to fair levels, with most sensitive fish and aquatic insects disappearing from the stream.
26-60%	These streams typically no longer support a diverse stream community. The stream channel becomes highly unstable, and many stream reaches experience severe widening, downcutting, and streambank erosion. Pool and riffle structure needed to sustain fish is diminished or eliminated and the substrate can no longer provide habitat for aquatic insects, or spawning areas for fish. Biological quality is typically poor, dominated by pollution tolerant insects and fish. Water quality is consistently rated as fair to poor, and water recreation is often no longer possible due to the presence of high bacteria levels.
>60%	These streams are typical of “urban drainage”, with most ecological functions greatly impaired or absent, and the stream channel primarily functioning as a conveyance for stormwater flows.

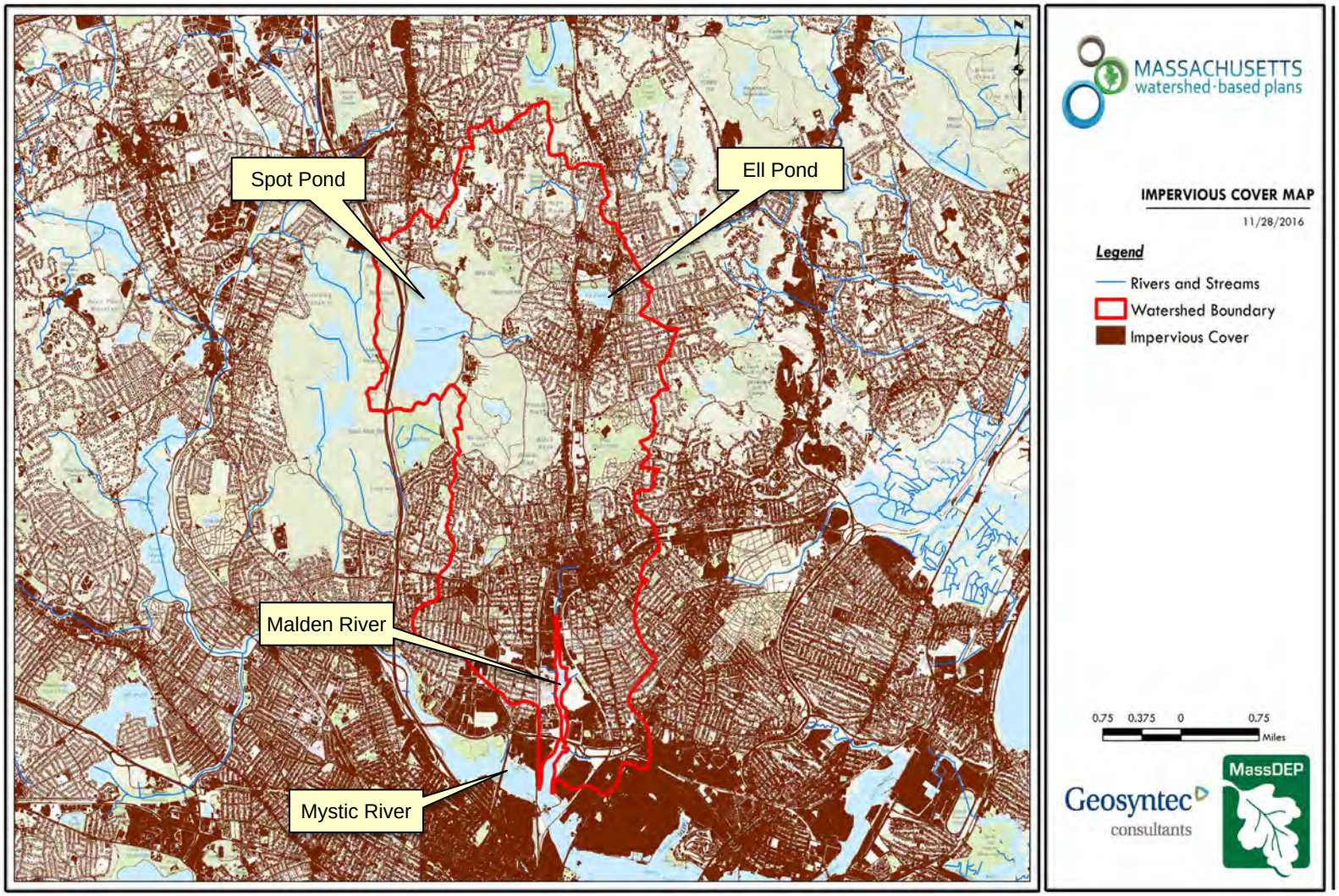

Figure A-8: Watershed Impervious Surface Map (MassGIS, 2007; MassGIS, 2009b; MassGIS, 1999; MassGIS, 2001; USGS, 2016)

Ctrl + Click on the map to view a full-sized image in your web browser.

Pollutant Loading

A Geographic Information System (GIS) was used for the pollutant loading analysis. The land use data (MassGIS, 2009b) was intersected with impervious cover data (MassGIS, 2009a) and United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) soils data (USDA NRCS and MassGIS, 2012) to create a combined land use/land cover grid. The grid was used to sum the total area of each unique land use/land cover type.

The amount of DCIA was estimated using the Sutherland equations as described above and any reduction in impervious area due to disconnection (i.e., the area difference between TIA and DCIA) was assigned to the pervious D soil category for that land use to simulate that some infiltration will likely occur after runoff from disconnected impervious surfaces passes over pervious surfaces.

Pollutant loading for key nonpoint source pollutants in the watershed was estimated by multiplying each land use/cover type area by its pollutant load export rate (PLER) as follows:

$$L_n = A_n * P_n$$

Where L_n = Loading of land use/cover type n (lbs./year);
A_n = area of land use/cover type n (acres);
P_n = pollutant load export rate of land use/cover type n (lbs./acre/year)

The PLERs are an estimate of the annual total pollutant load exported via stormwater from a given unit area of a particular land cover type. The PLER values for TN, TP and TSS were obtained from USEPA (USEPA, 2020; UNHSC, 2018, Tetra Tech, 2015) (see values provided in **Appendix C**). **Table A-15** presents the estimated land-use based TN, TP and TSS pollutant loading in the watershed. Bacteria loading has not been estimated for this WBP, because there are no known PLERs for bacteria. The Pathogen TMDL also did not include an existing loading estimate for bacteria as this type of analysis for pathogens and indicator bacteria is resource intensive and would have a large degree of uncertainty (MassDEP, et al., 2018). The largest contributor of the land-use-based TP, TN and TSS load for Malden River originates from areas designated as high density residential. Residential areas provide opportunities for pollutant load reductions through public education and outreach and implementation of residential BMPs.

Table A-15: Estimated Pollutant Loading for Key Nonpoint Source Pollutants

Land Use Type	Pollutant Loading[1]		
	Total Phosphorus (TP) (lbs./year)	Total Nitrogen (TN) (lbs./year)	Total Suspended Solids (TSS) (tons/year)
High Density Residential	3,495	22,983	344.09
Commercial	986	8,413	105.25
Industrial	482	4,122	51.57
Medium Density Residential	251	2,084	29.32
Forest	247	1,346	79.37
Open Land	218	1,809	40.22
Highway	213	1,756	102.04
Low Density Residential	5	46	0.63
Agriculture	1	3	0.02
TOTAL	5,896	42,562	752.52

[1]These estimates do not consider loads from point sources or septic systems.

Element B: Determine Pollutant Load Reductions Needed to Achieve Water Quality Goals

Element B of your WBP should:

Determine the pollutant load reductions needed to achieve the water quality goals established in Element A. The water quality goals should incorporate Total Maximum Daily Load (TMDL) goals, when applicable. For impaired water bodies, a TMDL establishes pollutant loading limits as needed to attain water quality standards.

Estimated Pollutant Loads

Estimated pollutant loads for TP (5,896 lbs./year), TN (42,562 lbs./year), and TSS (753 tons/year) were previously presented in **Table A-15** of this WBP. Bacteria loading has not been estimated for this WBP. The Pathogen TMDL also did not include an existing loading estimate for bacteria as this type of analysis for pathogens and indicator bacteria is resource intensive and would have a large degree of uncertainty (MassDEP, et al., 2018).

Water Quality Goals

There are many methodologies that can be used to set pollutant load reduction goals for a WBP. Goals can be based on water quality criteria, surface water standards, existing monitoring data, existing TMDL criteria, or other data established by the watershed stakeholders. As discussed by Element A, water quality goals for this WBP are focused on addressing the Final Pathogen TMDL for the Boston Harbor, Weymouth-Weir, and Mystic Watersheds TMDL, the listed TP, bacteria and DO impairment, and observed elevated concentrations of TP from ambient monitoring data. A description of criteria for each water quality goal is described by **Table B-1**. Since it is not practical to estimate bacteria and DO in terms of loading, the pollutant load reductions needed to achieve water quality goals are focused on TP. It is expected that efforts to reduce TP loading will also result in improvements to bacteria and DO in the Malden River watershed.

The following adaptive sequence is recommended to establish and track water quality goals for TP.

1. Establish an interim goal to reduce land use-based TP to the Malden River by five percent or 290 pounds/year over the next 10 years (by 2032) within the watershed.
2. Continue to implement the existing water quality monitoring programs described in elements H&I. Use monitoring results to perform trend analysis to identify if proposed Element C management measures are resulting in improvements.
3. Establish a long-term goal to meet all applicable water quality standards over the next 25 years, leading to the delisting of the Malden River from the 303(d) list. The current long-term goal for the entire Mystic

River watershed presented in the Alternative TMDL (ERG, et al. 2020) is 67 percent reduction in stormwater loads but this could vary for the Malden River.

Table B-1: Pollutant Load Reductions Needed

Pollutant	Existing Estimated Total Load	Water Quality Goal	Required Load Reduction
Total Phosphorus	5896 lbs./year	Total Phosphorus should not exceed 30 ug/L within waterbodies of the Malden River watershed (ERG, et al.,2020)	290 lbs./year (interim goal)
Bacteria	*N/A – Concentration based*	**Class B Standards** • Public Bathing Beaches: For *E. coli*, geometric mean of 5 most recent samples shall not exceed 126 colonies/ 100 ml and no single sample during the bathing season shall exceed 235 colonies/100 ml. For enterococci, geometric mean of 5 most recent samples shall not exceed 33 colonies/100 ml and no single sample during bathing season shall exceed 61 colonies/100 ml; • Other Waters and Non-bathing Season at Bathing Beaches: For *E. coli*, geometric mean of samples from most recent 6 months shall not exceed 126 colonies/100 ml (typically based on min. 5 samples) and no single sample shall exceed 235 colonies/100 ml. For enterococci, geometric mean of samples from most recent 6 months shall not exceed 33 colonies/100 ml, and no single sample shall exceed 61 colonies/100 ml. (See Note 2)	>90%– Concentration based (See Note 1)
Dissolved Oxygen	*N/A – Concentration based*	DO saturation should not be less than 5 mg/L in warm water fisheries or less than 6 mg/L in cold water fisheries.	Not applicable – Concentration Based

"lbs./year" = pounds per year

Notes:

1. *The required load reduction for bacteria is adapted from the "Final Pathogen TMDL for the Boston Harbor, Weymouth-Weir, and Mystic Watersheds" (MassDEP, et al. 2018), which states "Since accurate estimates of existing sources are generally unavailable, it is difficult to estimate the pollutant reductions for specific sources. For the illicit sources, the goal is complete elimination (100% reduction). However, overall wet weather indicator bacteria load reductions can be estimated using typical stormwater bacteria concentrations. These data indicate that in general two to three orders of magnitude (i.e., greater than 90%) reductions in stormwater bacteria loading will be necessary, especially in developed areas. This goal is expected to be accomplished through stepwise implementation of illicit discharge detection and elimination programs (IDDE), best management practices, such as those associated with the Phase I and Phase II control program for stormwater".*
2. *For all waterbodies, including impaired waters that have a pathogen TMDL, the water quality goal for bacteria is based on the Massachusetts Surface Water Quality Standards (MSWQS) (MassDEP, 2013) that apply to the Water Class of the selected water body.*
3. *Dissolved oxygen criteria are based on the Massachusetts Surface Water Quality Standards (MSWQS) (MassDEP, 2013).*

Element C: Describe management measures that will be implemented to achieve water quality goals

Element C: A description of the nonpoint source management measures needed to achieve the pollutant load reductions presented in Element B, and a description of the critical areas where those measures will be needed to implement this plan.

As discussed by the Recommended Load Reduction section in Element B, it is recommended that future planning initially focus on water quality goals related to TP, bacteria, and DO in the Malden River Watershed. It is expected that efforts to reduce TP loading will also result in improvements to *E. coli* and DO as well as the other listed impairments in the watershed.

Future Management Measures

Mystic Infiltration Trench Siting and Design Project

This project is funded by MassDEP's Section 604b Water Quality Management Planning Grant Program. The goal of this project is to identify locations for siting high efficiency, low-cost infiltration trenches attached to catch basins in at least 8 municipalities (including Everett and Melrose in the Malden River watershed), resulting in final design/ sizing, cost estimates, and phosphorus load reduction calculations for 250 BMPs. The project is still in progress; however, 19 sites have been identified in Everett and 35 sites have been identified in Melrose, as indicated during the stakeholder meeting (**Appendix A**).

Malden River Greenway and Malden River Works

MyRWA created a shared vision for a seamless waterfront park system along both sides of the Malden River, connecting communities in Medford, Malden and Everett to the River. Additionally, Malden River Works is a new project in Malden, which is building a coalition of community leaders of color, youth, environmental advocates, and government officials as well as designers with the goals of transforming the the Malden River waterfront into a park for public enjoyment and recreation. Additional goals include improving the Malden River's wildlife habitat and the City of Malden's flood resiliency. There is potential to incorporate nonpoint source management measures in the designs from these projects. More information is available at: https://mysticriver.org/maldenriver.

BMP Hotspot Map

The following GIS-based analysis was performed within the watershed to identify high priority parcels for best management practice (BMP) (also referred to as management measure) implementation[8]:

[8] GIS data used for the BMP Hotspot Map analysis included MassGIS (2015a); MassGIS (2015b); MassGIS (2017a); MassGIS (2017b); MassGIS (2020); MA Department of Revenue Division of Local Services (2016); MassGIS (2005); ArcGIS (2020); MassGIS (2009b); MassGIS (2012); and ArcGIS (2020b).

- Each parcel within the watershed was evaluated based on ten different criteria accounting for the parcel ownership, social value, and implementation feasibility (See **Table C-1** for more detail below);
- Each criterion was then given a score from 0 to 5 to represent the priority for BMP implementation based on a metric corresponding to the criterion (e.g., a score of 0 would represent lowest priority for BMP implementation whereas a score of 5 would represent highest priority for BMP implementation);
- A multiplier was also assigned to each criterion, which reflected the weighted importance of the criterion (e.g., a criterion with a multiplier of 3 had greater weight on the overall prioritization of the parcel than a criterion with a multiplier of 1); and
- The weighted scores for all the criteria were then summed for each parcel to calculate a total BMP priority score.

Table C-1 presents the criteria, indicator type, metrics, scores, and multipliers that were used for this analysis. Parcels with total scores above 60 are recommended for further investigation for BMP implementation suitability. **Figure C-1** presents the resulting BMP Hotspot Map for the watershed. The following link includes a Microsoft Excel file with information for all parcels that have a score above 60: hotspot spreadsheet.

This analysis solely evaluated individual parcels for BMP implementation suitability and likelihood for the measures to perform effectively within the parcel's features. This analysis does not quantify the pollutant loading to these parcels from the parcel's upstream catchment. When further evaluating a parcel's BMP implementation suitability and cost-effectiveness of BMP implementation, the existing pollutant loading from the parcel's upstream catchment and potential pollutant load reduction from BMP implementation should be evaluated.

Table C-1: Matrix for BMP Hotspot Map GIS-based Analysis

Criteria	Indicator Type	METRICS																										Multiplier	Maximum Potential Score
		Yes or No?		Hydrologic Soil Group				Land Use Type									Water Table Depth				Parcel Area			Parcel Average Slope						
		Yes	No	A or A/D	B or B/D	C or C/D	D	Low and Medium Density Residential	High Density Residential	Commercial	Industrial	Highway	Agriculture	Forest	Open Land	Water	101-200 cm	62-100 cm	31-61 cm	0-30 cm	Greater than 2 acres	Between 1-2 acres	Less than 1 acre	Less than 2%	Between 2% and 15%	Greater than 15%	Less than 50%	Between 51% and 100%		
Is the parcel a school, fire station, police station, town hall or library?	Ownership	5	0																									2	10
Is the parcel's use code in the 900 series (i.e. public property or university)?	Ownership	5	0																									2	10
Is parcel fully or partially in an Environmental Justice Area?	Social	5	0																									2	10
Most favorable Hydrologic Soil Group within Parcel	Implementation Feasibility			5	3	0	0																					2	10
Most favorable Land Use in Parcel	Implementation Feasibility							1	2	4	2	4	5	1	4	X[1]												3	15
Most favorable Water Table Depth (deepest in Parcel)	Implementation Feasibility																5	4	3	0								2	10
Parcel Area	Implementation Feasibility																				5	4	1					3	15
Parcel Average Slope	Implementation Feasibility																							3	5	1		1	5
Percent Impervious Area in Parcel	Implementation Feasibility																										5	2.5	1	5
Within 100 ft buffer of receiving water (stream or lake/pond)?	Implementation Feasibility	5	2																									2	10

Note 1: **X** denotes that parcel is excluded

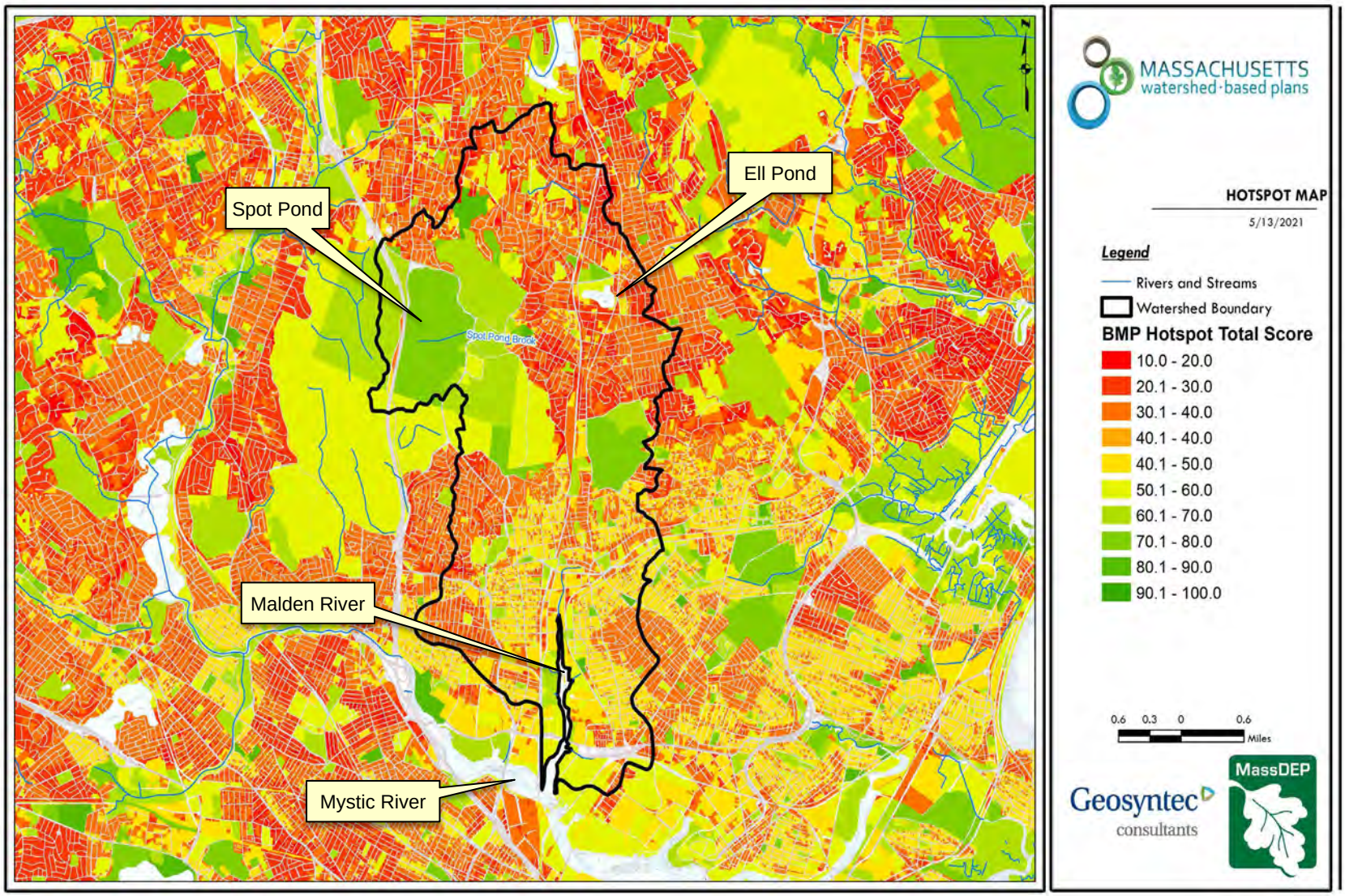

Figure C-1: BMP Hotspot Map (MassGIS (2015a), MassGIS (2015b), MassGIS (2017a), MassGIS (2017b), MassGIS (2020), MA Department of Revenue Division of Local Services (2016), MassGIS (2005), ArcGIS (2020), MassGIS (2009b), MassGIS (2012), ArcGIS (2020b))

Ctrl + Click on the map to view a full-sized image in your web browser.

Field Watershed Investigation

A total of 20 locations were selected for field investigation based on the BMP Hotspot Map desktop analysis and stakeholder input (**see Appendix A**). Geosyntec performed a field investigation on July 28, 2022, to further investigate the locations identified in **Appendix D** and listed in **Table C-2.**

Table C-2: Malden River Watershed BMP Opportunity Locations

Site Name	Municipality	Potential for future BMP based on field visit?	Selected for BMP Concept?	Additional field notes
Harris Park	Medford	x		Small drainage area
Park at River's Edge	Medford	x		New construction; looks like recently constructed wetland and signage
Malden River Crew boat launch	Malden	x		Private property; couldn't access
Super 88 Parking Lot	Malden	x		Private property; large impervious area adjacent to Malden River
MacArthur Park	Malden	x	x	Potential for subsurface infiltration in field area; good size drainage area
Bell Rock Park	Malden	x		Small drainage area; would only be treating green space of park area
Madeline English School (School Building)	Everett	x	x	Potential for cistern/bioretention; good public education/outreach opportunity
Madeline English School (Parking Lot)	Everett	x	x	Potential for bioretention; good public education/outreach opportunity
Wasgott Playground	Everett	x	x	Potential for subsurface infiltration in field area; good size drainage area
Newman Park/Ferryway School	Malden	x	x	Potential for subsurface infiltration in field area; good size drainage area
Malden High School	Malden	X		Public education/outreach potential
Malden Public Library	Malden	X		Potential to replace swale with bioswale; currently no treatment of roof runoff; small drainage area
Forest Dale Cemetery	Malden	X		Might be possible to put BMP downstream of residential area within cemetery property
Lewis Monk Memorial Park	Melrose	x	x	Good space for BMP; good public outreach potential
Melrose High School	Melrose	x		Potential in parking lot; public outreach potential

Site Name	Municipality	Potential for future BMP based on field visit?	Selected for BMP Concept?	Additional field notes
Conant Park	Melrose	x		Small drainage area; would only be treating park area
Colonial Park School	Stoneham	x		Possibility for pervious pavement or subsurface infiltration; don't have info on stormwater drainage network
McCarthy Field/East School Playground	Stoneham	x		Possibility for BMP in baseball field area depending on upstream stormwater drainage network
Stoneham High school	Stoneham	x		Currently undergoing major active construction; unable to access
Spot Pond Boating Center	Stoneham	x		Gravel parking lot; small drainage area

During field reconnaissance, Geosyntec assessed the locations for space constraints, potential accessibility issues, presence of mature vegetation that may cause conflicts (e.g., roots), potential utility conflicts, site-specific drainage patterns, and other factors that may cause issues during design, construction, or long-term maintenance. BMP concept sheets were developed for the six most promising locations, based on the field investigation. **Appendix D and E** identify the locations of the six locations, and **Appendix E** includes the BMP concept sheets for each of the six locations. Each BMP concept sheet includes the following:

- A site summary that describes current conditions and stormwater drainage area
- A description of proposed improvements and anticipated operations and maintenance
- BMP sizing parameters, including drainage area, design storm depth for which the BMP was sized,[9] and the percent impervious area within the drainage area of the proposed BMP
- Estimated planning-level costs that represent installed contractor construction costs (i.e., capital costs)
- Estimated TP, TN, and TSS pollutant load reduction for the proposed BMP[10]

Geosyntec also performed a ranking analysis to identify a prioritized list for future implementation of the six BMP concepts. The site-specific prioritization criteria included expected TP pollutant load reductions, cost per TP

[9] Proposed BMPs should be designed to treat the water quality volume to the maximum extent practicable. The water quality volume is defined in the Massachusetts Stormwater Handbook as the volume equal to 0.5 inches of runoff times the total impervious area that drains to the BMP. However, each proposed BMP should be designed to achieve the most treatment that is practical given the size and logistical constraints of the site.

[10] The planning level cost estimates and pollutant load reduction estimates and estimates of BMP footprint were obtained using the WBP tool; some costs were adjusted based on professional judgment and recent economic inflation. References used by the WBP tool include: Geosyntec Consultants, Inc. (2014); Geosyntec Consultants, Inc. (2015); King and Hagen (2011); Leisenring, et al. (2014); King and Hagen (2011); MassDEP (2016a); MassDEP (2016b); University of Massachusetts, Amherst (2004); USEPA (2020); UNHSC (2018); and Tetra Tech, Inc. (2015).

pollutant load reduction, implementation complexity, potential outreach opportunities and visibility to public, and expected operation and maintenance/accessibility effort. Results of the prioritization are presented in **Table C-3.** The six BMP concepts are not intended to be an all-inclusive listing of additional potential stormwater improvements in the watershed. Rather, these recommendations are representative examples of potential opportunistic stormwater improvements and retrofits. Additionally, all six concepts are viable, and the prioritized list is a tool for planning purposes, which can be modified as new information becomes available and with future iterations of this WBP.

Table C-3: Priority Ranking of Malden River Structural BMP Concepts (see Appendix E for Concepts)

BMP ID	BMP Location	BMP Type(s)	Planning Level Capital Cost[1]	TP Pollutant Load Reduction[2]		Capital Cost / TP Pollutant Load Reduction		Implementation Complexity[3]	Visibility to Public/Outreach Potential[4]	Operation and Maintenance/ Accessibility Effort[5]	TOTAL	PRIORITY
			$	Lbs./year	Rank	($/lbs./year)	Rank	Rank	Rank	Rank		
1	Lewis Monk Memorial Park	Bioretention Cell	40,000	0.5	6	80,000	6	2	3	3	20	**4**
2	MacArthur Park	Subsurface infiltration	1,320,000	73.4	1	17,984	3	5	5	5	19	**3**
3	Madeline English School (Parking Area)	Bioretention Cell	23,000	1.4	5	16,429	1	1	2	1	10	**1**
4	Madeline English School (Building)	Cistern and Bioretention Cell	43,000	1.5	4	28,667	5	3	1	2	15	**2**
5	Newman Park	Subsurface Infiltration	1,138,500	40.1	3	28,392	4	4	4	4	19	**3**
6	Wasgott Park	Subsurface Infiltration	720,500	40.5	2	17,790	2	6	6	6	22	**5**

Nonstructural BMPs

Nonstructural BMPs, including street sweeping and catch basin cleaning, are implemented by the municipalities within the Malden River watershed in order to comply with their respective permits under the Clean Water Act's National Pollutant Discharge Elimination System (NPDES) Phase II stormwater regulations. It is recommended, if it has not already been done, that these nonstructural BMPs be evaluated, and potentially optimized for removal of TP and bacteria. First, it is recommended that potential pollutant load removals from ongoing activities be calculated in accordance with **Elements H and I** of this WBP. Next, it is recommended that ongoing activities be evaluated to see if potential improvements can be implemented to achieve higher pollutant load reductions, such as increased frequency or improved technology.

Other nonstructural BMPs could include septic system maintenance, municipal sewer system inspection and maintenance, land use regulation revision, protection of open space, impervious cover reduction, adoption of good housekeeping practices, and public education and outreach (see Element E).

Element D: Identify Technical and Financial Assistance Needed to Implement Plan

Element D: Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan.

Future Management Measures

Depending on if any of the infiltration trench locations identified in the Mystic Infiltration Trench Siting and Design Project (City of Everett, 2020) (described in Element C) are in the Malden River watershed, the technical and financial assistance needed to implement the BMPs at those locations should be included in this section in future iterations of this WBP.

Table D-1 presents the anticipated funding needed to implement the proposed BMPs presented in Element C and **Appendix E** of this WBP. The table includes planning level capital construction costs for structural BMPs, technical assistance (i.e., engineering) costs, and operation and maintenance costs. The table also includes summary statistics of proposed BMPs, including potential pollutant load reductions, drainage area, and percent impervious area.

Funding for implementation of these BMPs within the Malden River watershed may be provided by a variety of sources, such as the CWA Section 319 Nonpoint Source Pollution Grant Program, city/town capital funds, state grants such as Coastal Pollution Remediation grants, Municipal Vulnerability Preparedness or other grant programs such as hazard mitigation funding. Other more local sources that could be used to fund smaller projects include business, service organizations, and community foundations. CWA Section 604b watershed planning grants are also available to support BMP design work and water quality sampling and assessment.

The MyRWA and the City of Everett have previously been successful with and will continue to pursue securing grant funding through various sources. Guidance is available to provide additional information on potential funding sources for nonpoint source pollution reduction efforts[11].

[11] http://prj.geosyntec.com/prjMADEPWBP_Files/Guide/Element%20D%20-%20Funds%20and%20Resources%20Guide.pdf

Table D-1: Summary of Proposed BMPs and Estimated Funding Needed Implement

Site Priority Rank	BMP Identification / Location	Drainage Area (ac)	Impervious Area (%)	Estimated Load Reduction (lbs./year)			Cost Estimates ($)			
				TN	TP	TSS	Capital[1]	Engineering[2]	O&M Materials[3]	Total
1	Madeline English School Bioretention Cell	1.1	97	9.3	1.4	444	$23,000	$9,200	$1,000	$33,200
2	Madeline English School Cistern and Bioretention Cell	1.1	99	9.5	1.5	453	$43,000	$17,200	$1,000	$61,200
3	MacArthur Park Subsurface Infiltration	89.9	72	716.0	73.4	18,962	$1,320,000	$264,000	$5,000	$1,589,000
4	Newman Park/ Ferryway School Subsurface Infiltration	38.1	73	341.2	40.1	12,524	$1,138,500	$227,700	$5,000	$1,371,200
4	Lewis Monk Memorial Park Bioretention Cell	1.1	33	3.5	0.5	255	$40,000	$16,000	$2,000	$58,000
5	Wasgott Park Subsurface Infiltration	45.0	80	395.6	40.5	10,451	$720,500	$144,100	$4,000	$868,600
TOTALS				1475.1	157.4	43,089	$3,285,000	$678,200	$18,000	$3,981,200

General Notes

1. Planning level capital costs for BMPs obtained from WBP Element C and professional judgement.

2. Engineering (i.e., design, survey, permitting, construction quality assurance) estimated based on 20-40 percent of capital costs.

3. Annual operation and maintenance estimated based on professional judgment. Actual costs may vary widely based on which entity performs maintenance.

Element E: Public Information and Education

Element E: Information and Education (I/E) component of the watershed plan used to:

1. Enhance public understanding of the project; and
2. Encourage early and continued public participation in selecting, designing, and implementing the NPS management measures that will be implemented.

Public information and education was one of the major topics discussed during the stakeholder meeting of July 11, 2022 (**Appendix A**). Components of the nonpoint source public information and education program, within the Malden River watershed, are described below. It is recommended that this section of the WBP be updated when the plan is reevaluated in 2025 in accordance with Elements F&G of this document

Step 1: Goals and Objectives

The goals and objectives for the watershed information and education program.

1. Provide information to promote watershed stewardship.
2. Provide information about nonpoint source pollution and structural and non-structural BMPs within the watershed.
3. Provide information about completed and proposed stormwater BMPs and their anticipated water quality benefits.
4. Meet Massachusetts MS4 Permit Requirements.

Step 2: Target Audience

Target audiences that need to be reached to meet the goals and objectives identified above.

1. Residents within the watershed.
2. Businesses, institutions, and commercial facilities within the watershed.
3. Schools within the watershed.
4. Watershed organizations and other user groups.
5. Developers (construction) within the watershed.
6. Industrial facilities within the watershed.

Step 3: Outreach Products and Distribution

The outreach product(s) and distribution form(s) that will be used for each.

1. Watershed public outreach events such as “Trash Free Mystic” which includes volunteer mapping of trash density and trash clean ups.
2. Educational Kiosks such as those at the Park at Rivers Edge which describe the function and purpose of stormwater BMP like constructed wetlands.

3. Educational curriculums at Malden High School which includes background about the Malden River, water quality, and ways to keep the river clean, as well as general environmental science concepts.
4. Stormwater educational postings on the Friends of the Malden River Facebook page, City/Town webpages, and the MyRWA webpage

Step 4: Evaluate Information/Education Program

Information and education efforts and how they will be evaluated.

1. Track the amount of trash cleaned under "Trash Free Mystic"
2. Track the number of materials and information distributed, such as pamphlets, newsletters, and emails, and the size of the lists receiving these materials.
3. Track number of presentations given, classes and/or students reached, and teachers using the curriculum each year
4. Track the number of watershed public outreach events and attendance at each.
5. Track the number of people reached by each stormwater message using metrics such as number of subscribers to a given publication and hit counters on web articles.

Elements F & G: Implementation Schedule and Measurable Milestones

Element F: Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.

Element G: A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.

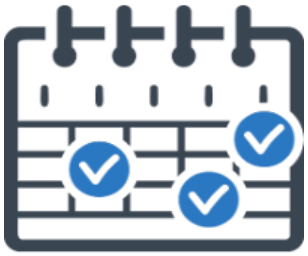

Table FG-1 provides a preliminary schedule for implementation of recommendations provided by this WBP. It is expected that the WBP will be re-evaluated and updated, by the Malden River watershed stakeholders, in 2025, or as needed, based on ongoing monitoring results and other ongoing efforts. New projects will be identified through future data analysis and stakeholder engagement and will be included in updates to the implementation schedule.

Table FG-1: Implementation Schedule and Interim Measurable Milestones

Category (and Stakeholder Involved)	Action	Estimated Cost	Year(s)
Monitoring (Mystic River Watershed Association; Massachusetts Water Resources Authority)	Continue the existing monitoring programs and perform water quality sampling at key locations along Malden River watershed segments per Element H&I		Annual
Structural BMPs (Municipalities within the watershed)	Obtain funding, design, and implement Madeline English School Bioretention Cell	$33,200	2023
	Obtain funding, design, and implement Madeline English School Cistern and Bioretention Cell	$61,200	2023
	Obtain funding, design, and implement MacArthur Park Subsurface Infiltration	$1,589,000	2026
	Obtain funding, design, and implement Newman Park/ Ferryway School Subsurface Infiltration	$1,371,200	2028
	Obtain funding, design, and implement Lewis Monk Memorial Park Bioretention Cell	$58,000	2030
	Obtain funding, design, and implement Wasgott Park Subsurface Infiltration	$868,600	2032
Nonstructural BMPs (all municipalities within the watershed)	Continue to document potential pollutant removals from ongoing nonstructural BMPs (i.e., street sweeping, catch basin cleaning). The methodology is included in the 2016 Massachusetts Small MS4 Permit and in Elements H&I of this WBP.		Annual
	Evaluate ongoing nonstructural BMPs and determine if modifications can be made to optimize pollutant removals (e.g., increase frequency).		2023
	Routinely implement optimized nonstructural BMPs.		Annual
Public Education and Outreach (all municipalities and watershed groups within the watershed)	Community outreach education and events (Friends of the Malden River; Mystic River Watershed Association)		Annual
	Malden High School Educational Curriculum on Malden River and Environmental Science		Annual
	MS4 Permit Required Outreach and Education (all municipalities)		Annual

Category (and Stakeholder Involved)	Action	Estimated Cost	Year(s)
Adaptive Management and Plan Updates (all stakeholders)	Establish a working group that includes stakeholders and other interested parties to implement recommendations and track progress. Meet at least twice per year.		2022
	Reevaluate WBP at least once every three years and adjust, as needed, based on ongoing efforts (e.g., based on monitoring results, 319 funding, etc.). – Next update, September 2025		2025
	Reach interim goal to reduce land-based phosphorus by 290 lbs./year		**2032**
	Reach long-term goal Delist Malden River watershed segments from the 303(d) list.		**2047**

Elements H & I: Progress Evaluation Criteria and Monitoring

Element H: A set of criteria used to determine (1) if loading reductions are being achieved over time and (2) if progress is being made toward attaining water quality goals. Element H asks "**how will you know if you are making progress towards water quality goals?**" The criteria established to track progress can be direct measurements (e.g., E. coli bacteria concentrations) or indirect indicators of load reduction (e.g., number of beach closings related to bacteria).

Element I: A monitoring component to evaluate the effectiveness of implementation efforts over time, as measured against the Element H criteria. Element I asks "**how, when, and where will you conduct monitoring?**"

The water quality goals are presented under Elements A and B of this WBP. To achieve the interim water quality goals, the annual TP loading must be reduced to the amount described in Element B. Element C of this plan describes the various management measures that will be implemented to help make progress towards this targeted load reduction. The evaluation criteria and monitoring program described below will be used to measure the effectiveness of the proposed management measures (described in Element C) in improving the water quality of the Malden River watershed and in making progress toward achieving the water quality goals.

Direct Measurements

As also described in Element A, there are four main monitoring programs conducted in the Mystic River watershed by MyRWA and the MWRA. The four programs are listed below:

- MyRWA's Baseline Water Quality Monitoring Program: The baseline monitoring program has been in operation since 2000 and is used to monitor a variety of trends in watershed water quality. Collected constituents include pathogen indicators, nutrients, and physical-chemical water quality parameters (e.g., total suspended solids, pH, etc.).
- MyRWA's Phosphorus Loading Monitoring Program: The phosphorus loading monitoring program has been conducted since 2015 and is used to collect information on parameters that contribute to eutrophication impairments (e.g., TP) and response parameters, which could potentially be used as indicators of nutrient over enrichment.
- MWRA's Combined Sewer Overflow (CSO) Event Monitoring Program: CSO monitoring is conducted to evaluate water quality risks associated with the discharge of untreated sewages and stormwater runoff into the watershed during CSO events. Monitoring is conducted on an ongoing basis in Alewife Brook, Chelsea River, Little River, and the Mystic River. Note that monitoring is not restricted to CSO discharge events. The CSO monitoring program collects data on pathogen indicators and on physical-chemical water quality parameters.

- MWRA's Water Quality Monitoring Program: The MWRA water quality monitoring in general started in 1989, with the beginning of the CSO monitoring program. The Boston Harbor monitoring in the Harbor proper began in 1993, and in the rivers in 1995. This program was created to establish long-term water quality trends in the Harbor and tributary watersheds for pathogen indicators, nutrients, and physical-chemical water quality parameters. This program has not been implemented in the Malden River watershed.

Indirect Indicators of Load Reduction

Nonstructural BMPs

Potential load reductions from non-structural BMPs (i.e., street sweeping and catch basin cleaning) can be estimated from indirect indicators, such as the number of miles of streets swept or the number of catch basins cleaned. The City of Malden, as well as the other municipalities in the watershed, currently perform street sweeping and catch basin cleaning, in addition to other non-structural BMPs. Appendix F of the 2016 Massachusetts Small MS4 General Permit provides specific guidance for calculating TP removal from these practices. As indicated by **Element C**, the City of Malden, and the other municipalities in the watershed, annually estimate the potential TP removal from these ongoing activities in accordance with the 2016 Massachusetts Small MS4 General Permit. TP load reductions from street sweeping and catch basin cleaning is estimated in accordance with Appendix F of the 2016 Massachusetts Small MS4 General Permit as summarized by **Figure HI-1 and HI-2**.

$$Credit_{sweeping} = IA_{swept} \times PLE_{IC\text{-}land\ use} \times PRF_{sweeping} \times AF \qquad \textbf{(Equation 2-1)}$$

Where:

$Credit_{sweeping}$	=	Amount of phosphorus load removed by enhanced sweeping program (lb/year)
IA_{swept}	=	Area of impervious surface that is swept under the enhanced sweeping program (acres)
$PLE_{IC\text{-}land\ use}$	=	Phosphorus Load Export Rate for impervious cover and specified land use (lb/acre/yr) (see Table 2-1)
$PRF_{sweeping}$	=	Phosphorus Reduction Factor for sweeping based on sweeper type and frequency (see Table 2-3).
AF	=	Annual Frequency of sweeping. For example, if sweeping does not occur in Dec/Jan/Feb, the AF would be 9 mo./12 mo. = 0.75. For year-round sweeping, AF=1.0[1]

As an alternative, the permittee may apply a credible sweeping model of the Watershed and perform continuous simulations reflecting build-up and wash-off of phosphorus using long-term local rainfall data.

Table 2-3: Phosphorus reduction efficiency factors ($PRF_{sweeping}$) for sweeping impervious areas

Frequency[1]	Sweeper Technology	$PRF_{sweeping}$
2/year (spring and fall)[2]	Mechanical Broom	0.01
2/year (spring and fall)[2]	Vacuum Assisted	0.02
2/year (spring and fall)[2]	High-Efficiency Regenerative Air-Vacuum	0.02
Monthly	Mechanical Broom	0.03
Monthly	Vacuum Assisted	0.04
Monthly	High Efficiency Regenerative Air-Vacuum	0.08
Weekly	Mechanical Broom	0.05
Weekly	Vacuum Assisted	0.08
Weekly	High Efficiency Regenerative Air-Vacuum	0.10

Figure HI-1. Street Sweeping Calculation Methodology

$$Credit_{CB} = IA_{CB} \times PLE_{IC\text{-}land\ use} \times PRF_{CB} \qquad \textbf{(Equation 2-2)}$$

Where:

$Credit_{CB}$	=	Amount of phosphorus load removed by catch basin cleaning (lb/year)
IA_{CB}	=	Impervious drainage area to catch basins (acres)
$PLE_{IC\text{-}and\ use}$	=	Phosphorus Load Export Rate for impervious cover and specified land use (lb/acre/yr) (see Table 2-1)
PRF_{CB}	=	Phosphorus Reduction Factor for catch basin cleaning (see Table 2-4)

Table 2-4: Phosphorus reduction efficiency factor (PRF_{CB}) for semi-annual catch basin cleaning

Frequency	Practice	PRF_{CB}
Semi-annual	Catch Basin Cleaning	0.02

Figure HI-2. Catch Basin Cleaning Calculation Methodology

Project-Specific Indicators

Number of BMPs Installed and Pollution Reduction Estimates

Anticipated pollutant load reductions from ongoing (i.e., under construction) and future BMPs will be tracked as BMPs are installed. For example, it was estimated that the future management measures presented in Element C will result in a load reduction of approximately 157 lbs/year of TP.

TMDL Criteria.

The Pathogen TMDL states that municipalities are the primary responsible parties for achieving water quality standards through elimination of the sources identified in the TMDL. TMDL implementation to achieve these 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 Town of Malden, and other municipalities in the watershed, have Illicit Discharge Detection and Elimination (IDDE) plans, in accordance with the 2016 Massachusetts Small MS4 General Permit (MassDEP, et al. 2018).

In addition, the TMDL monitoring criteria applicable to the Malden River watershed (MassDEP, et al. 2018), include:

- Waterbody meets the use criteria,
- Monitoring areas where BMPs and other control strategies have been implemented or discharges have been removed to assess the effectiveness of the modification or elimination,
- Assembling data collected by each monitoring entity to formulate a concise report where the basin is assessed as a whole and an evaluation of BMPs can be made, and
- Adding/ removing/modifying BMPs as needed based on monitoring results.
- The monitoring plan should be an ever-changing document that requires flexibility to add, change or delete sampling locations, sampling frequency, methods, and analysis. At the minimum, all monitoring should be conducted with a focus on:
    - capturing water quality conditions under varied weather conditions,
    - establishing sampling locations in an effort to pin-point sources,
    - researching new and proven technologies for separating human from animal bacteria sources, and
- Assessing efficacy of BMPs
- Monitoring areas within the watershed where data are lacking or absent.

Data Gaps and Recommendations for Future Sampling Efforts

The following data gaps were identified in the Alternative TMDL (ERG, 2020), which could be addressed through future monitoring efforts:

Ecological/biological indicators of over-enrichment

Currently, little data is available on excess vegetative growth. Measurements are limited to chlorophyll-a and do not include macrophyte abundance, percent cover, or broader measures of species richness. MyRWA and EPA

should consider including, at a minimum, percent of macrophyte cover in the waterbodies during monitoring events for baseline and phosphorus loading.

Streamflow

There are few locations in the watershed where it is currently feasible to make direct flow measurements. To develop reliable estimates of nutrient loads through the watershed, measurements or reliable estimates of flows in the watershed will be needed. This task is further complicated by multiple impoundments. Should methods for reliable direct measurement prove infeasible, other approaches for estimating flow based on well-established modeling techniques (e.g., using climatological, land use, and soil type data available in GIS databases) may be explored to estimate precipitation-driven flows.

Sediment

Sediment attributes (e.g., TP concentrations, sediment oxygen demand) would be useful for future modeling but was not available for the modeling portion of the project, and it is recommended to include these attributes in future watershed surveillance efforts, if feasible.

Adaptive Management

The criteria identified in this section (**Element HI**) will be used to evaluate progress towards achieving the water quality goals outlined in Element A and Element B. It is recommended that long-term goals be re-evaluated by MyRWA, City of Malden and other stakeholders at least once every three years and adaptively adjusted based on additional monitoring results and other indirect indicators. If monitoring results and indirect indicators do not show improvement to the bacteria and TP concentrations within the watershed, the management measures and loading reduction analysis as described in Elements A through D should be revisited and modified accordingly.

References

ArcGIS (2020a). "*USA Soils Hydrologic Group*" Imagery Layer

ArcGIS (2020b). "*USA Soils Water Table Depth*" Imagery Layer

City of Everett. (2020). "*Mystic Infiltration Trench Siting and Design Project 604b Grant Application.*" Prepared by the City of Everett. Dated 2020.

City of Malden. (2019). "*Stormwater Management Program Plan.*" Prepared by the City of Malden Engineering Department and Nangle Consulting Associations, Inc. Dated June 2019.

Geosyntec Consultants, Inc. (2014). "*Least Cost Mix of BMPs Analysis, Evaluation of Stormwater Standards Contract No. EP-C-08-002, Task Order 2010-12.*" Prepared for Jesse W. Pritts, Task Order Manager, U.S. Environmental Protection Agency

Geosyntec Consultants, Inc. (2015). "*Appendix B: Pollutant Load Modeling Report, Water Integration for the Squamscott-Exeter (WISE) River Watershed.*"

Eastern Research Group, Inc. (ERG) (2020). "Mystic River Watershed Alternative TMDL Development for Phosphorus Management - Final Report". Prepared for U.S. Environmental Protection Agency. EPA Contract No. EP-C-16-003. January 2020.

King, D. and Hagan, P. (2011). "*Costs of Stormwater Management Practices in Maryland Counties.*" University of Maryland Center for Environmental Science Chesapeake Biological Laboratory. October 11, 2011.

Leisenring, M., Clary, J., and Hobson, P. (2014). "*International Stormwater Best Management Practices (BMP) Database Pollutant Category Statistical Summary Report: Solids, Bacteria, Nutrients and Metals.*" Geosyntec Consultants, Inc. and Wright Water Engineers, Inc. December 2014.

MA Department of Revenue Division of Local Services (2016). "*Property Type Classification Codes, Non-arm's Length Codes and Sales Report Spreadsheet Specifications*" June 2016

MassDEP (2010). "*Mystic River Watershed and Costal Drainage Area 2004-2008 Water Quality Assessment Report*"

MassDEP (2013). *314 CMR 4: The Massachusetts Surface Water Quality Standards*. MassDEP, Boston, MA. https://www.mass.gov/doc/314-cmr-400-surface-water-quality-standards/download.

MassDEP (2016a). "*Massachusetts Clean Water Toolkit*"

MassDEP (2016b). "*Massachusetts Stormwater Handbook, Vol. 2, Ch. 2, Stormwater Best Management Practices*"

MassDEP, USEPA, and ENSR (2018). *"Final Pathogen TMDL for the Boston Harbor, Weymouth-Weir, and Mystic Watersheds". October 2018.*

MassDEP (2019). "*Massachusetts Year 2016 Integrated List of Waters Final Listing of Massachusetts' Waters Pursuant to Sections 305(b), 314 and 303(d) of the Clean Water Act*" December 2019.

MassGIS (1999). "*Networked Hydro Centerlines*" Shapefile

MassGIS (2001). "*USGS Topographic Quadrangle Images*" Image

MassGIS (2005). "*Elevation (Topographic) Data (2005)*" Digital Elevation Model

MassGIS (2007). "*Drainage Sub-basins*" Shapefile

MassGIS (2009a). "*Impervious Surface*" Image

MassGIS (2009b). "*Land Use (2005)*" Shapefile

MassGIS (2012). "*2010 U.S. Census Environmental Justice Populations*" Shapefile

MassGIS (2013). "*MassDEP 2012 Integrated List of Waters (305(b)/303(d))*" Shapefile

MassGIS (2015a). "*Fire Stations*" Shapefile

MassGIS (2015b). "*Police Stations*" Shapefile

MassGIS (2017a). "*Town and City Halls*" Layer

MassGIS (2017b). "*Libraries*" Layer

MassGIS (2020). "*Massachusetts Schools (Pre-K through High School)*" Datalayer

MassGIS (2021). "*Standardized Assessors' Parcels*" Mapping Data Set

Schueler, T.R., Fraley-McNeal, L, and K. Cappiella (2009). "*Is impervious cover still important? Review of recent research*" Journal of Hydrologic Engineering 14 (4): 309-315.

Tetra Tech, Inc. (2015). "*Update of long-term runoff time series for various land uses in New England.*" Memorandum in Opti-Tool zip package. 20 November 2015. Available at: Opti-Tool: EPA Region 1's Stormwater Management Optimization Tool | US EPA

United States Bureau of Labor Statistics (2016). "*Consumer Price Index*"

United States Geological Survey (2016). "*National Hydrography Dataset, High Resolution Shapefile*"

University of Massachusetts, Amherst (2004). "*Stormwater Technologies Clearinghouse*"

University of New Hampshire Stormwater Center (UNHSC) (2018). "*Stormwater Control Measure Nomographs with pollutant removal and design cost estimates.*" Available at: Stormwater Tools in New England | US EPA.

USDA NRCS and MassGIS (2012). "*NRCS SSURGO-Certified Soils*" Shapefile

USEPA (1986). "*Quality Criteria for Water (Gold Book)*" EPA 440/5-86-001. Office of Water, Regulations and Standards. Washington, D.C.

USEPA. (2010). "*EPA's Methodology to Calculate Baseline Estimates of Impervious Area (IA) and Directly Connected Impervious Area (DCIA) for Massachusetts Communities.*"

USEPA. (2020). "*General Permits for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems in Massachusetts (as modified); Appendix F – Requirements for MA Small MS4s Subject to Approved TMDLs.*" 7 December 2020.

Walker Environmental Research LLC. (2016). "*Malden River: Exploratory Water Quality Data Analysis.*" Prepared for the Mystic River Watershed Association by Jeffrey D. Walker, Walker Environmental Research LLC. August 9, 2016.

Appendices

Appendix A – Stakeholder Meeting Minutes

Meeting Minutes

Project Name:	Malden River Watershed-Based Plan		
Location:	Malden River Watershed (Malden, Melrose, Stoneham, Medford, Everett, and Wakefield MA)		
Meeting Date, #:	July 11, 2022	Meeting Time:	2:00 – 3:30 PM
Prepared By:	Emma Williamson	Meeting Location:	Zoom videoconference per Geosyntec invitation
Distribution:	All listed below		

Attendees:

Name	Organization	Contact Information
Emma Williamson	Geosyntec Consultants, Inc	EWilliamson@Geosyntec.com
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Minutes to be considered final unless comments are received within five (5) business days.

AGENDA

- Greeting – Julia Keay, Geosyntec & Meghan Selby, MassDEP
- Brief Introductions from All Participants – All
- Watershed & Goals Overview – Julia Keay, Geosyntec
- s. 604b Grant Project Spotlight – Cat Pedemonti, MyRWA
- Discussion of Completed, Ongoing, and Future Efforts – All

WATERSHED & GOALS OVERVIEW/SECTION 319 GRANT PROJECT SPOTLIGHT

Julia Keay. Good afternoon, thanks for joining this meeting. This is the stakeholder meeting for the Malden River Watershed-based Plan (WBP). The purpose of the meeting is to get stakeholders together and to get your input and gather information for the WBP. Several municipalities received Section 604b funding for a project in the entire Mystic River watershed which includes the Malden River Watershed. The agenda for this meeting is as follows: everyone will give a give introduction then we will give a basic overview of the watershed and water quality goals, then Cat Pedemonti will describe the 604b project and then we will open it up for a discussion. The purpose of the call is to get input on the WBP. I work at Geosyntec and I'm the project manager for the WBP projects.

Emma Williamson. I'm also from Geosyntec and have been involved with several of these plans.

Meghan Selby. I'm the Section 604(b) coordinator for MassDEP. Excited to do planning before implementation work. It's great that we are able to start this with this project.

Padmini Das. I work for MassDEP's Non-point Source (NPS) team. I'm the section chief of NPS pollution program.

Malcolm Harper. I'm the coordinator for MassDEP's Section 319 grant program.

Judy Rondeau. I'm the watershed specialist for MassDEP. I provide support to Meghan and Malcolm in their programs.

Yem Lip. I'm the City Engineer for the City of Malden.

Cat Pedemonti. I'm a project manager with MyRWA. I've conducted sampling for last 20 years, as well as sediment sampling. I've also worked on human health risk assessment including the sediment sampling. We are currently siting some infiltration trenches in Everett.

Amber Christofferson. I'm the Great Bays director for MyRWA. I work on park and path projects on the Mystic and Malden Rivers. This work includes building new parks and green infrastructure that will impact the water quality in Malden River positively, including Malden River Works. This work includes converting pavement to park and installing rain gardens.

Michelle Romero. I'm the city planner for City of Malden. Evan Spetrini may be joining this call; he is the lead on City-side. I hope to learn more about this project.

Mark Jacobson. I'm from PaddleBoston. We rent canoes and kayaks at multiple locations including the Malden Boat House and paddlers use the Malden River.

Julia Keay. Provided an overview of the watershed, including watershed delineation, land use (42% high density residential), and impervious cover (throughout the watershed but concentrated downstream). The water quality goals will be based off of the Pathogen TMDL and the Alternative TMDL for Phosphorus.

Meghan Selby. I'm the Section 604b project coordinator for MassDEP including the 2020 project spearheaded by the City of Everett, working with MyRWA and other municipalities. The project involves siting low-cost infiltration trenches which have been done in other towns/cities previously. The goal is to reduce phosphorus within the watershed. Since there is limited space in urban areas, there is not enough space to do larger BMPs. The idea is to do smaller BMPs but do a lot of them.

Cat Pedemonti. Section 319 grant funding is supporting these as well. We have trenches planned to go in. We are hoping to secure funds to build those. The total cost is $500,000 for other parks of the Mystic River watershed.

DISCUSSION OF COMPLETED, ONGOING, AND FUTURE PROJECTS

A general discussion was held on the following topics:

- ⇒ **Past, current, or planned stormwater best management practice (BMP) projects in the watershed**
- ⇒ **Pollutant load reduction estimates for BMP projects**
- ⇒ **Water quality monitoring efforts**
- ⇒ **Potential pollution sources or problem areas**
- ⇒ **Public education and outreach**
- ⇒ **Additional grant funding available**

Amber Christofferson. Could you please specifically define best management practices (BMPs)?

Julia Keay. Generally structural BMPs such as gravel wetlands, infiltration trenches, etc.

Meghan Selby. We look holistically at the watershed. The WBP sets it up so that whoever is developing it can figure out how long it will take to implement, potential funding sources, water quality analysis, see if solutions are making improvements on the goals. And to identify areas throughout the watershed that might be hotspots for nutrients/bacteria that is getting into the waterbody. Also areas that are degrade would be a good spot to put a BMP in. Could be a small trench or a larger BMP. It's good to get all the ideas out there and see what has the most potential. Also to work with communities to see what they are interested in moving forward with.

Cat Pedemonti. Locations in the watershed include Gateway Park in Everett; there is a boardwalk being built as well as wetland restoration. The outfall that comes in may need some further examination. I'm assuming this will also be included in MS4 outfall testing data.

Julia Keay. Yes, if that information is available. It could be good to include.

Cat Pedemonti. It is a large catchment area. There is lots of green space that the City has been looking at, especially between Route 16 and Revere Beach Parkway.

Julia Keay. For the current 604b locations, do you know how many are included within the Malden River watershed?

Cat Pedemonti. There are 19 in Everett and 35 sites in Melrose for infiltration trenches. We have not gotten to Medford yet and Malden is not part of project.

Julia Keay. Should we not focus on 604b locations when we are doing the field investigation?

Meghan Selby. Are those locations available?

Cat Pedemonti. Yes, I can share them.

Meghan Selby. We don't want to exclude them if there is a good roadway site.

Cat Pedemonti. There is about $230,000 from Mass Bays that is going to Malden stormwater improvements. The exact scope is still getting worked out. We should probably coordinate around that as well. Yem, do you have anything to add?

Yem Lip. I have nothing to add to that. Patrick [City of Malden] is working on that. At some point, will have a consultant (Nangle Associations) who prepares the MS4 permits and will set aside money to help with tidying the list of things we need to get done with the permit.

Cat Pedemonti. I can send the draft scope. It includes stormwater ordinances, stormwater utility analysis, gap analysis, and opportunities to site green infrastructure. However, it is a draft and is still being confirmed.

Amber Christofferson. We are working along the Malden River. There is lots of runoff from Malden City Works. The project has a number of bioretention basins and rain gardens trying to capture runoff from building and the site (2-acre park). The site has a lot of interventions planned. We are close to 75% design but still a few years out. The whole shoreline is basically parking lots draining straight to the river with not a lot of vegetated areas. There is lot of runoff coming straight off the parking lots. It is the most unvegetated overpaved part of the river currently.

Malcolm Harper. Have you prioritized any other sites?

Michelle Romero. The RiverWorks site is big priority project. Now we have a Malden River site plan review process that is triggered when an abutting property does a certain type or level of improvements to the property. Issues are reviewed in terms of stormwater management, removal of invasive species, things like that. We haven't actually had a project yet that has

triggered the review since the ordinance was put on the books. The sites are already built and developed and exempt from zoning. I agree that stretch of parking lots and from Medford up is a priority area, including the National Grid situation. Not sure what is going on with that. I know there was litigation and a lot going on with what they were required to do. Not sure exactly what the status is of that. Might want to get more information on that.

Amber Christofferson. The National Grid site is a 30+ acre site that has a Chapter 91 violation. MassDEP issued a written determination in 2018. It's not looking at water quality. National Grid is the largest landowner on the Malden River.

Michelle Romero. Another site is the Heritage Wholesale site. It received permits before the ordinance. It was in a Tidelands location, but they are appealing a lot of it. They are savvy with regulations, appeals, and how to do the minimums as opposed to what we want to see for the riverfront. The first parcels had a riverfront path. It is a tough road dealing with these properties.

Meghan Selby. Can you email me the ordinance?

Michelle Romero. Yes.

Meghan Selby. All this information is really helpful to give us the local knowledge. Any other information along the same lines would be helpful. Anywhere where water quality/sediment sampling has been happening.

Julia Keay. In the Alternative TMDL there are 3 locations along the Malden River that include phosphorus data. The WBP Tool produces a hotspot map. There is a high priority park half in Melrose and half in Malden. Would it be a good area for us to look at for BMP implementation?

Michelle Romero. We have done work with Gradient Corp including a human health risk assessment. I can send a presentation to share with others in case they have more information. What is the timeline?

Meghan Selby. We want to open up to availability for funding for townships. We know there is a plan for the rest of the Mystic River watershed. Realized that this subwatershed is the only part left that doesn't have plan coverage, which is why we decided to fund it and look for locations. Having a plan in place/conceptual designs will hopefully make it easier for a municipality to move forward with it.

Michelle Romero. There was a slide that listed towns/cities in the watershed. Malden is not included in the 604b grant but is definitely included in the WBP?

Cat Pedemonti. We reached out to everyone, who had the capacity to participate. Could probably roll some of it into Mass Bays funding if Malden is interested.

Meghan Selby. We have a 604b grant request out right now. We are also anticipating having another RFR in the fall, under the bipartisanship bill with more funding. The focus is on getting money into EJ communities and climate aspects as well. Keep an eye out for that in the fall. I can add you to email distribution list. We also have 319 implementation RFR (not date set yet, but probably August).

Malcolm Harper. We anticipate approx. $2 million being available this summer**.**

Julia Keay. That's more than normal?

Malcolm Harper. Yes. Subgrant RFR in spring time for usual $1.5-1.6 million.

Julia Keay. Has there been any work in terms of public education and outreach? It is one of the 9 elements in the plan.

Meeting Minutes

Cat Pedemonti. We coordinate with other community engagements up and down the Malden River. Everyone is trying not to wear out the public and have a ton of small engagements. We are trying to do things that hit on a bunch of different projects. There is existing community engagement in Malden and Everett along the river.

Amber Christofferson. I know Karen Buck was doing a bunch of outreach related to trash in the river. She is a good person to chat with. We have been doing a lot of outreach around the park itself but not water quality focused.

Michelle Romero. Malden River Works is doing ongoing public outreach and community meetings. Definitely talk to Evan Spetrini.

Amber Christofferson. We are taking a back seat since the project is at 75% design. There is an invasive removal plant ID workshop and an on-site music festival. More related to park activity than water quality.

Cat Pedemonti. In Chelsea we were doing community engagement. Did a lot of piggybacking on existing events. It's a better way to engage people when they were already there for something else.

Amber Christofferson. There are two events this fall, both in September relating to Malden River Works. Music festival and invasive plant event.

Meghan Selby. MassDEP also has a handful of the Enviroscapes that they lend out to towns for farmers markets or other events. There are two in the Worcester office. If you are interested, let us know.

Amber Christofferson. If there is a BMP coinciding with providing access to rivers since that's something we've been working on the long time with the DEP waterways program. So much private ownership, not a lot in control of municipalities in terms of what the communities want to see.

Julia Keay. So the biggest hurdle is that there is so much private land?

Amber Christofferson. Private ownership is an issue. Getting the public to understand that there is a Malden River and how to get to it. It is burdened by its past of commerce in a bad way.

Michelle Romero. I will send ordinates and other report with MAPC for plan. It's a compilation of efforts we have been making and history.

Amber Christofferson. The Greenways/vision plan is on the Mystic River website: https://mysticriver.org/maldenriver

Cat Pedemonti. For the water quality data, do you want us to get it from Andy? We have 20 years of data and can send anything.

Meghan Selby. Thanks everyone for joining, let us know if anything else comes to mind. We will send out meeting minutes/notes with our contact information.

Contact: Julia Keay, JKeay@geosyntec.com
Emma Williamson, EWilliamson@geosyntec.com
Judith Rondeau, Judith.Rondeau@mass.gov
Meghan Selby, Meghan.Selby@mass.gov

Appendix B – Excerpts from the Mystic River Watershed and Coastal Area 2004-2008 Water Quality Assessment Report

Mystic River Watershed and Coastal Drainage Area 2004-2008 Water Quality Assessment Report (MA71-05 - Malden River)

Aquatic Life
A USGS study found that some chemicals are present in sufficiently high concentrations in Malden River sediment to pose a threat to benthic organisms and impair the Aquatic Life Use. MWRA and MyRWA documented highly productive conditions, including: elevated total phosphorus levels, high pH, and frequent supersaturation of dissolved oxygen. The Aquatic Life Use is also impaired for low dissolved oxygen conditions documented by MWRA. The fish community was dominated by macrohabitat fish species classified as moderately tolerant to pollution, which is consistent with an impaired condition. One andromous fish species (Alewife) was present at both stations sampled.

Fish Consumption
Due to the presence of PCBs, DDT, and Chlordane, MA DPH has issued the following advisory for the Malden River recommending: “No one should consume any fish from this water body.”

Primary Contact
Yearly E. coli geometric means calculated for the Primary Contact Recreation season from 1 MWRA station sampled monthly from 2002 to 2007 in this segment did not exceed 126 cfu/100mL. 0 out of 6 years of Primary Contact Recreation geomeans exceeded standards. Yearly E. coli geometric means calculated for the Primary Contact Recreation season from 1 MyRWA baseline monitoring station sampled monthly from 2002 to 2008 in this segment exceeded 126 cfu/100mL. 7 out of 7 years of Primary Contact Recreation geomeans for MyRWA bacteria data exceeded standards, most recently in 2008. The MyRWA station is upstream of the MWRA station, and a seperate MyRWA study indicates that bacteria levels are extremely high in the upper 2/3 of the segment but tend to decrease at the bottom. The chronic high bacteria numbers at the upper station justify impairing this segment. In addition, MWRA documented poor Secchi disk transparencies sufficient to impair the Aesthetics Use and thus the Primary Contact Use.

Secondary Contact
Yearly E. coli geometric means from 1 MWRA station sampled monthly from 2002 to 2007 in this segment did not exceed 630 cfu/100mL. 0 out of 6 yearly geomeans exceeded standards. Yearly E. coli geometric means from 1 MyRWA baseline monitoring station sampled monthly from 2002 to 2008 in this segment exceeded 630 cfu/100mL. 1 out of 7 yearly geomeans exceeded for MyRWA bacteria data, most recently in 2002. Bacteria levels indicate Support with “Alert Status”, however MWRA documented poor Secchi disk transparencies as well as objectionable odors sufficient to impair the Aesthetics Use and thus the Secondary Contact use is impaired.

Aesthetics
MWRA documented poor Secchi disk transparencies sufficient to impair the Aesthetics Use. 77 Secchi disk depths were recorded between 2002 and 2006, with 72 reported as less than 1.2 meters (94%). MyRWA volunteers most often recorded no odor, but also noted smells such as " oily, chemical/acidic, fruity, slightly fishy, decay, soapy, rotten eggs, vegetal, slight detergent," and others at their monitoring station.

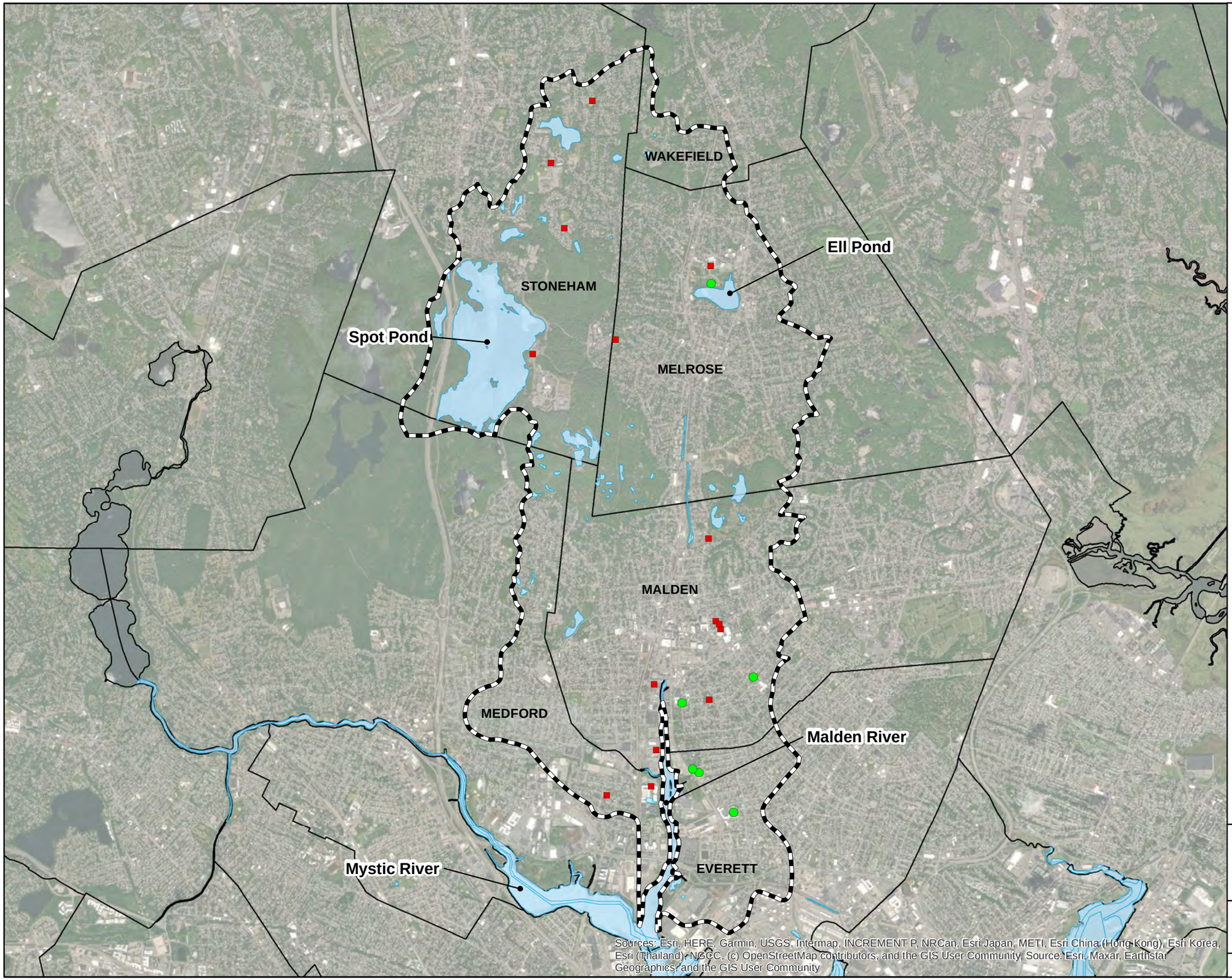
Report Recommendations:
NA

Appendix C – Pollutant Load Export Rates (PLERs)

Land Use & Cover[1]	PLERs (lbs./acre/year)		
	(TP)	(TSS)	(TN)
AGRICULTURE, HSG A	0.45	7.14	2.6
AGRICULTURE, HSG B	0.45	29.4	2.6
AGRICULTURE, HSG C	0.45	59.8	2.6
AGRICULTURE, HSG D	0.45	91	2.6
AGRICULTURE, IMPERVIOUS	1.52	650	11.3
COMMERCIAL, HSG A	0.03	7.14	0.3
COMMERCIAL, HSG B	0.12	29.4	1.2
COMMERCIAL, HSG C	0.21	59.8	2.4
COMMERCIAL, HSG D	0.37	91	3.7
COMMERCIAL, IMPERVIOUS	1.78	377	15.1
FOREST, HSG A	0.12	7.14	0.5
FOREST, HSG B	0.12	29.4	0.5
FOREST, HSG C	0.12	59.8	0.5
FOREST, HSG D	0.12	91	0.5
FOREST, HSG IMPERVIOUS	1.52	650	11.3
HIGH DENSITY RESIDENTIAL, HSG A	0.03	7.14	0.3
HIGH DENSITY RESIDENTIAL, HSG B	0.12	29.4	1.2
HIGH DENSITY RESIDENTIAL, HSG C	0.21	59.8	2.4
HIGH DENSITY RESIDENTIAL, HSG D	0.37	91	3.7
HIGH DENSITY RESIDENTIAL, IMPERVIOUS	2.32	439	14.1
HIGHWAY, HSG A	0.03	7.14	0.3
HIGHWAY, HSG B	0.12	29.4	1.2
HIGHWAY, HSG C	0.21	59.8	2.4
HIGHWAY, HSG D	0.37	91	3.7
HIGHWAY, IMPERVIOUS	1.34	1,480	10.5
INDUSTRIAL, HSG A	0.03	7.14	0.3
INDUSTRIAL, HSG B	0.12	29.4	1.2
INDUSTRIAL, HSG C	0.21	59.8	2.4
INDUSTRIAL, HSG D	0.37	91	3.7

INDUSTRIAL, IMPERVIOUS	1.78	377	15.1
LOW DENSITY RESIDENTIAL, HSG A	0.03	7.14	0.3
LOW DENSITY RESIDENTIAL, HSG B	0.12	29.4	1.2
LOW DENSITY RESIDENTIAL, HSG C	0.21	59.8	2.4
LOW DENSITY RESIDENTIAL, HSG D	0.37	91	3.7
LOW DENSITY RESIDENTIAL, IMPERVIOUS	1.52	439	14.1
MEDIUM DENSITY RESIDENTIAL, HSG A	0.03	7.14	0.3
MEDIUM DENSITY RESIDENTIAL, HSG B	0.12	29.4	1.2
MEDIUM DENSITY RESIDENTIAL, HSG C	0.21	59.8	2.4
MEDIUM DENSITY RESIDENTIAL, HSG D	0.37	91	3.7
MEDIUM DENSITY RESIDENTIAL, IMPERVIOUS	1.96	439	14.1
OPEN LAND, HSG A	0.03	7.14	0.3
OPEN LAND, HSG B	0.12	29.4	1.2
OPEN LAND, HSG C	0.21	59.8	2.4
OPEN LAND, HSG D	0.37	91	3.7
OPEN LAND, IMPERVIOUS	1.52	650	11.3
[1]HSG = Hydrologic Soil Group			

Appendix D – BMP Opportunity Locations and BMP Concept Locations Figure



Legend

- BMP Concept Location
- BMP Opportunity Location
- Malden River Watershed
- City Boundaries
- Ponds and Rivers

N

0 0.6 Miles

BMP Opportunity Locations and BMP Concept Locations

Malden River Watershed
Massachusetts

Geosyntec consultants

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Appendix E – BMP Conceptual Designs

General Site Location within Malden River Watershed

Site Name: Lewis Monk Memorial Park Bioretention Cell

BMP Type: Bioretention Cell
BMP Location: Lewis Monk Memorial Park, Melrose, MA
Priority Rank: 4

Site Summary:
Lewis Monk Memorial Park is a recreational park, adjacent to Ell Pond, with various ball fields, walking trails, and a farmers' market. The paved parking area at the park is in disrepair with visible signs of erosion and ponding. Additionally, there is eutrophication in the pond, indicating excessive nutrient loads. A stormwater drain manhole and outfall were observed near the proposed BMP.

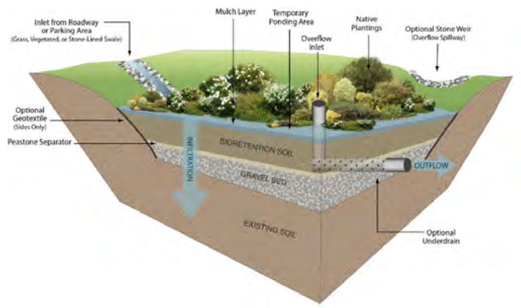
Proposed BMP:
Install a bioretention cell (infiltrating or with an underdrain depending on soil/infiltration tests) with vegetated filter strip pretreatment to treat sheet flow stormwater runoff from the park and parking area and reduce nutrient and sediment loading to Ell Pond. Add signage that will provide public education on green infrastructure and stormwater management. The bioretention cell should be filled with a mix of sandy loam and graded to allow a ponding depth of 6-8" and should include a 12-18" gravel layer, a 3" peastone layer, and a 12-18" bioretention/ soil layer. Vegetation support materials (such as compost) should be carefully selected to limit nutrient export. There is also opportunity to provide additional treatment here by routing runoff from the existing manhole to subsurface infiltration in the playing fields west-adjacent to the parking area, which was proposed in the 2020 "Ell Pond Park Feasibility Study" (information can be found here: https://www.cityofmelrose.org/sites/g/files/vyhlif3451/f/pages/ell_pond_park_public_meeting_presentation_11.19.2020.pdf)

Expected O&M:
Inspect the bioretention cell and filter strip regularly (at least twice per year) for sediment build-up, structural damage and standing water. Inspect for erosion and re-mulch void areas on a monthly basis or as necessary. Remove sediment and debris. Remove and replace dead vegetation in Spring and Fall. Remove invasive species. Do not store snow in BMP area.

Parcel Ownership: Publicly Owned.

Area of proposed Bioretention Cell looking towards Ell Pond

Sizing Characteristics	
BMP Drainage Area (acres)	1.1
BMP Design Storm Depth (inches)	1.00
BMP Footprint (square feet)	995
Estimated Pollutant Load Reduction	
Total Phosphorus (lbs/year)	0.5
Total Nitrogen (lbs/year)	3.5
Total Suspended Solids (lbs/year)	255
Estimated Cost	
Planning-level Capital Cost	$40,000
Annual Operation & Maintenance Cost	$2,000



Typical Bioretention Cross Section
Note: underdrain is optional and based on the infiltrative capacity of the soil

Legend
- Drainage Area to Proposed BMP
- Proposed BMP Footprint
- Ponds and Rivers
- Parcels

N

0 60 Feet

Lewis Monk Memorial Park Bioretention Cell Conceptual Design

Malden River Watershed
Massachusetts

Geosyntec consultants

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Figure 1

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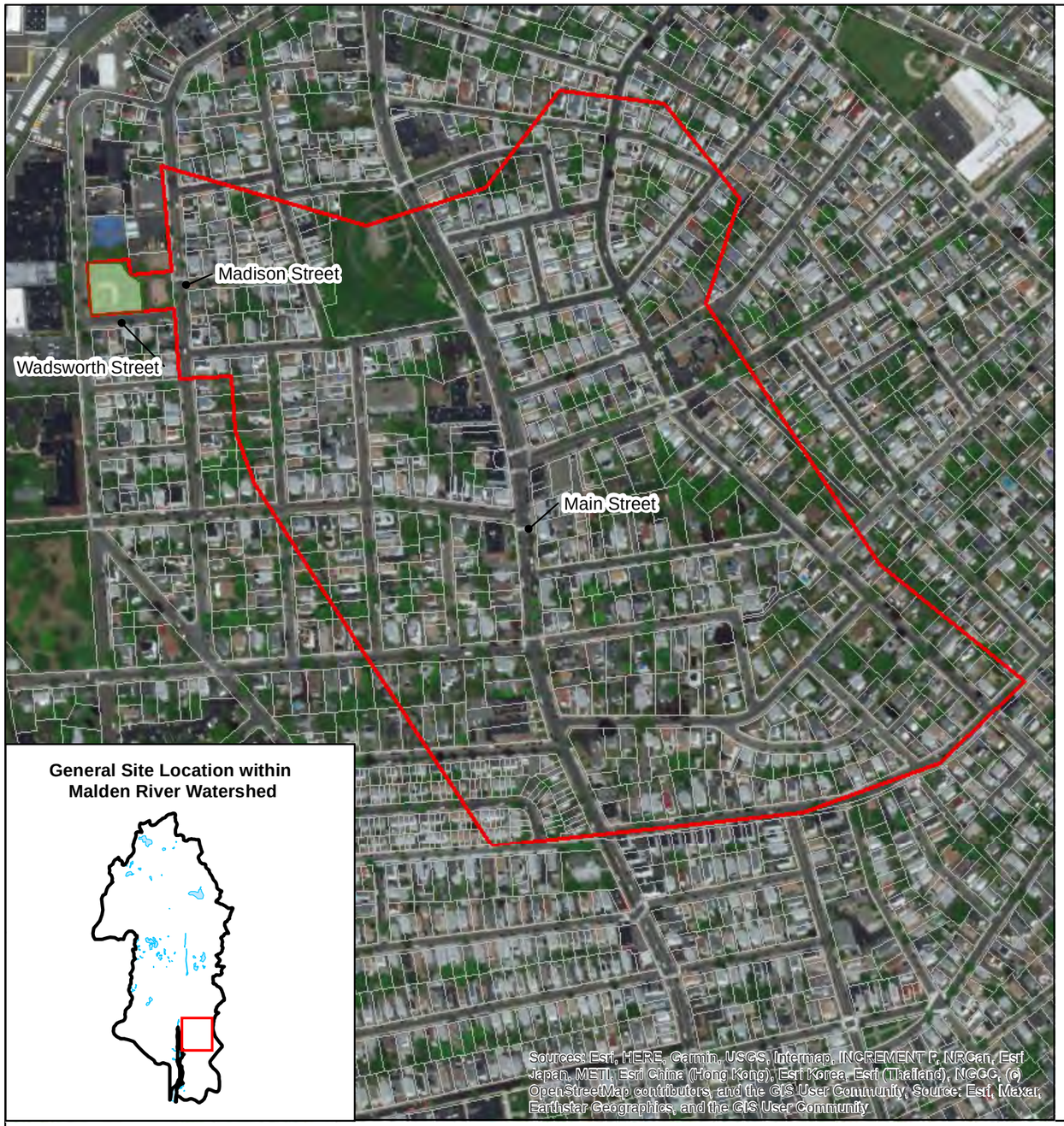

General Site Location within Malden River Watershed

Site Name: MacArthur Park Subsurface Infiltration

BMP Type: Subsurface Infiltration
BMP Location: MacArthur Park, Malden, MA
Priority Rank: 3

Site Summary:
MacArthur Park is a recreational park that includes a baseball field and a playground. The drainage area to the park was delineated by consulting the available Municipal Separate Stormwater Sewer System (MS4) map for the City of Malden.

Proposed BMP:
Install a flow splitter, pretreatment structure, and piping from stormwater drainage manhole along Madison Street (east-adjacent to MacArthur Park) and route stormwater runoff to subsurface recharge structures underneath the baseball field at MacArthur Park. The subsurface underground recharge structures would capture runoff and gradually infiltrate into the groundwater through rock and gravel. This feasibility of this BMP type is dependent on the infiltration capacity of the soil and groundwater depth. The available soils map indicates hydrologic soil group (HSG) A in this location; field infiltration and soils testing will be required before advancing the design at this location.

Expected O&M:
Inspect inlets/inspection ports at least twice per year and as needed. Remove any debris that might clog the system. A vacuum truck or other similar devices can be used to remove sediment from the treatment train.

Parcel Ownership: Publicly Owned. MacArthur Park is open to the public.

Sizing Characteristics	
BMP Drainage Area (acres)	89.9
BMP Design Storm Depth (inches)	0.25
BMP Footprint (square feet)	24,000
Estimated Pollutant Load Reduction	
Total Phosphorus (lbs/year)	73.4
Total Nitrogen (lbs/year)	716.0
Total Suspended Solids (lbs/year)	18,962
Estimated Cost	
Planning-level Capital Cost	$1,320,000
Annual Operation & Maintenance Cost	$5,000

Example of Subsurface Recharge Structure Installation

View of proposed subsurface infiltration area from Wadsworth Street

Legend
- Drainage Area to Proposed BMP
- Proposed BMP Footprint
- Ponds and Rivers
- Parcels

N

0 420 Feet

MacArthur Park Subsurface Infiltration Conceptual Design

Malden River Watershed
Massachusetts

Geosyntec consultants

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Figure 2

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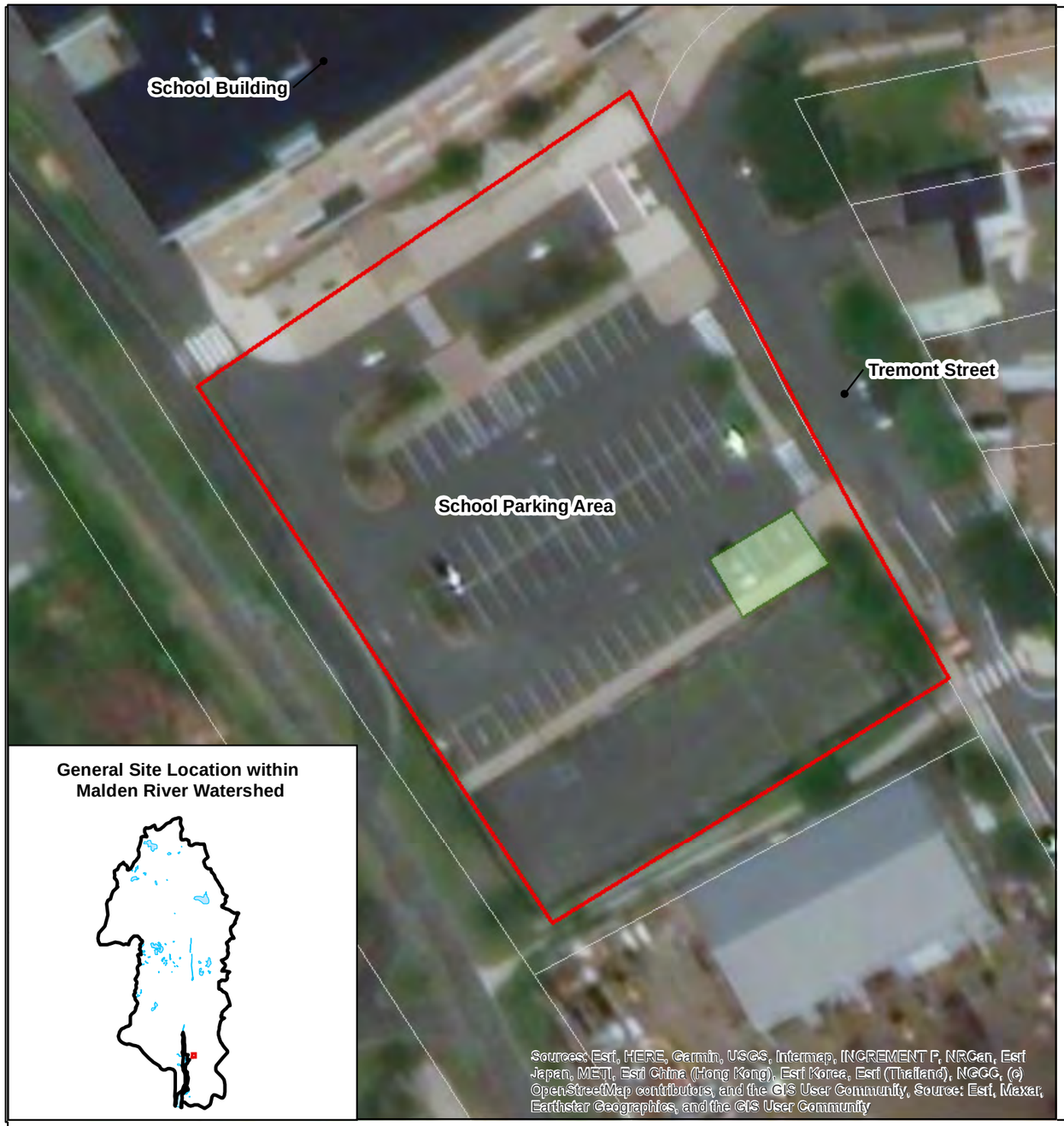


General Site Location within Malden River Watershed

Site Name: Madeline English School Bioretention Cell

BMP Type: Bioretention Cell
BMP Location: Madeline English School, Everett, MA
Priority Rank: 1

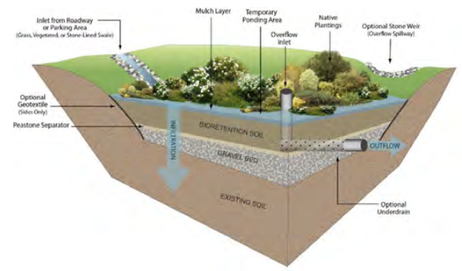
Site Summary:
The drainage area includes a paved parking area and basketball court of Madeline English School (Grades K-8 public school). A catch basin is located in the area of the proposed bioretention cell, which collects sheet flow runoff and appeared to be routed to the manhole on Tremont Street via a stormwater pipe.

Proposed BMP:
Install a bioretention cell (infiltrating or with an underdrain depending on soil/infiltration tests) to treat stormwater runoff from the parking area. Add signage that will provide public education on green infrastructure and stormwater management. The bioretention cell should be filled with a mix of sandy loam and graded to allow a ponding depth of 6-8" and should include a 12-18" gravel layer, a 3" peastone layer, and a 12-18" bioretention/ soil layer. Vegetation support materials (such as compost) should be carefully selected to limit nutrient export. Retrofit the existing catch basin to be used as an overflow outlet.

Expected O&M:
Inspect the bioretention cell regularly (at least twice per year) for sediment build-up, structural damage and standing water. Inspect for erosion and re-mulch void areas on a monthly basis or as necessary. Remove sediment and debris. Remove and replace dead vegetation in Spring and Fall. Remove invasive species. Do not store snow in BMP area.

Parcel Ownership: Publicly Owned.

Sizing Characteristics	
BMP Drainage Area (acres)	1.1
BMP Design Storm Depth (inches)	0.50
BMP Footprint (square feet)	1,030
Estimated Pollutant Load Reduction	
Total Phosphorus (lbs/year)	1.4
Total Nitrogen (lbs/year)	9.3
Total Suspended Solids (lbs/year)	444
Estimated Cost	
Planning-level Capital Cost	$23,000
Annual Operation & Maintenance Cost	$1,000



Typical Bioretention Cell Cross Section
Note: underdrain is optional and based on the infiltrative capacity of the soil

View of existing catch basins where bioretention cell is proposed looking towards school buliding

Legend
- Drainage Area to Proposed BMP
- Proposed BMP Footprint
- Ponds and Rivers
- Parcels

N

0 50 Feet

Madeline English School Bioretention Cell Conceptual Design

Malden River Watershed
Massachusetts

Geosyntec consultants

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Figure 3

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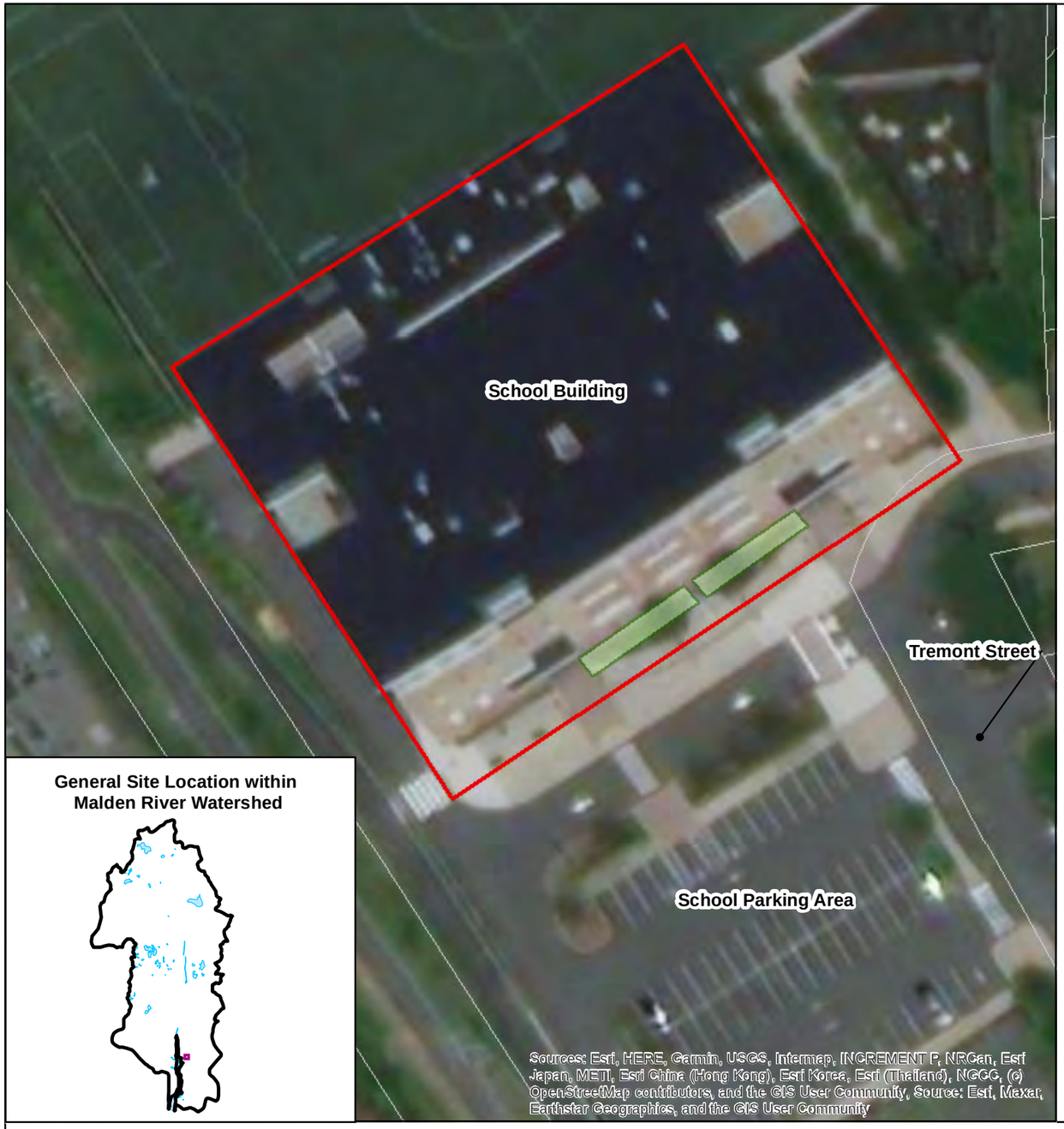


General Site Location within Malden River Watershed

Site Name: Madeline English School Cistern and Bioretention Cell

BMP Type: Cistern and Bioretention Cell
BMP Location: Madeline English School, Everett, MA
Priority Rank: 2

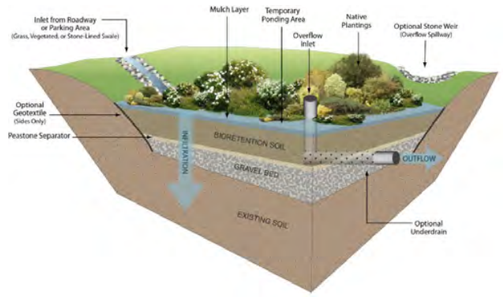
Site Summary:
The drainage area includes the roof of the school building and part of the walkway at the front of the building of Madeline English School (Grades K-8 public school).

Proposed BMP:
Install a cistern to collect roof runoff and install bioretention cells/rain gardens (with underdrain) at the front of the building in the existing planter areas. Route the cistern overflow to the bioretention cell and use the stored water for irrigation of the bioretention cell during dry periods. Route the bioretention underdrain and overflow to the existing municipal separate sewer system along Tremont Street. Add signage that will provide public education on green infrastructure and stormwater management. The bioretention cell should be filled with a mix of sandy loam and graded to allow a ponding depth of 6-8" and should include a 12-18" gravel layer, a 3" peastone layer, and a 12-18" bioretention/ soil layer. Vegetation support materials (such as compost) should be carefully selected to limit nutrient export. Retrofit the existing catch basin to be used as an overflow outlet.

Expected O&M:
Inspect the cistern and bioretention cell regularly (at least twice per year) for sediment build-up, structural damage and standing water. Inspect for erosion and re-mulch void areas on a monthly basis or as necessary. Remove sediment and debris. Remove and replace dead vegetation in Spring and Fall. Remove invasive species. Do not store snow in BMP area.

Parcel Ownership: Publicly Owned.

Sizing Characteristics	
BMP Drainage Area (acres)	1.1
BMP Design Storm Depth (inches)	0.50
BMP Footprint (square feet)	1,050
Estimated Pollutant Load Reduction	
Total Phosphorus (lbs/year)	1.5
Total Nitrogen (lbs/year)	9.5
Total Suspended Solids (lbs/year)	453
Estimated Cost	
Planning-level Capital Cost	$43,000
Annual Operation & Maintenance Cost	$1,000



Typical Bioretention Cell Cross Section
Note: underdrain is optional and based on the infiltrative capacity of the soil

View of the existing planter areas at the front of the school building where bioretention cells are proposed

Legend
- Drainage Area to Proposed BMP
- Proposed BMP Footprint
- Ponds and Rivers
- Parcels

N

0 50 Feet

Madeline English School Cistern and Bioretention Cell Conceptual Design
Malden River Watershed
Massachusetts

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Figure 4

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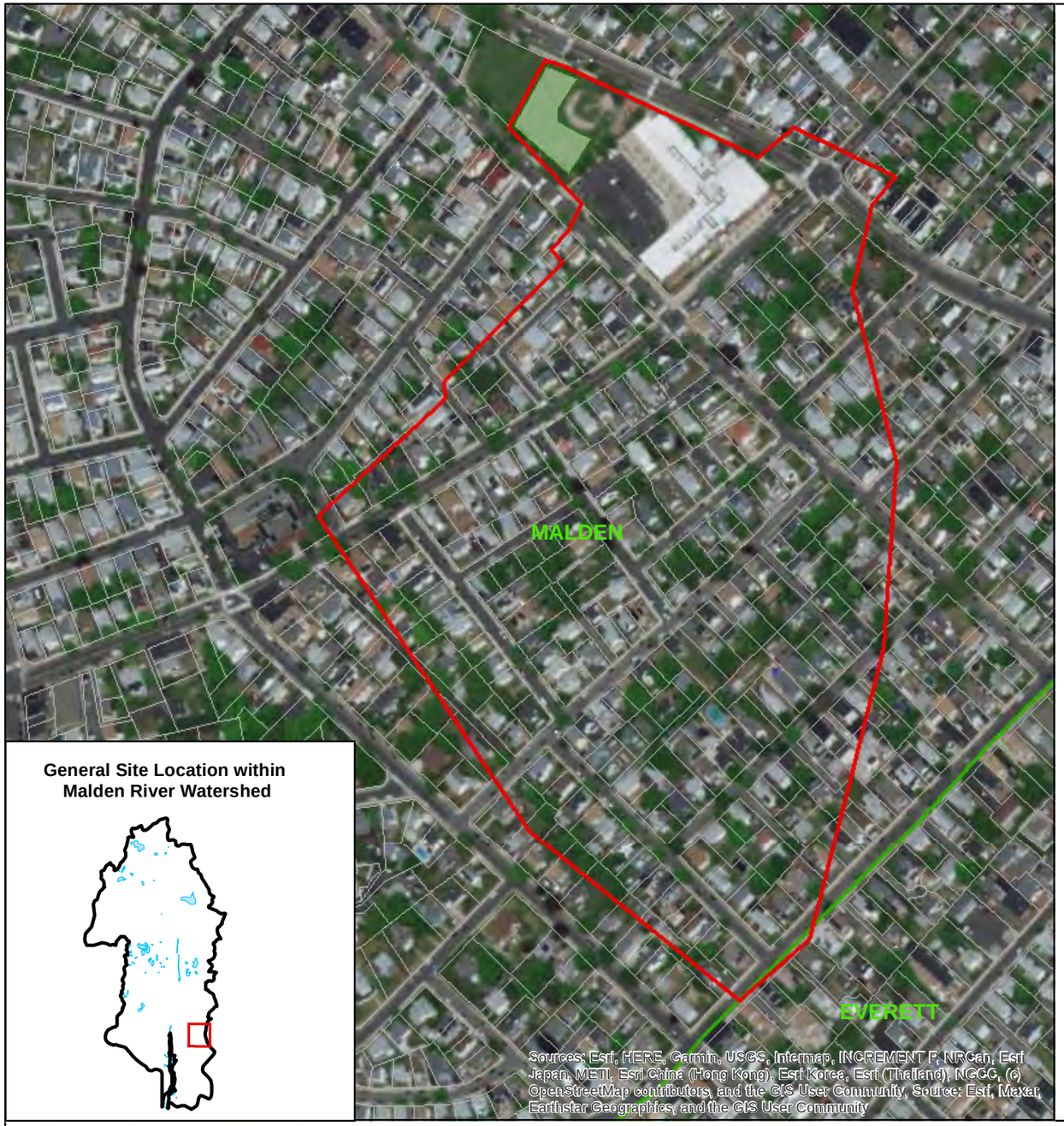

General Site Location within Malden River Watershed

Site Name: Newman Park/ Ferryway School Subsurface Infiltration

BMP Type: Subsurface Infiltration
BMP Location: Newman Park/ Ferryway School, Malden, MA
Priority Rank: 3

Site Summary:
Newman Park is a recreational park that includes a baseball field and open space and is directly adjacent to the Ferryway School. The drainage area to the park was delineated by consulting the available Municipal Separate Stormwater Sewer System (MS4) map for the City of Malden. The MS4 collects runoff from the parking area and the school and routes through the park.

Proposed BMP:
Install a flow splitter, pretreatment structure, and piping from stormwater drainage manhole in the park area directly downstream of the school parking area and route stormwater runoff to subsurface recharge structures underneath the green space of the park. The subsurface underground recharge structures would capture runoff and gradually infiltrate into the groundwater through rock and gravel. This feasibility of this BMP type is dependent on the infiltration capacity of the soil and groundwater depth. The available soils map indicates hydrologic soil group (HSG) A in this location; field infiltration and soils testing will be required before advancing the design at this location.

Expected O&M:
Inspect inlets/inspection ports at least twice per year and as needed. Remove any debris that might clog the system. A vacuum truck or other similar devices can be used to remove sediment from the treatment train.

Parcel Ownership: Publicly Owned.

Sizing Characteristics	
BMP Drainage Area (acres)	38.1
BMP Design Storm Depth (inches)	0.50
BMP Footprint (square feet)	20,700
Estimated Pollutant Load Reduction	
Total Phosphorus (lbs/year)	40.1
Total Nitrogen (lbs/year)	341.2
Total Suspended Solids (lbs/year)	12,524
Estimated Cost	
Planning-level Capital Cost	$1,138,500
Annual Operation & Maintenance Cost	$5,000

Example of Subsurface Recharge Structure Installation

View of Newman Park, where subsurface infiltration is proposed, facing towards the school building

Legend
- Drainage Area to Proposed BMP
- Proposed BMP Footprint
- Ponds and Rivers
- City Boundaries
- Parcels

N

0 280 Feet

Newman Park Subsurface Infiltration Conceptual Design

Malden River Watershed
Massachusetts

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Figure 5

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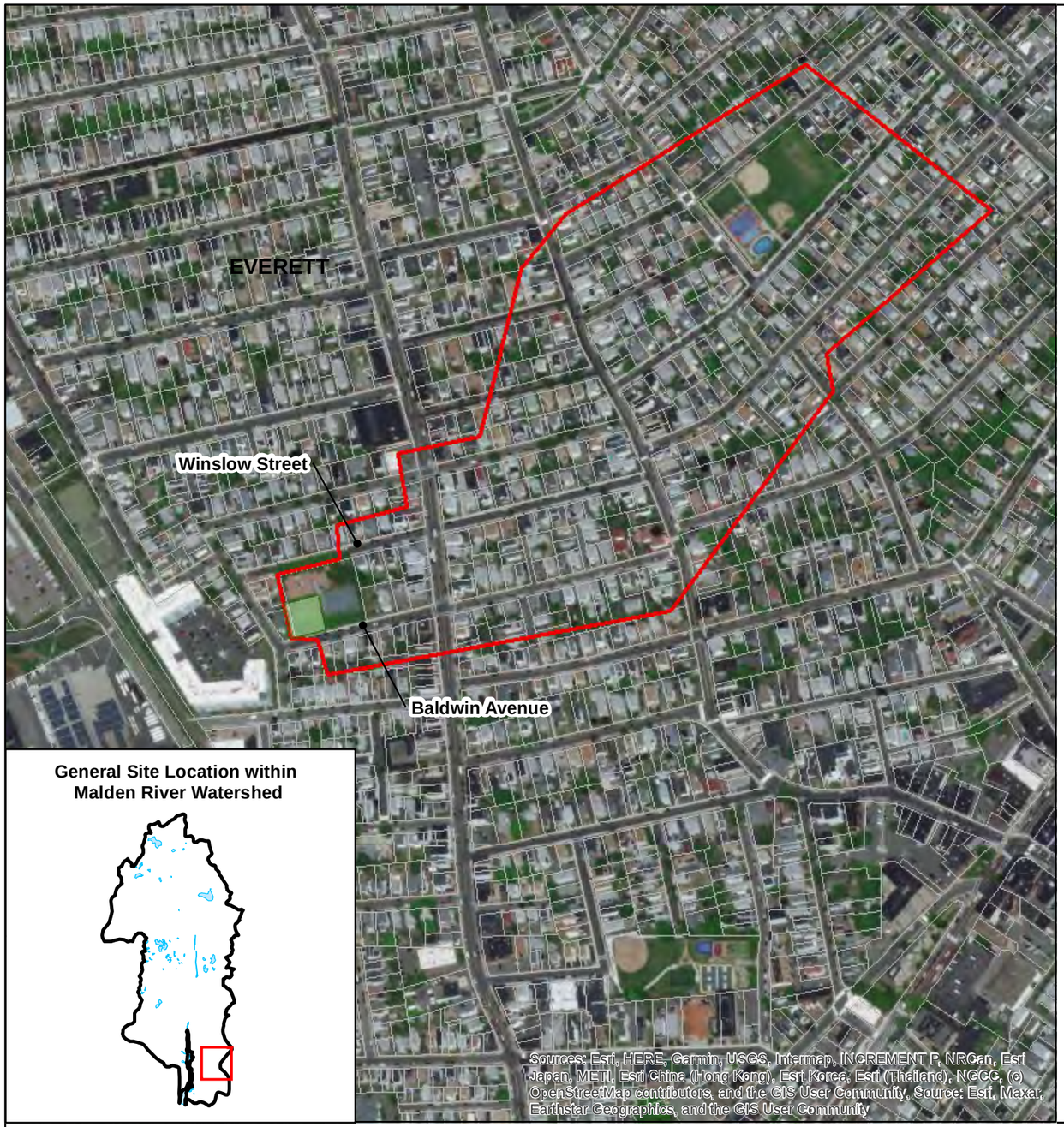

General Site Location within Malden River Watershed

Site Name: Wasgott Park Subsurface Infiltration

BMP Type: Subsurface Infiltration
BMP Location: Wasgott Park, Everett, MA
Priority Rank: 5

Site Summary:
Wasgott Park is a recreational park that includes two basketball courts, a playground, and open space. The drainage area to the park was delineated by consulting the available Municipal Separate Stormwater Sewer (MS4) map for the City of Everett.

Proposed BMP:
Install a flow splitter, pretreatment structure, and piping from stormwater drainage manholes on Winslow Street and Baldwin Avenue and route stormwater runoff to subsurface recharge structures underneath the green space of the park. The subsurface underground recharge structures would capture runoff and gradually infiltrate into the groundwater through rock and gravel. This feasibility of this BMP type is dependent on the infiltration capacity of the soil and groundwater depth. The available soils map indicates hydrologic soil group (HSG) A in this location; field infiltration and soils testing will be required before advancing the design at this location.

Expected O&M:
Inspect inlets/inspection ports at least twice per year and as needed. Remove any debris that might clog the system. A vacuum truck or other similar devices can be used to remove sediment from the treatment train.

Parcel Ownership: Publicly Owned. Wasgott Park is open to the public.

Sizing Characteristics	
BMP Drainage Area (acres)	45.0
BMP Design Storm Depth (inches)	0.25
BMP Footprint (feet)	13,100
Estimated Pollutant Load Reduction	
Total Phosphorus (lbs/year)	40.5
Total Nitrogen (lbs/year)	395.6
Total Suspended Solids (lbs/year)	10,451
Estimated Cost	
Planning-level Capital Cost	$720,500
Annual Operation & Maintenance Cost	$4,000

Example of Subsurface Recharge Structure Installation

View of Wasgott Park, where subsurface infiltration is proposed, facing towards the playground

Legend
- Drainage Area to Proposed BMP
- Proposed BMP Footprint
- Ponds and Rivers
- Parcels

N

0 420 Feet

Wasgott Park Subsurface Infiltration Conceptual Design

Malden River Watershed
Massachusetts

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Figure 6

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