MASSACHUSETTS
watershed·based plans

WATERSHED-BASED PLAN

Hinsdale Brook (MA33-21)

August 2023

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Prepared For:

MassDEP
Commonwealth of Massachusetts
Department of Environmental Protection

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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 (USEPA's) recommended format for "nine-element" watershed plans. This WBP was developed by Geosyntec Consultants, Inc. (Geosyntec) under the direction of the Massachusetts Association of Conservation Districts (MACD) with funding, input, and collaboration from the Massachusetts Department of Environmental Protection (MassDEP).

This WBP was prepared for the Hinsdale Brook watershed, which is in the towns of Greenfield, Shelburne, and Colrain, Massachusetts. The total area of the Hinsdale Brook watershed is approximately 4,063 acres (approximately 6.3 square miles). Major streams in the watershed include Hinsdale Brook (MA33-21), Punch Brook (MA33-100), Stewart Brook (MA33-132), Unnamed Tributary (MA33-103), and Unnamed Tributary (MA33-104). The headwaters of Hinsdale Brook are in Colrain and Shelburne; Punch Brook discharges into Hinsdale Brook approximately 1,000 feet upstream of where Hinsdale Brook discharges into the Green River, a tributary to the Deerfield River[1]. For this WBP, the watershed was delineated to the confluence with Punch Brook.

Impairments and Pollution Sources: Hinsdale Brook (MA33-21) is a category 5 water body on the 2016 Massachusetts Integrated List of Waters (303(d) list) due to *Escherichia coli* (*E. coli*) from agriculture and unknown sources. There is limited water quality data for Hinsdale Brook but data available from 2005 and 2012 indicated elevated levels of *E. coli* [above the Massachusetts Water Quality Standards]. In addition to agricultural pollution sources, sediment loading from fluvial erosion adjacent to Brook Road has been identified as a pollution source in numerous assessments of the Hinsdale Brook watershed (Shelburne Hazard Mitigation Committee and FRCOG 2021; FRCOG, 2015; FRCOG, 2008).

Goals, Management Measures, and Funding: The long-term goal of this WBP is to reduce *E. coli* and Total Phosphorus (TP) loading to Hinsdale Brook, eventually leading to delisting of impaired waterbodies in the study area from the 303(d) list. It is expected that these pollutant load reductions will result in improvements to other water quality parameters throughout the watershed as well.

It is expected that these goals will be accomplished primarily through installation of agricultural Best Management Practices (BMPs) to capture runoff and reduce *E. coli* loading as well as implementation of watershed education and outreach to achieve additional pollutant load reductions. Agricultural BMP planning and implementation will initially be performed at various farms in the watershed, with funding from the Fiscal Year 2021 Section 319 grant program (MACD, 2020). MACD was awarded this funding to conduct outreach and education to farmers in the Hinsdale Brook watershed; develop conservation plans outlining BMPs to reduce pollutant runoff; assist landowners in obtaining access to financial resources; implement BMPs and ensure farmers follow operation and maintenance practices (MACD, 2020).

It is expected that future funding for management measures will be obtained from a variety of sources including Section 319 Grant Funding, Climate Smart Agricultural Program (CSAP), Massachusetts Environmental Trust (MET) grants, the Agricultural Environmental Enhancement Program (AEEP), the

[1] A WBP for the entire Deerfield River watershed was previously developed in 2015 (FRCOG, 2015).

Agricultural Produce Safety Improvement Program (APSIP), Town capital funds, volunteer efforts, and United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) grants including the Environmental Quality Incentives Program (EQIP) and the Agricultural Management Assistance (AMA) program.

Public Education and Outreach: Goals of public education and outreach are to provide information about proposed stormwater improvements and to promote watershed stewardship.

MACD will engage in outreach and dialogue with farmers in the Hinsdale Brook watershed and share information about the availability of funds from MassDEP, the Massachusetts Department of Agricultural Resources (MDAR) and NRCS to implement BMPs to reduce contaminated runoff from agricultural operations.

An initial stakeholder meeting was held on November 8, 2021, which included core stakeholders in the Hinsdale Brook watershed. The purpose of the meeting was to introduce stakeholders to one another and gain consensus on elements of this WBP. A follow-up meeting was held on April 18, 2023, to discuss progress towards the WBP and potential BMPs.

Implementation Schedule and Evaluation Criteria: The implementation schedule includes milestones for outreach and education; monitoring; development and implementation of farm conservation plans; assisting farmers in obtaining access to financial resources; BMP implementation; and operation and maintenance plans.

This WBP recommends expanding the current water quality monitoring program that is managed by Deerfield River Watershed Association (DRWA), to include sampling at key locations along Hinsdale Brook. This would help achieve a better understanding of water quality trends in Hinsdale Book 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, 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. The Franklin Regional Council of Governments (FRCOG) has expressed interest in maintaining this plan and may be able to lead periodic plan evaluations/updates.

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 (USEPA's) recommended format for "nine-element" watershed plans, as described below.

All states are required to develop WBPs, 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 federal watershed implementation grant funds** under Section 319 of the Clean Water Act.

USEPA 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 for the Hinsdale Brook watershed includes nine elements (a through i) in accordance with USEPA 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 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 (EQIP) 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 nonpoint source management measures that will be implemented.

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

g) A description of **interim, measurable milestones** for determining whether nonpoint source 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 towards attaining water quality standards and, if not, the criteria for determining whether this WBP needs to be revised or, if a nonpoint source 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 Massachusetts Association of Conservation Districts (MACD) with funding, input, and collaboration from MassDEP. This WBP was developed using funds from the Section 319 program to assist grantees in developing technically robust WBPs using MassDEP's Watershed-Based Planning Tool (WBP Tool). The MACD was a recipient of Section 319 funding in Fiscal Year 2021 to implement public outreach and education as well as farm conservation plans and agricultural BMPs in the Hinsdale Brook watershed (MACD, 2020).

The following are core project stakeholders:

- Michael Leff – MACD
- Judith Rondeau – MassDEP
- Meghan Selby – MassDEP
- Malcolm Harper – MassDEP
- Tamsin Flanders – Franklin County Regional Council of Governments (FRCOG)
- Ryan O'Donnell – Connecticut River Conservancy (CRC)

This WBP was developed as part of an iterative process as outlined below:

- The Geosyntec project team first collected and reviewed existing data from MACD and other available sources.
- Subsequently, a stakeholder meeting was held on November 8, 2021, to solicit additional 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, a WBP was drafted and reviewed by MassDEP.
- A follow-up meeting was held on April 18, 2023 to discuss progress towards the WBP development and potential BMPs. Michael Leff, Malcolm Harper, Judith Rondeau, Meghan Selby, and Tamsin Flanders attended the meeting.
- The WBP was updated and finalized based on MassDEP and MACD input.

This WBP is meant to be a living document. It should be reevaluated 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 strongly recommended that a working group including additional stakeholders be established to meet at least biannually to implement and update this WBP, and track progress. FRCOG has expressed interest in leading the implementation of this plan.

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 Section 319 grant application for "Western Massachusetts Agricultural Nonpoint Source Program" (MACD, 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

This WBP was prepared for the Hinsdale Brook watershed, which is in the towns of Greenfield, Shelburne, and Colrain, Massachusetts. The headwaters of Hinsdale Brook are in Colrain and Shelburne; Punch Brook discharges into Hinsdale Brook approximately 1,000 feet upstream of where it discharges into the Green River, which is a tributary to the Deerfield River[2]. For this WBP, the watershed was delineated to the confluence with Punch Brook. The total area of the Hinsdale Brook watershed is approximately 4,063 acres (approximately 6.3 square miles). Major streams in the watershed include Hinsdale Brook (MA33-21), Punch Brook (MA33-100), Stewart Brook (MA33-132), Unnamed Tributary (MA33-103), and Unnamed Tributary (MA33-104).

Table A-1 presents the general watershed information for the Hinsdale Brook watershed and **Figure A-1** includes a map of the watershed boundary.

Table A-1: Hinsdale Brook General Watershed Information

Watershed Name (Assessment Unit ID):	Hinsdale Brook (MA33-21) Punch Brook (MA33-100) Stewart Brook (MA33-132) Unnamed Tributary (MA33-103) Unnamed Tributary (MA33-104)
Major Basin:	Deerfield River
Watershed Area (within MA):	4062.6 (ac)

[2] A WBP for the entire Deerfield River watershed was previously developed in 2015 (FRCOG, 2015).

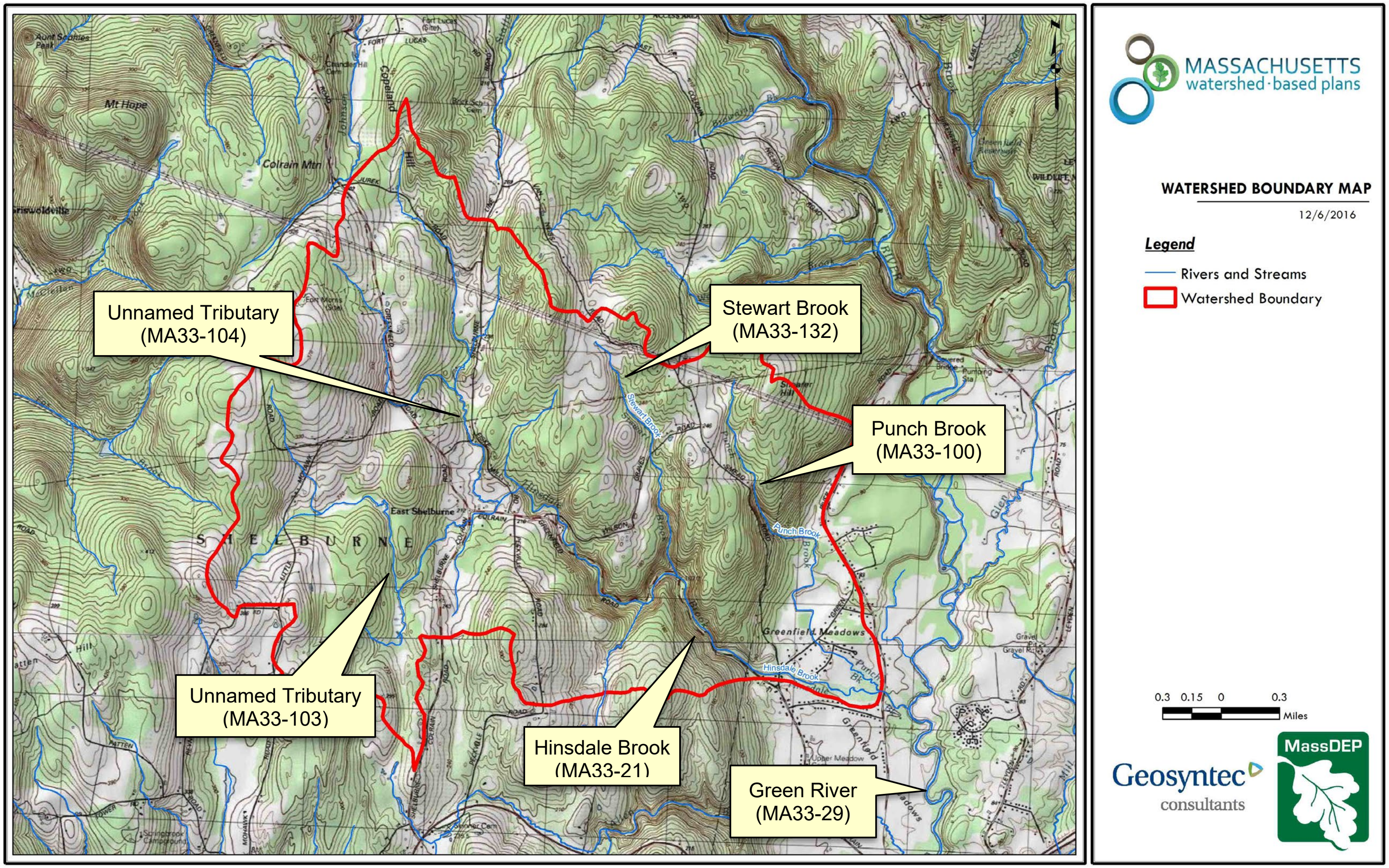


Figure A-1: Hinsdale Brook Watershed Boundary Map

(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 section below summarizes the findings of the available Water Quality Assessment Reports and/or TMDLs that relate to water quality and water quality impairments.

The following water quality assessment report is available:

- Deerfield River Watershed 2000 Water Quality Assessment Report (MassDEP, 2000)

The Hinsdale Brook watershed does not have a TMDL[3]. Select excerpts from the water quality assessment report relating to the water quality in the Hinsdale Brook watershed are included in **Appendix B** (note: relevant information is included directly from these documents for informational purposes and has not been modified).

Water Quality Impairments and Pollution Sources

303 (d) List Impairments

Impairment categories from the MassDEP 2018/2020 Massachusetts Integrated List of Waters (303(d) List) (MassDEP, 2021) are listed in **Table A-2**. Known water quality impairments, as documented in the 2018/2020 303(d) List are illustrated in **Figure A-2** and listed in **Table A-3,** which indicates that Hinsdale Brook (MA33-21) is identified as a category 5 water body due to *Escherichia coli* (*E. coli*) from agricultural and unknown sources.

Table A-2: 2018/2020 MA Integrated List of Waters Categories

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.

[3] Hinsdale Brook is part of the Connecticut River watershed; the Connecticut River flows into the Long Island Sound. The Long Island Sound has a TMDL: "A Total Maximum Daily Load Analysis to Achieve Water Quality Standards for Dissolved Oxygen in Long Island Sound".

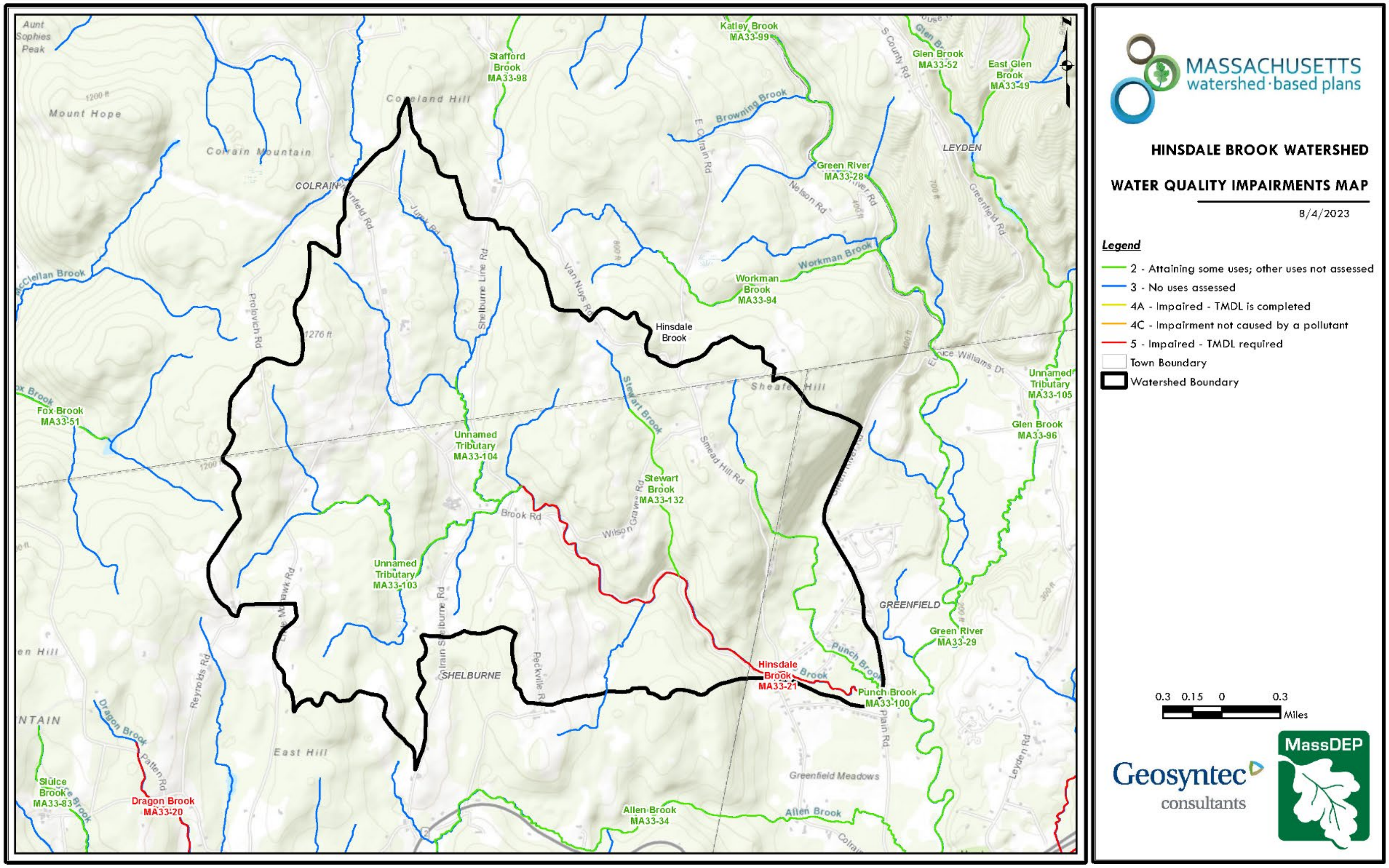


Figure A-2: Hinsdale Brook Watershed Boundary Map
(MassGIS, 2022a; MassGIS, 2022b; ESRI et al., 2023)

Table A-3: Water Quality Impairments (MassDEP, 2021)

Assessment Unit ID	Waterbody	Integrated List Category	Designated Use	Impairment Cause	Suspected Impairment Source
MA33-21	Hinsdale Brook	5	Primary Contact Recreation	Escherichia Coli (*E. coli*)	Agriculture
MA33-21	Hinsdale Brook	5	Primary Contact Recreation	Escherichia Coli (*E. coli*)	Source Unknown

Shelburne Multi-Hazard Mitigation Plan

Hinsdale Brook, which runs parallel to Brook Road, is identified in the Town of Shelburne's Multi-Hazard Mitigation Plan as having potential to cause localized flooding. The flooding causes frequent erosion, landslides, and slumping and the road is periodically closed due to these conditions. Brook Road is designated as an evacuation route for the northeast section of the Town of Shelburne so the chronic flooding is also a safety concern (Shelburne Hazard Mitigation Committee and FRCOG 2021).

Deerfield River Watershed-based Plan

The Deerfield River WBP (FRCOG, 2015) identified mass failures along Hinsdale Brook adjacent to Brook Road as a major source of sediment loading to the Green River. **Figure A-3** presents representative photos from the Deerfield River WBP.

Figure 11. Mass failures along Hinsdale Brook contribute a large volume of sediment to the Green River. Photos from 2017 showing a) a closeup of recent slip from top of bank and rills in glacial till and b) a panoramic view of extensive mass failure adjacent to Brook Road.

Figure A-3: 2017 Photos of Mass failures along Hinsdale Brook adjacent to Brook Road (FRCOG, 2015)

FRCOG Nonpoint Source Pollution Assessment

FRCOG conducted a nonpoint source pollution assessment in 2008 with funding from MassDEP's 604(b) grant program (FRCOG, 2008). The goal of this project was to provide an inventory and assessment of potential sources of nonpoint source pollution in the six priority subwatersheds of the Deerfield River watershed (including the Green River watershed, which Hinsdale Brook is within) and provide recommendations for future work to prevent or mitigate nonpoint source pollution. The study identified Hinsdale Brook, specifically, as very flashy with ongoing erosion problems along Brook Road, with many areas lacking riparian buffer, and indicated that the first step for a long-term solution would be a geomorphic assessment of Hinsdale Brook that would include recommendations for managing high flows and stabilizing the streambanks. The study also noted that the eroding banks often extend for hundreds of feet and that the pollutant loading from these banks must be significant due to the sheer size and extent of the problem. Photos from the report (FRCOG, 2008) of observed erosion along Hinsdale Brook are presented in **Figure A-4.**

Extreme erosion on Hindsdale Brook – Looking upstream.

Extreme erosion on Hindsdale Brook. Looking downstream.

Figure A-4: Photos of extreme erosion along Hinsdale Brook (FRCOG, 2008)

November 8, 2021 Stakeholder Meeting Pollutant Sources Identification

The main potential pollution sources to Hinsdale Brook that were discussed during the stakeholder meeting on November 8, 2021 (meeting minutes included in **Appendix A**) included sediment loading from fluvial erosion adjacent to Brook Road and agricultural operations in the watershed. The FRCOG has a particular interest in the fluvial erosion occurring on Hinsdale Brook, especially along Brook Road. See Element C for the locations of various farms within the Hinsdale Brook watershed.

Additional Water Quality Data

MassDEP Water Quality Monitoring Program Data

Historical and current Technical Memoranda ™ produced by the MassDEP Watershed Planning Program are available here: Water Quality Technical Memoranda | Mass.gov 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). Many of these TMs have helped inform Clean Water Act 305(b) assessment and 303(d) listing decisions.

Water quality monitoring data is available for Hinsdale Brook from the years 2005 and 2012 (MassDEP, 2021). **Figure C-1** in Element C of this WBP includes the locations of these two monitoring stations.

The *E. coli* data is presented in **Table A-4**, and both years (2005, 2012) exceeded the Massachusetts Surface Water Quality Standards (MSWQS) (314 CMR 4.00, 2013) for *E. coli*, which states that the geometric mean of samples from the most recent 6 months shall not exceed 126 colonies per 100 milliliters (typically based on a minimum of 5 samples) and no single sample shall exceed 235 colonies per 100 milliliters; however, the 2012 data was much closer to meeting the MSWQS with the geometric mean meeting the standard but a single sample exceeding the standard.

The TP data from 2012 is presented in **Table A-5**, and the average and maximum TP concentrations were all below the TP USEPA "Gold Book" (USEPA, 1986) standard of 50 micrograms per liter (µg/L).

Table A-4: MassDEP Water Quality Monitoring Program *E. coli* Data for Hinsdale Brook (MassDEP, 2021)

Unique ID	Sampling Location	Date	*E. coli* (CFU/100 mL or MPN/100 mL)
W1346	[Green River Road, Greenfield (downstream of storm water swale and discharge pipes)]	5/17/2005	93
		6/7/2005	291
		7/19/2005	921
		8/16/2005	210
		9/21/2005	10
W1346	**2005 Minimum**		10
	2005 Maximum		921
	2005 Median		210
	2005 Geometric Mean		139
W2275	[approximately 3,550 feet upstream of Green River Road, Shelburne (and approximately 700 feet downstream of the Stewart Brook confluence)]	5/23/2012	8
		6/13/2012	276
		6/28/2012	17
		8/2/2012	26
		8/30/2012	19
		9/27/2012	10
W2275	**2012 Minimum**		8
	2012 Maximum		276
	2012 Median		18
	2012 Geometric Mean		24

Sources: MassDEP, 2021
"MPN/100 mL" = most probable number per 100 milliliters
"CFU/100 mL"= colony forming units per 100 milliliters
Samples taken samples taken in 2005 were reported in CFU/100 mL and those taken in 2012 were reported in MPN/100 mL

Table A-5: MassDEP Water Quality Monitoring Program TP Data for Hinsdale Brook (MassDEP, 2021)

Unique ID	Sampling Location	Date	TP (µg/L)
W2275	[approximately 3,550 feet upstream of Green River Road, Shelburne (and approximately 700 feet downstream of the Stewart Brook confluence)]	5/23/2012	10
		6/28/2012	9
		8/2/2012	12
		8/30/2012	10
		9/27/2012	10

Sources: MassDEP, 2021
"µg/L" = micrograms per Liter

Deerfield River Watershed Association (DRWA) Macroinvertebrate Assessment

Deerfield River Watershed Association (DRWA) conducted a macroinvertebrate assessment in the Green River watershed September 23—October 2, 2005 (Cole, 2006). The objectives of the program were to augment MA DEP/DWM biomonitoring efforts to assess surface waters in the watershed with respect to their aquatic-life-use status and to familiarize citizens of the watershed with biological monitoring to increase support for and participation in watershed enhancement and protection activities. One of the sampling stations (HDBM1) was located along Hinsdale Brook, downstream of road crossing immediately north of the Polish picnic area on Plains Road. The assessment noted that extensive sediment deposition apparently caused by significant bank erosion and hillslope failures was observed along Hinsdale Brook. Despite the large quantity of sediment that had recently been deposited in the reach, the metric scores of the analysis suggested that the macroinvertebrate community appeared to be relatively unaffected. The report concluded that although the metric scores suggested that Hinsdale Brook was non-impacted, total macroinvertebrate densities were lower in this reach than in any tributaries of the Green River, except one, indicating that the recent sediment deposition may have reduced total macroinvertebrate abundance in Hinsdale Brook (Cole, 2006).

Water Quality Goals

Water quality goals may be established for a variety of purposes, including the following:

a) For **waterbodies with known impairments**, a TMDL is established by MassDEP and USEPA as the maximum amount of the target pollutant that the waterbody can receive and still safely meet water quality standards. If the waterbody has a TMDL for TP or total nitrogen (TN), or total suspended solids (TSS), that information is provided below and included as a water quality goal.[4]

b) For **waterbodies without a TMDL for** TP, a default water quality goal for TP is based on target concentrations established in the Quality Criteria for Water (USEPA, 1986) (also known as the "Gold Book"). The Gold Book states that TP should not exceed 50 µg/L in any stream at the point where it enters any lake or reservoir, nor should TP exceed 25 µg/L within a lake or reservoir. For the purposes of developing WBPs, MassDEP has adopted 50 µg/L as the TP target for all streams at their downstream discharge point, regardless of which type of water body the stream discharges to.

c) Massachusetts Surface Water Quality Standards (314 CMR 4.00, 2013) prescribe the minimum water quality criteria required to sustain a waterbody's designated uses. **Table A-6** includes the Massachusetts surface water classifications by assessment unit within the Hinsdale Brook watershed. All of the waterbodies in the watershed are Class 'B' waterbodies. The water quality goals for *E. coli* bacteria are based on the Massachusetts Surface Water Quality Standards.

Table A-6: Surface Water Quality Classification by Assessment Unit

Assessment Unit ID	Waterbody	Class
MA33-100	Punch Brook	B
MA33-103	Unnamed Tributary	B
MA33-104	Unnamed Tributary	B
MA33-132	Stewart Brook	B
MA33-21	Hinsdale Brook	B

d) **Other water quality goals set by the community** (e.g., protection of high-quality waters, in-lake TP concentration goal to reduce recurrence of cyanobacteria blooms, etc.).

Based on the Hinsdale Brook impairment and water quality data identified above, quantitative water quality goals were identified for TP and bacteria (*E. coli*) and qualitative goals were identified for TSS. These goals

[4] As noted above, Hinsdale Brook does not have a TMDL. It is worth noting that Hinsdale Brook is part of the Connecticut River watershed; the Connecticut River flows into the Long Island Sound. The Long Island Sound has a TMDL: "A Total Maximum Daily Load Analysis to Achieve Water Quality Standards for Dissolved Oxygen in Long Island Sound".

are listed in **Table A-7**. Element C of this WBP includes proposed management measures to address these water quality goals.

Table A-7: Water Quality Goals for Hinsdale Brook (MA33-21)

Pollutant	Goal	Source
Total Phosphorus (TP)	Total phosphorus should not exceed: --50 ug/L in any stream --25 ug/L within any lake or reservoir	Quality Criteria for Water (USEPA, 1986)
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.	Massachusetts Surface Water Quality Standards (314 CMR 4.00, 2013)
Total Suspended Solids (TSS)	Reduce TSS loading from severely eroding streambanks along Hinsdale Brook	N/A

Land Use and Impervious Cover Information

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

Watershed Land Uses

Land use in the Hinsdale Brook watershed is mostly forested (approximately 72 percent); approximately 19 percent of the watershed is agricultural; approximately 6 percent of the watershed is residential; approximately 3 percent of the watershed is open land or water; less than 1 percent of the watershed is commercial; and 0 percent of the watershed is designated as industrial or highway.[5] (**Table A-8**; **Figure A-5**).

Table A-8: Subwatershed Land Uses

Land Use	Area (acres)	% of Watershed
Forest	2,905.4	71.5
Agriculture	766.8	18.9
Low Density Residential	246.8	6.1
Open Land	119.8	2.9
Commercial	14.5	0.4
High Density Residential	5.8	0.1
Water	3.6	0.1
Highway	0	0
Industrial	0	0
Medium Density Residential	0	0

[5] Although 0 percent of the watershed is designated as highway in the land use GIS source data, there are roads in the Hinsdale Brook watershed.

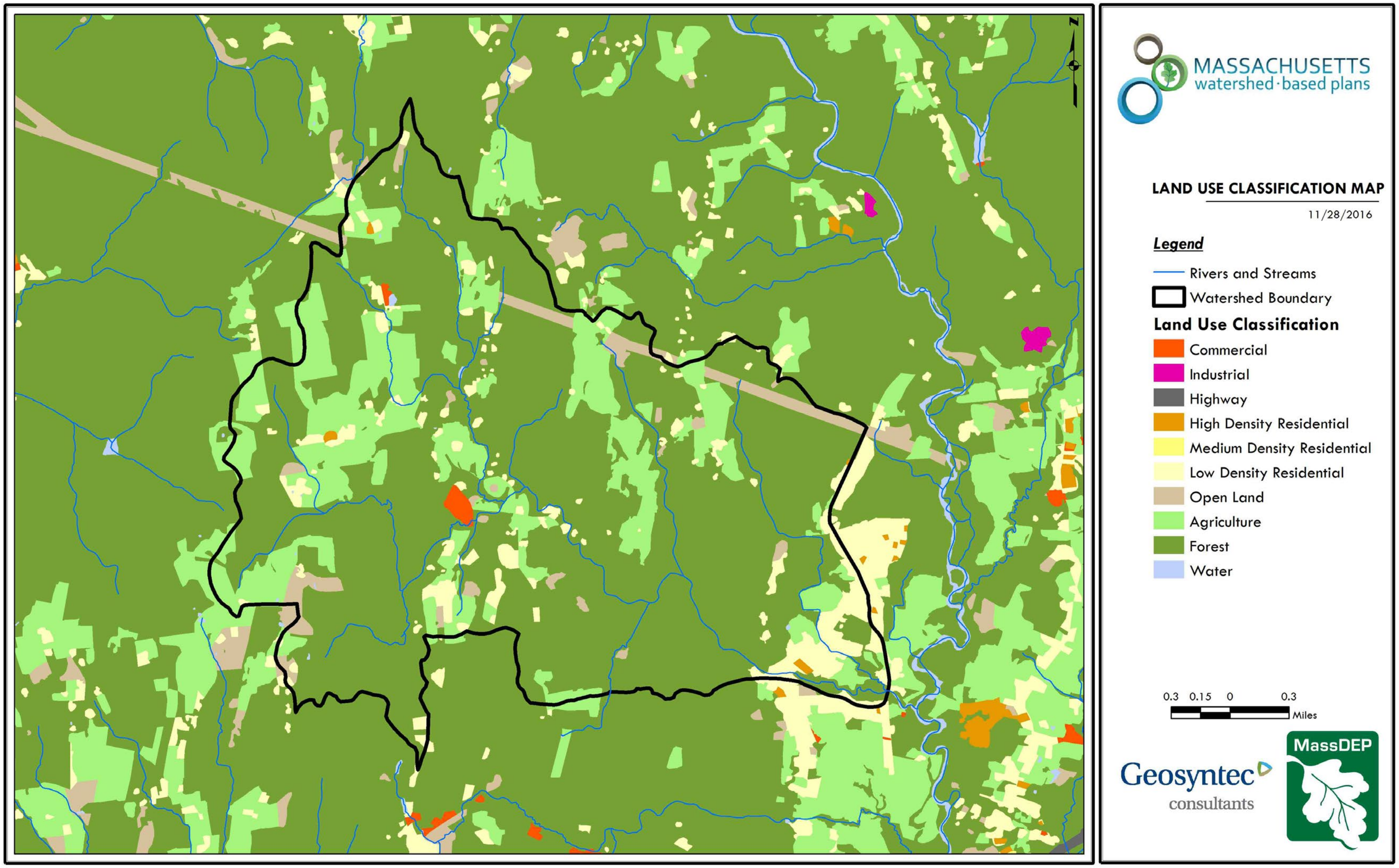


Figure A-5: Hinsdale Brook Watershed Land Use Map

(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. Impervious area in the Hinsdale Brook watershed is mainly associated with roads. **Figure A-6** is an impervious cover map for Hinsdale Brook watershed.

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 Hinsdale Brook watershed is 2.6 percent and 1.9 percent, respectively.

The relationship between TIA and water quality can generally be categorized as listed by **Table A-9** (Schueler et al. 2009). The TIA value for the watershed range is 2.6 percent; therefore, the river and surrounding tributaries would be expected to show good to excellent water quality. However, Hinsdale Brook is impaired for *E. coli*, due to agricultural sources and possibly additionally sources that are currently unknown (MassDEP, 2021).

Table A-9: Relationship between Total Impervious Area (TIA) and water quality (Schueler et al. 2009)

% Watershed Impervious Cover	Stream Water Quality
0% to 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% to 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% to 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.

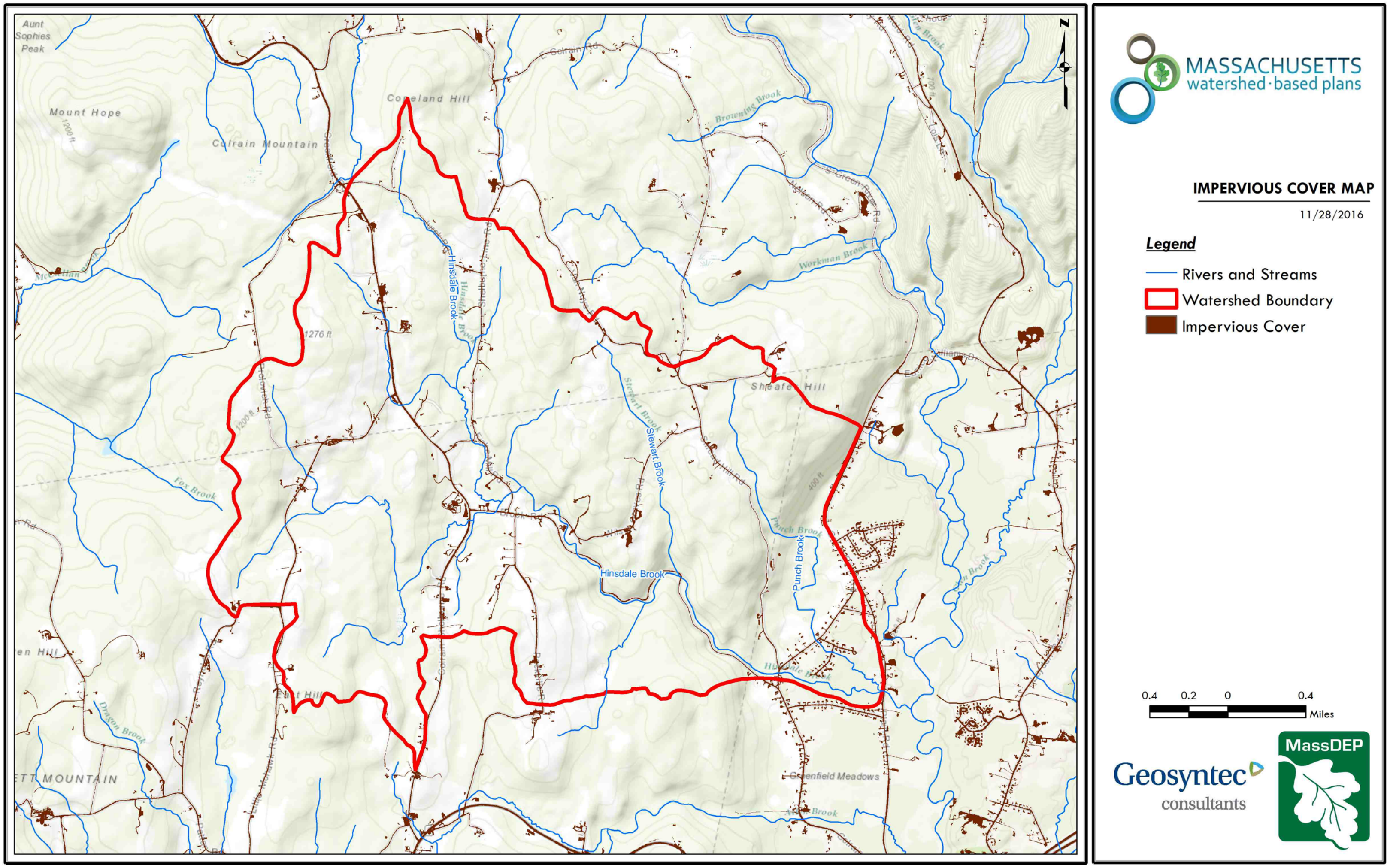


Figure A-6: Hinsdale Brook Impervious Surface Map

(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

Geographic Information Systems (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 (pound per year (lb/yr)); A_n = area of land use/cover type n (acres); P_n = pollutant load export rate of land use/cover type n (pound per acre per year (lb/acre/yr))

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-10 presents the estimated land-use based TP, TN and TSS within the Hinsdale Brook watershed. The largest contributor of the land use-based TP and TSS load originates from areas designated as forested. TP and TN generated from forested areas is generally a result of natural processes such as decomposition of leaf litter and other organic material; the forested portions of the watershed therefore are unlikely to provide opportunities for nutrient load reductions through best management practices. Agricultural areas are the second largest contributors of land-use based TP and TSS load and the largest contributor of TN load in the watershed. Agricultural areas provide excellent opportunities for nutrient load reductions through agricultural BMPs as described in the following sections.

Table A-10: Estimated Pollutant Loading in the Hinsdale Brook Watershed for Key Nonpoint Source Pollutants

Land Use Type	Pollutant Loading[1]		
	Total Phosphorus (TP) (lb/yr)	Total Nitrogen (TN) (lb/yr)	Total Suspended Solids (TSS) (tons/yr)
Forest	377	1,861	69.2
Agriculture	371	2,220	25.8
Low Density Residential	52	525	7.1
Open Land	22	213	3.3
Commercial	8	72	0.9
High Density Residential	2	16	0.23
Highway	0	0	0
Industrial	0	0	0
Medium Density Residential	0	0	0
TOTAL	832	4,906	106.5

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

It is important to note pollutant loads presented in **Table A-10** do not consider loads from point sources or septic systems. Septic system sources should be separately evaluated to determine whether septic system upgrades or sanitary sewer system conversion would cost-effectively reduce bacteria and nutrient sources in the watershed.

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 landuse-based pollutant loads for TP (832 lb/yr), TN (4,906 lb/yr), and TSS (106.5 tons/yr) were previously presented in **Table A-10** of this WBP. *E. coli* landuse-based loading has not been estimated for this WBP, as there are not yet established PLERs available for *E. coli*: this may be updated in future revisions to this WBP.

Water Quality Goals and Required Load Reduction

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. As discussed in Element A, water quality goals for this WBP are focused on reducing *E. coli* and TP loading to Hinsdale Brook. The water quality goals, and corresponding required loading reductions are included in **Table B-1**.

The method used in the WBP tool[6] for calculating a water quality goal for TP produces a water quality goal that is greater than the estimated TP load of 832 bs/yr. Given the iterative and adaptive nature of this WBP, the monitoring portion of this WBP (**Element I**) recommends that monitoring be performed to better understand the existing TP loading to Hinsdale Brook, which may help establish a specific TP related water quality goal with the next update of the WBP (expected in 2026). In the interim, a 10 percent reduction in the estimated watershed loading to 749 lb/yr is proposed to improve the water quality within Hinsdale Brook.

[6] According to the EPA Gold Book, TP should not exceed 50 ug/L in any stream at the point where it enters any lake or reservoir. The WBP tool estimated the water quality loading goal by multiplying this target maximum TP concentration (50 ug/L) by the estimated annual watershed discharge for the Hinsdale Brook watershed. To estimate the annual watershed discharge, the mean flow was used, which was estimated based on United States Geological Survey (USGS) “Runoff Depth” estimates for Massachusetts (Cohen and Randall, 1998). Cohen and Randall (1998) provide statewide estimates of annual Precipitation (P), Evapotranspiration (ET), and Runoff (R) depths for the northeastern U.S. According to their method, Runoff Depth (R) is defined as all water reaching a discharge point (including surface and groundwater), and is calculated by: P - ET = R. A mean Runoff Depth R was determined for the watershed by calculating the average value of R within the watershed boundary.

The proposed projects described in this WBP are expected to reduce both *E. coli* and TP loads to Hinsdale Brook; however, additional load reductions may be required to meet the water quality goals.

The following adaptive sequence is recommended to sequentially track and meet these load reduction goals:

1. Given current water quality conditions, establish an **interim goal** to reduce land use-based TP by 10 percent (83 lb/yr) over the next 10 years (by 2032).

2. Given current water quality conditions, establish an **interim goal** to reduce the concentration of *E. coli* so that the 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. over the next 10 years (by 2032).

3. Establish a qualitative goal to reduce TSS loading from severely eroding streambanks along Hinsdale Brook; the first step for a long-term solution would involve a geomorphic assessment of Hinsdale Brook that would include recommendations for managing high flows and stabilizing the streambanks (FRCOG, 2008).

4. Develop a baseline water quality monitoring program in accordance with **Element I**. Results from the monitoring program should advise if **Element C** management measures have been effective at addressing listed water quality impairments or water quality goals for other indicator parameters established by **Table A-7** of this WBP (e.g., TP and *E. coli*). Results can further be used to periodically inform or adjust load reduction goals.

5. Establish a **long-term reduction goal** to reduce land-use-based TP, *E. coli,* and TSS over the next 15 years. Based on monitoring data, establish additional **long-term reduction goal(s)**, if needed, to lead to delisting of Hinsdale Brook from the 303(d) list.

Table B-1: Pollutant Load Reductions Needed for Hinsdale Brook Watershed

Pollutant	Existing Estimated Total Load	Water Quality Goal	Required Load Reduction
Total Phosphorus	832 lb/yr	749 lb/yr	83 lb/yr
Bacteria (*E. coli*)[1]	*MSWQS for bacteria are concentration standards (e.g., colonies of fecal coliform bacteria per 100 ml), which are difficult to predict based on estimated annual loading.*	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.	N/A Concentration-based
Total Suspended Solids	*N/A*	Reduce TSS loading from severely eroding streambanks along Hinsdale Brook	N/A

1. *As noted in Element A, the E. coli water quality goal in the Hinsdale Brook watershed is based on the Massachusetts Surface Water Quality Standards (MSWQS) (314 CMR 4.00, 2013) that apply to the Water Class of the selected water body. All segments in the Hinsdale Brook watershed are classified as "Class B" waterbodies.*

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.

Ongoing and Future Management Measures

Western Massachusetts Agricultural Nonpoint Source Program

As presented in Element A, pollutant load modeling (**Table A-10**) indicated that approximately 45% of the total land-use based TP loading in the watershed originates from agricultural areas. Hinsdale Brook is also impaired for *E. coli* from agricultural (as well as unknown) sources (MassDEP, 2021). MACD was awarded Fiscal Year 2021 Section 319 grant funding for its "Western Massachusetts Agricultural Nonpoint Source Program", which includes implementing watershed-wide farm conservation practices and agricultural BMPs in the Hinsdale Brook watershed to contribute to addressing this loading. The MACD's general strategy is to conduct outreach and education to farmers in the Hinsdale Brook watershed; develop conservation plans outlining BMPs to reduce pollutant runoff; assist landowners in obtaining access to financial resources; and ensure farmers follow operation and maintenance practices recommended by MACD and/or NRCS (MACD, 2020).

MACD's approach is to build relationships with the agricultural community to guide BMP development. MACD is currently in the conceptual and planning-level phases with two different farms in the watershed in implementing agricultural BMPs. The estimated pollutant load reduction (TP and *E. coli*) that will be achieved from these projects is currently unknown but will be calculated once the BMPs are closer to completion and updated in future iterations of this WBP. Typical agricultural BMPs that may be implemented as part of these projects are described below.

1. **Livestock Exclusion:** This practice involves the fencing of an area not intended for grazing to exclude livestock from accessing that area. Livestock exclusion may improve water quality by preventing livestock from being in the water, preventing access to steep or highly erodible banks, and by preventing animal waste deposition in surface waters. This practice prevents compaction of the soil by livestock and prevents losses of vegetation and undergrowth. This may maintain or increase evapotranspiration. Increased soil permeability may reduce erosion and decrease the transport of sediment and other pollutants to surface waters. By protecting existing vegetation, this practice also promotes shading along streams and may reduce surface water temperature.

2. **Riparian Buffers:** A riparian buffer is the area of trees, shrubs and grasses adjacent to a river that can intercept pollutants from both surface and shallow groundwater before reaching a river or stream. This practice involves the protection, maintenance, and restoration of riparian forest areas. The ability of a riparian buffer to remove pollutants is dependent on the width of the buffer, the type of vegetation, the manner in which runoff traverses the vegetated areas, the slope and the soil composition within the

riparian area. Riparian buffers also provide habitat for wildlife and enhance fish habitat by reducing water temperature.

3. **Alternative Livestock Water Supply:** An alternate livestock drinking water supply located away from surface waters can reduce stream bank erosion, prevent the deposition of animal waste within water bodies, protect riparian vegetation, and provide a dependable, clean source of water for livestock. In some locations, artificial shade may also be constructed to encourage use of upland sites for shading and loafing. Alternative livestock water can be provided through the following practices:

    - Pond: A water impoundment made by constructing a dam or an embankment or by excavation of a pit or dugout.
    - Trough or Tank: By the installation of troughs or tanks, livestock may be better distributed over the pasture, grazing can be better controlled, and surface runoff reduced, thus reducing erosion.
    - Well: A drinking water supply well can be constructed or improved to provide water for livestock.
    - Spring Development: This practice includes improving springs and seeps by excavating, cleaning, capping, or providing collection and storage facilities. Temporary erosion and sedimentation may occur from any disturbed areas during and immediately following any related construction activities.
    - Pipeline/Pump System: A gravity pipeline or pump system can be developed in combination with the practices described above to increase to distance between a water source (e.g., well, spring) and targeted water supply areas within the pasture.

4. **Rotational Grazing Systems and Improved Pasture Management:** Rotational grazing systems and improved pasture management are recommended in conjunction with livestock exclusion and alternative livestock water supply projects. Grazing systems and improved pasture management allow farmers to better use grazing land and includes:

    - managing livestock rotation to maintain minimum grazing height recommendations and sufficient rest periods for plant recovery;
    - locating feeding and watering facilities away from sensitive areas (see alternative livestock water supply above);
    - designating a sacrifice lot/paddock (that does not drain directly into ponds, creeks, etc.) to locate livestock during the rainy season or when pastures are not growing actively to prevent overgrazing and trampling[7];
    - using compost-bedded pack barns (large, open resting area, under covered housing, usually bedded with sawdust or dry, fine wood shavings and manure composted into place and mechanically stirred on a regular basis) for dairy cows; and
    - chain harrowing pastures (at least twice a year) to break up manure piles and uniformly spread manure, after livestock are removed.

5. **Afforestation of Hay and Pasture Land:** Using a small portion of hay and pasture land for tree planting. This converts pasture that is not well suited for grazing due to slope and other characteristics, optimizes the use of suitable pastureland in the watershed, and prevents runoff and soil loss from marginal pastures.

[7] See here for more information and recommended footing materials recommended for sacrifice areas: https://ag.umass.edu/sites/ag.umass.edu/files/fact-sheets/pdf/horse_footing_materials_15_05.pdf

6. **Cropland Management Practices:** Cropland management practices include, among others, continuous no till, cover crops, and fertilizer management.

    - Continuous no till is used to encourage procedures to convert fields under some degree of tillage to a system of minimal soil disturbance that will maintain a minimum a 60% rain drop intercepting residue cover.
    - Cover crops keep cover on fields during times of year when they would otherwise be left barren in order to minimize runoff and erosion from the soil surface and also decrease leaching of nitrogen through the soil.
    - Farmers can implement fertilizer management practices to help maintain high yields and save money on fertilizers while reducing nonpoint source pollution. A Crop Nutrient Management Plan[8]; is a tool that farmers can use to achieve these goals.

MACD references guidance from USDA when planning and implementing BMPs with farm owners. The Massachusetts "Field Office Technical Guide" provides detailed information on agricultural BMPs that may be implemented at farms in the watershed[9]. Appendix D also includes a list, provided by FRCOG, of potential agricultural BMPs that may be implemented in the watershed.

November 8, 2021 Stakeholder Meeting

During the stakeholder meeting that was held on November 8, 2021, numerous farms in the Hinsdale Brook watershed were identified for outreach and possible implementation of agricultural BMPs. These farms, as well as other areas of interest, are identified in **Figure C-1**.

[8] See here for ten key components to include in a crop nutrient management plan: megamanual.geosyntec.com/npsmanual/cropnutrient.aspx

[9] The Massachusetts "Field Office Technical Guide" can be accessed at: https://efotg.sc.egov.usda.gov/#/state/MA/documents/section=4&folder=-3 ; the list of BMPs, as well as detailed information on each, is found under "Section 4 - Practice Standards and Supporting Documents" > "Conservation Practice Standards & Support Documents".

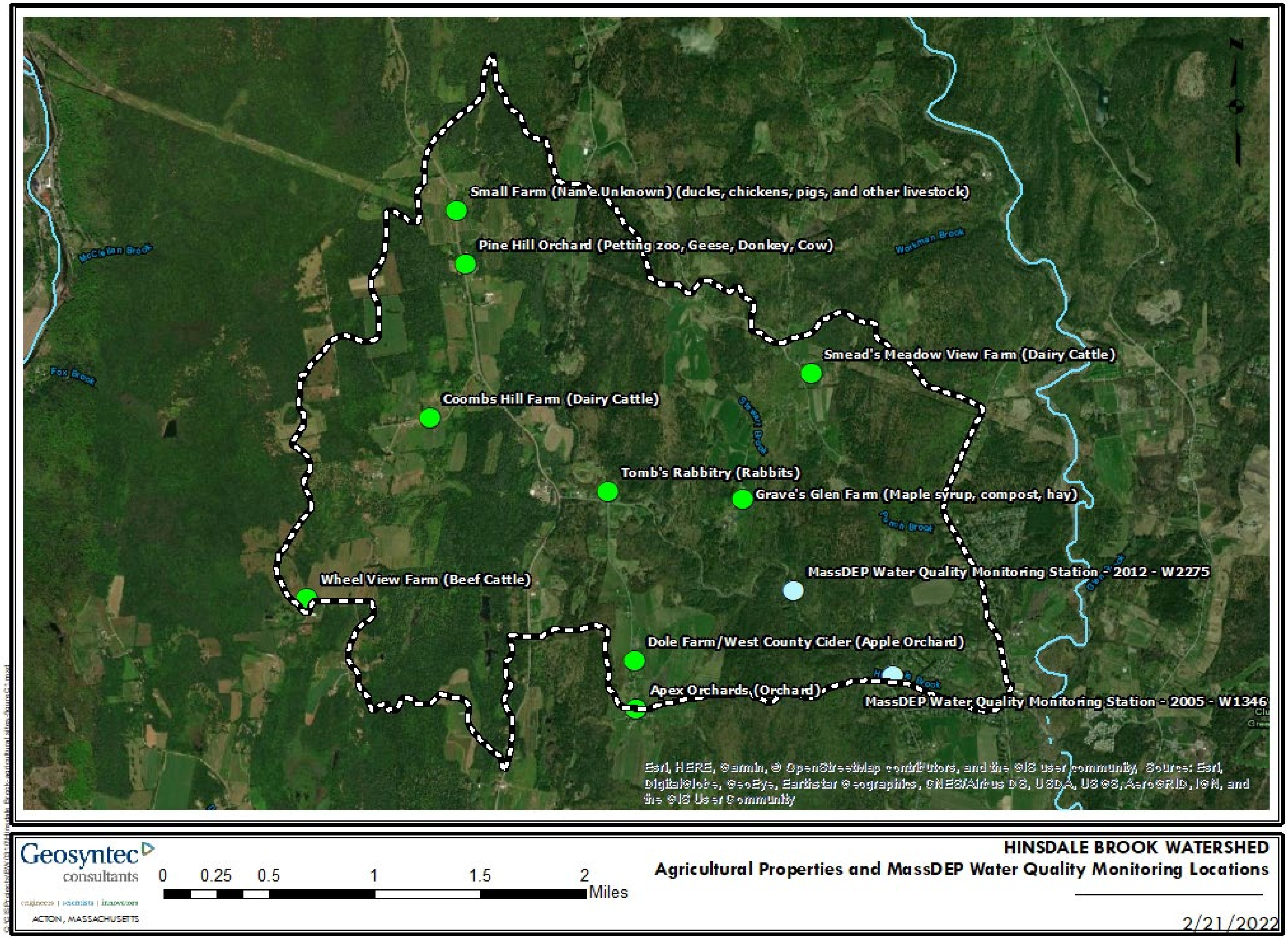
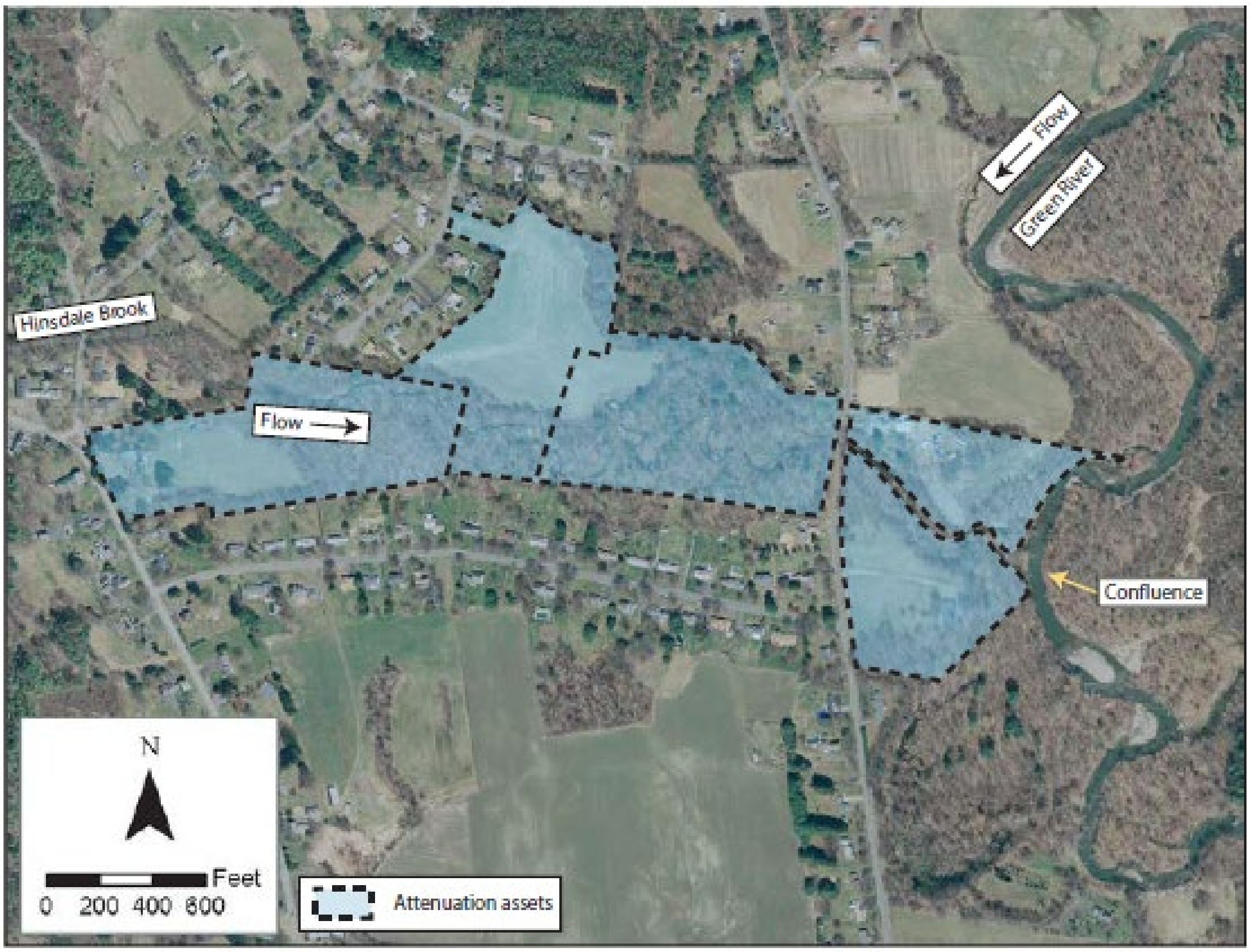


Figure C-1: Agricultural Properties and MassDEP Water Quality Monitoring Locations

Conservation of Attenuation Assets

The Deerfield River WBP (FRCOG, 2015) recommended conservation of attenuation assets along the lower Hinsdale Brook upstream of the confluence with the Green River (see **Figure C-2**). Conservation of attenuation assets refers to land that is conserved for the purpose of allowing stream meander formation and storage of sediment. This type of land typically consists of fallow agricultural parcels that have sustained flood or erosion damage in the past or are low-value parcels without the necessary frontage for development that are located along artificially straightened stream channels. The premise is that these riparian lands may be valuable to the community as flood storage attenuation assets.



Conservation of attenuation assets and encroachment removal - Green River Watershed. Identified attenuation assets along lower Hinsdale Brook upstream of Green River confluence in Greenfield, MA. Continued development along straightened channel threatens to increase fluvial erosion hazards in stream corridor.

Figure C-2: Proposed Conservation of Attenuation Assets and Encroachment Removal along Lower Hinsdale Brook (FRCOG, 2015)

Hinsdale Brook Bank Stabilization

As noted in Element A, the FRCOG Nonpoint Source Pollution Assessment (FRCOG, 2008) recommended a geomorphic assessment of Hinsdale Brook that would include recommendations for managing high flows and stabilizing the areas with severely eroding streambanks. The Town of Shelburne Hazard Mitigation Plan (Shelburne

Hazard Mitigation Committee and FRCOG, 2021) identified hiring a consultant to conduct geomorphic engineering assessment of Hinsdale Brook to determine possible bank stabilization measures to mitigate damages to the environment and nearby infrastructure (e.g., Brook Road). Once theses stabilization measures are identified, funding will be sought for implementing the recommended measures. This action item was identified as medium priority, which is defined in the plan as "Strategies that would have some benefit to people and property and are somewhat cost effective at reducing damage to property and people" (Shelburne Hazard Mitigation Committee and FRCOG, 2021).

Identification of Priority Locations for Structural BMPs.

Implementing agricultural BMPs, along with incorporating structural BMPs (e.g., low impact development practices) on new and existing development, and investigation and remediation of potential other sources such as failing septic systems will be necessary to achieve a measurable and sustainable improvement in water quality in Hinsdale Brook.

The following general sequence is recommended to identify and implement future structural BMPs[10]. Examples of structural BMPs include (but not limited to):

- bioretention areas and rain gardens,
- deep sump catch basins,
- dry wells,
- constructed stormwater wetlands (e.g., gravel wetland),
- porous pavement,
- sand filters,
- vegetated filter strips,
- wet ponds,
- infiltration basins and trenches,
- oil/grit separators, and water quality swales.

Note this approach applies largely to non-agricultural BMPs that might be implemented by other watershed stakeholders, as MACD's project is to build relationships with the agricultural community, which would guide any future agricultural BMP implementation.

1. **Identify Potential Implementation Locations:** Perform a desktop analysis using aerial imagery and GIS data to develop a preliminary list of potentially feasible implementation locations based on land use; soil type (i.e., hydrologic soil groups A and B); available public open space (e.g., lawn area in front of a police station); potential redevelopment sites where additional public-private partnerships may be leveraged; and other factors such as proximity to receiving waters, known problem areas, or publicly owned right of ways or easements. See BMP Hotspot Map analysis below, which helps identify potential implementation locations.
2. **Visit Potential Implementation Locations:** Perform field reconnaissance, preferably during a period of active runoff-producing rainfall, to evaluate potential implementation locations, gauge feasibility, and identify

[10] For detailed information on BMP selection, siting and sizing, refer to the following document: https://prj.geosyntec.com/prjMADEPWBP_Files/Files/BMP%20Selection,%20siting%20and%20sizing%20Guidance_FINAL.pdf.
An additional reference for developing BMP concepts in unpaved road areas/eroded streambanks is "Massachusetts Unpaved Roads BMP Manual" (Berkshire Regional Planning Commission, 2001): https://megamanual.geosyntec.com/npsmanual/Unpaved%20Road.pdf

potential BMP ideas. During field reconnaissance, assess identified 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.

3. **Develop BMP Concepts:** Once potential BMP locations are conceptualized, use the BMP-selector tool on the watershed-based planning tool to help develop concepts. Concepts can vary widely. One method is to develop 1-page fact sheets for each concept that includes a site description, including definition of the problem, a description of the proposed BMPs, annotated site photographs with conceptual BMP design details, and a discussion of potential conflicts such as property ownership, O&M requirements, and permitting constraints. The fact sheet can also include information obtained from the BMP-selector tool including cost estimates, load reduction estimates, and sizing information (i.e., BMP footprint, drainage area, etc.).

4. **Rank BMP Concepts:** Once BMP concepts are developed, perform a priority ranking based on site-specific factors to identify the implementation order. Ranking can include many factors including cost, expected pollutant load reductions, implementation complexity, potential outreach opportunities and visibility to public, accessibility, expected operation and maintenance effort, and others. Prioritized BMP concepts should focus on reducing *E. coli* and TP loading to Hinsdale Brook as summarized by **Element B.**

BMP Hotspot Map

The following GIS-based analysis[11] was performed within the watershed to identify high priority parcels for BMP (also referred to as management measure) implementation:

- 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-2 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-3** presents the resulting BMP Hotspot Map for the Hinsdale Brook watershed. **Table C-3** includes hotspot score and address information for all parcels that have a score above 60.

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

[11] 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).

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.

Large agricultural parcels of the watershed, adjacent to Hinsdale Brook, received high hot spot scores above 60, which indicates that these properties provide opportunities for pollutant load reductions through BMPs.

Table C-2: 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

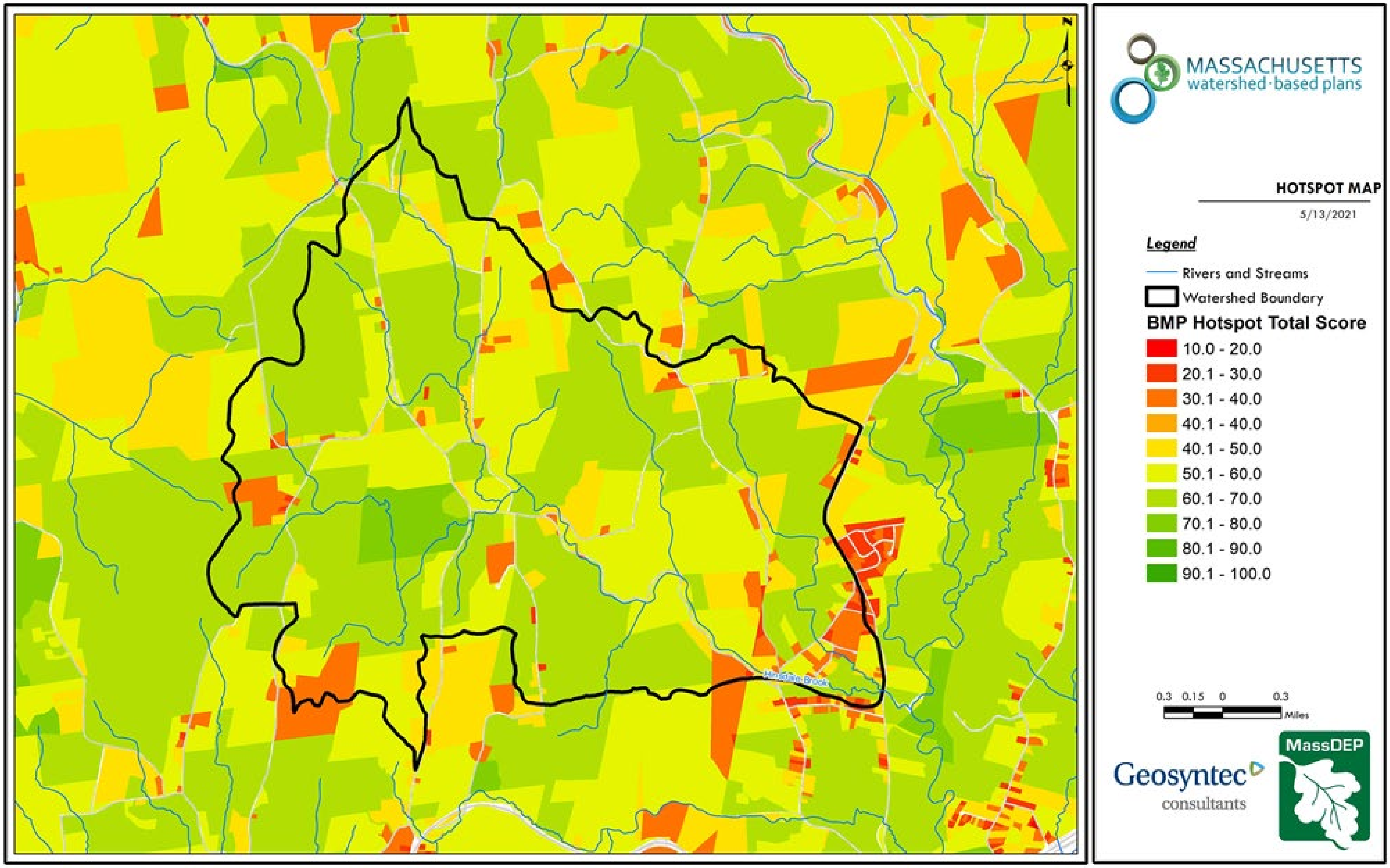


Figure C-3: Hinsdale Brook Watershed BMP Hotspot Map (MassGIS (2015a), MassGIS (2015b), MassGIS (2017a), MassGIS (2017b), MassGIS (2020), MA Department of Revenue Division of Local Services (2016), MassGIS (2005), ArcGIS (2020), MassGIS (2009a), MassGIS (2012), ArcGIS (2020b))

Table C-3: Hotspot Scores and Address Information for Parcels in Hinsdale Brook Watershed with Hotspot Scores above 60

Hotspot Score	Address	City	Parcel ID
74	0 COLRAIN-SHELBURNE RD	Shelburne	033.D-0003-0000.0
71	0 COLRAIN-SHELBURNE RD	Shelburne	037.D-0002-0000.0
69	386 COLRAIN-SHELBURNE RD	Shelburne	037.D-0001-0000.0
68	PLUM TREE LN	GREENFIELD	R34-101-0
68	807 COLRAIN RD	GREENFIELD	R34-64-0
68	100 GREEN RIVER RD	GREENFIELD	R34-37-0
68	0 SHEARER RD.	Shelburne	038.D-0006-0000.1
68	313 COLRAIN-SHELBURNE RD	Shelburne	033.D-0014-0000.7
68	311 COLRAIN-SHELBURNE RD	Shelburne	033.D-0014-0000.8
68	273 COLRAIN-SHELBURNE RD	Shelburne	033.D-0014-0000.9
68	0 LITTLE MOHAWK RD.	Shelburne	036.D-0009-0000.0
68	0 CARPENTER RD.	Shelburne	037.D-0022-0000.0
68	270 GREENFIELD RD	COLRAIN	4130-0029-00000
66	200 GREEN RIVER RD	GREENFIELD	R33-13-0
66	PLAIN RD	GREENFIELD	R34-8-0
66	156 GREEN RIVER RD	GREENFIELD	R34-25-0
66	180 SMEAD HILL RD.	Shelburne	038.D-0012-0000.1
66	0 LITTLE MOHAWK RD.	Shelburne	036.D-0006-0000.0
66	241 GREENFIELD RD	COLRAIN	4130-0023-00000
66	0 GREENFIELD RD	COLRAIN	4130-0024-00000
66	0 GREENFIELD RD	COLRAIN	4130-0025-00000
66	0 JUREK RD	COLRAIN	4130-0037-00010
66	0 PROLOVICH RD	COLRAIN	4130-0008-00000
66	0 COOMBS HILL RD	COLRAIN	4130-0013-00010
66	0 GREENFIELD RD	COLRAIN	4140-0009-00010
66	0 GREENFIELD RD	COLRAIN	4140-0017-00000
65	0 BROOK RD.	Shelburne	033.D-0013-0000.0
64	108 GREEN RIVER RD	GREENFIELD	R34-32-0
64	76 GREEN RIVER RD	GREENFIELD	R34-38-0
64	120 GREEN RIVER RD	GREENFIELD	R34-31-0
64	276 GREEN RIVER RD	GREENFIELD	R33-30-0
64	208 PECKVILLE RD.	Shelburne	028.D-0017-0000.0
64	157 PECKVILLE RD.	Shelburne	029.D-0001-0000.0
64	0 BROOK RD.	Shelburne	033.D-0007-0000.0
64	337 PECKVILLE RD.	Shelburne	033.D-0008-0000.0
64	0 WILSON GRAVES RD.	Shelburne	038.D-0001-0000.0
64	230 WILSON GRAVES RD.	Shelburne	038.D-0002-0000.0
64	163 SMEAD HILL RD.	Shelburne	038.D-0007-0000.0
64	146 SMEAD HILL RD.	Shelburne	038.D-0011-0000.0
64	0 WILSON GRAVES RD.	Shelburne	038.D-0013-0000.0
64	0 VAN NUYS RD	COLRAIN	4220-0004-00000
64	268 EAST COLRAIN RD	COLRAIN	4220-0070-00000
64	208 PECKVILLE RD.	Shelburne	028.D-0017-0000.0
64	0 LITTLE MOHAWK RD.	Shelburne	032.D-0005-0000.0
64	240 COLRAIN-SHELBURNE RD	Shelburne	033.D-0002-0000.1
64	0 BROOK RD.	Shelburne	033.D-0007-0000.0
64	337 PECKVILLE RD.	Shelburne	033.D-0008-0000.0
64	0 WILSON GRAVES RD.	Shelburne	038.D-0001-0000.0
64	32 COLLIS LN	COLRAIN	4140-0018-00000
64	147 SHELBURNE LINE RD	COLRAIN	4140-0021-00000
64	248 GREENFIELD RD	COLRAIN	4130-0028-00000
64	318 GREENFIELD RD	COLRAIN	4130-0032-00000
64	261 SHELBURNE LINE RD	COLRAIN	4130-0036-00000

Hotspot Score	Address	City	Parcel ID
64	0 VAN NUYS RD	COLRAIN	4220-0004-00000
63	0 SMEAD HILL RD.	Shelburne	038.D-0012-0000.0
63	30 PROLOVICH RD	COLRAIN	4140-0007-00000
63	162 GREENFIELD RD	COLRAIN	4140-0016-00020
62	48 GREEN RIVER RD	GREENFIELD	R34-43-0
62	SMEAD HILL RD	GREENFIELD	R34-92-0
62	298 BROOK RD.	Shelburne	034.D-0020-0000.0
62	0 FISKE MILL RD.	Shelburne	037.D-0018-0000.0
62	138 SMEAD HILL RD.	Shelburne	038.D-0009-0000.0
62	106 VAN NUYS RD	COLRAIN	4220-0017-00000
62	105 VAN NUYS RD	COLRAIN	4220-0004-00010
62	212 REYNOLDS RD.	Shelburne	032.D-0001-0000.0
62	0 LITTLE MOHAWK RD.	Shelburne	032.D-0002-0000.0
62	0 LITTLE MOHAWK RD.	Shelburne	032.D-0006-0000.0
62	253 COLRAIN-SHELBURNE RD	Shelburne	033.D-0014-0000.10
62	267 COLRAIN-SHELBURNE RD	Shelburne	033.D-0014-0000.0
62	48 BROOK RD.	Shelburne	033.D-0005-0000.0
62	694 LITTLE MOHAWK RD.	Shelburne	036.D-0005-0000.1
62	705 LITTLE MOHAWK RD.	Shelburne	036.D-0009-0000.1
62	0 FISKE MILL RD.	Shelburne	037.D-0018-0000.0
62	510 LITTLE MOHAWK RD.	Shelburne	032.D-0007-0000.1
62	257 GREENFIELD RD	COLRAIN	4130-0020-00000
62	0 COOMBS HILL RD	COLRAIN	4130-0016-00010
61	SMEAD HILL RD	GREENFIELD	R33-13B-0
61	50 FISKE MILL RD.	Shelburne	037.D-0020-0000.0
61	269 GREENFIELD RD	COLRAIN	4130-0017-00020
60	318 PLAIN RD	GREENFIELD	R34-13-0
60	224 GREEN RIVER RD	GREENFIELD	R33-18-0
60	168 GREEN RIVER RD	GREENFIELD	R33-16-0
60	0 WILSON GRAVES RD.	Shelburne	034.D-0015-0000.0
60	0 SHEARER RD	COLRAIN	4220-0074-00000
60	280 COLRAIN-SHELBURNE RD	Shelburne	033.D-0002-0000.4
60	0 COLRAIN-SHELBURNE RD	Shelburne	033.D-0002-0000.5
60	10 BROOK RD.	Shelburne	033.D-0004-0000.0
60	239 COLRAIN-SHELBURNE RD	Shelburne	033.D-0014-0000.11
60	0 PECKVILLE RD.	Shelburne	033.D-0012-0000.0
60	10 BROOK RD.	Shelburne	033.D-0004-0000.1
60	2 FISKE MILL RD.	Shelburne	037.D-0019-0000.0
60	0 GREENFIELD RD	COLRAIN	4130-0017-00010
60	0 PROLOVICH RD	COLRAIN	4130-0002-00010
60	0 GREENFIELD RD	COLRAIN	4130-0026-00000
60	225 SHELBURNE LINE RD	COLRAIN	4130-0037-00020
60	205 GREENFIELD RD	COLRAIN	4140-0009-00210
60	0 GREENFIELD RD	COLRAIN	4140-0009-00220

Additional Non-structural BMPs

It is recommended, if it has not already been done, that nonstructural BMPs that the Towns of Colrain, Shelburne, and Greenfield currently implement, including street sweeping and catch basin cleaning, be evaluated and potentially optimized for removal of TP and *E. coli*. First, it is recommended that potential pollutant load removals from ongoing activities be calculated in accordance with **Elements H and I** of this document. 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 that are recommended to be implemented include (but not limited to):

- septic system maintenance,
- pet waste management,
- municipal sewer system inspection and maintenance,
- land use regulation revision (e.g., construction erosion and sediment control requirements),
- protection and conservation of open space, riparian buffers, wetlands and stream corridors,
- impervious cover reduction,
- Impervious cover disconnection (e.g., disconnecting roof downspouts from impervious areas),
- Municipal adoption of
- adoption of good housekeeping practices (e.g., yard waste management, leaf litter disposal, fertilizer application best practices), and
- public education and outreach (see Element E).

WBP Implementation

As stated in the introduction, this WBP is meant to be a living document. It should be reevaluated 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 strongly recommended that a working group including additional stakeholders be established to meet at least biannually to implement and update this WBP, and track progress. FRCOG has expressed interest in leading the implementation of this plan.

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.

Current Management Measures

MACD Western Massachusetts Agricultural Nonpoint Source Program

The funding needed to implement the MACD Western Massachusetts Agricultural Nonpoint Source Program (described in **Element C**) is presented in **Table D-1** (MACD, 2020). These costs will be divided between the Hinsdale Brook watershed and four other watersheds in Western Massachusetts. The total cost for the program was estimated at $434,000.

Table D-1: Summary of Proposed BMPs Costs (Western Massachusetts Agricultural Nonpoint Source Program)

Expense Item	s.319 Amount	Non-Federal Match and Source[1]	Total Amount
Salary and Wages			
Project Coordinator	$9,000	$2,000	$11,000
Sub-contractors	$81,000	$5,000	$86,000
Students Assistance	$3,882	$0	$3,882
Supplies			
BMP Materials and Supplies	$160,000	$0	$160,000
DMBE/DWBE		$168,000	$168,000
Travel	$750	$0	$750
Indirect Costs			
Overhead	$9,000	$0	$9,000
Totals	**$259,000**	**$175,000**	**$434,000**

1. This column reflects the anticipated financial contribution of the farmers and other potential non-federal funding sources (e.g., Massachusetts Division of Agricultural Resources (MDAR)).

Future Management Measures

Agricultural BMPs

As noted in Element C, MACD is currently in the conceptual and planning-level phases with two different farms in the watershed in implementing agricultural BMPs. The estimated costs of these projects is currently unknown but will be updated in future iterations of this WBP.

Conservation of Attenuation Assets

The estimated cost for conservation of attenuation assets along the lower Hinsdale Brook upstream of the confluence with the Green River was presented in the Deerfield River WBP (FRCOG, 2015) and is included in **Table D-3**. Please note this cost does not account for inflation since 2015.

Table D-3: Conservation of Attenuation Assets Estimated Probable Cost (FRCOG, 2015)

Treatment/Item	Unit	Quantity	Unit Cost ($)	Task Cost ($)
Land acquisition / corridor easement	acre	50	$1,500	$75,000
Berm removal	unit	1	$20,000	$20,000
Bank cutting / flow diversion	unit	1	$10,000	$10,000
Machinery	day	3	$4,000	$12,000
Construction Oversight	day	3	$1,680	$5,040
Treatment Subtotal				$122,040
20% Contingency				$24,408
Construction subtotal				$146,448
Surveying, permitting and legal costs				$70,000
Project total				**$216,448**

Hinsdale Brook Bank Stabilization

The funding needed to implement the consultant costs for the Hinsdale Brook bank stabilization assessment is presented in **Table D-2** (Shelburne Hazard Mitigation Committee and FRCOG, 2021). The cost includes town staff time for grant application and administration and consultant costs.

Table D-2: Summary of Proposed Consultant Costs (Hinsdale Brook Bank Stabilization Assessment)

Action Description	Responsible Department/Board	Estimated Cost	Potential Funding Source
Hire a consultant to conduct a geomorphic engineering assessment of the Hinsdale Brook to determine possible bank stabilization measures to mitigate damages to the environment and nearby infrastructure. Seek funding to implement recommended measures.	Select Board, Conservation Commission, Highway Department	>$100,000	Town of Shelburne, Massachusetts Emergency Management Agency (MEMA), MassDEP, Municipal Vulnerability Preparedness (MVP)

Identification of Additional Management Measures

Funding for future BMP installations to further reduce loads within the watershed may be provided by a variety of sources including Section 319 funding, Climate Smart Agricultural Program (CSAP), Massachusetts

Environmental Trust (MET) grants, the Agricultural Environmental Enhancement Program (AEEP), the Agricultural Produce Safety Improvement Program (APSIP), Town and City capital funds, volunteer efforts, and NRCS grants including the Environmental Quality Incentives Program (EQIP) and the Agricultural Management Assistance (AMA) program. MACD has 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[12].

[12] Guidance on funding sources to address nonpoint source pollution: http://prj.geosyntec.com/prjMADEPWBP_Files/Guide/Element%20D%20-%20Funds%20and%20Resources%20Guide.pdf

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 topics discussed during the stakeholder meeting of November 8, 2021 (**Appendix A**). A large component of the MACD Western Massachusetts Agricultural Nonpoint Source Program involves outreach to farmers. Farmer outreach through this program includes building relationships with farm owners through attendance at agricultural commission meetings, attendance at farm bureau meetings, word of mouth, phone calls and visiting of farms.

Additional components of the watershed public information and education program are described below. Additional outreach efforts will be determined when future management measures and activities are planned for implementation in the watershed. This section of the WBP will be updated when the plan is reevaluated in 2026 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 and incentives to farmers on funding resources for BMP implementation
2. Provide information about farm conservation plans and agricultural BMPs and their anticipated water quality benefits.
3. Provide information to promote watershed stewardship.
4. Provide information to all residents in the watershed about proposed stormwater improvements and their anticipated water quality benefits.

Step 2: Target Audience

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

1. Farm-owners in the watershed (targeted through MACD), with a focus on farmers who have had previous contact with NRCS and/or MACD.
2. Watershed organizations and other user groups, including the CRC and the DRWA.
3. Businesses, schools, and local government within the watershed.
4. All watershed residents.

Step 3: Outreach Products and Distribution

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

1. MACD representatives will conduct one-on-one meetings with farm-owners and assist farm-owners with development of farm conservation plans.
2. MACD will conduct outreach and education activities, including farm tours highlighting agricultural BMPs.
3. MACD will publish the work completed under the Western Massachusetts Agricultural Nonpoint Source on the MACD website.
4. CRC and the DRWA provide information about the Connecticut River watershed and Deerfield River watershed including the Hinsdale Brook watershed on their websites (https://www.ctriver.org/; https://deerfieldriver.org/) and typically host events such as river clean up days.
5. Informational signs will be developed and posted at implemented BMP locations.

Step 4: Evaluate Information/Education Program

Information and education efforts and how they will be evaluated.

1. Track the number of workshops and farm tours and the attendance at each.
2. Track the number of materials and information, such as fact sheets and emails, and the size of the lists receiving these materials.
3. Track the number of farmers participating in outreach and education efforts, conservation plans, and implementation of BMPs.

Resources for Additional Outreach Products

Other public education and outreach activities and topics should also be considered, such as (but not limited to) yard waste management (leaf litter and fertilizer), pet waste management, and septic system maintenance and pump outs, as discussed in the Non-structural BMP section in Element C.

The EPA's "Nonpoint Source Outreach Toolbox" (www.epa.gov/nps/toolbox) provides information, tools, and more than 700 outreach materials that can be used or adapted to develop an outreach campaign. The toolbox focuses on six nonpoint source pollution categories:

- stormwater
- household hazardous waste
- septic systems
- lawn care
- pet care
- automotive care

Outreach products in the Toolbox include print ads, public service announcements, and a variety of materials for billboards, signage, kiosks, posters, brochures, fact sheets, and giveaways that help to raise awareness and promote non-polluting behaviors. Permission-to-use information is included for outreach products, which makes it easy to tailor them to local priorities. Evaluations of several outreach campaigns also offer real-world examples of what works best in terms of messages, communication styles, and formats. Other helpful resources include:

- MassDEP's Clean Water Toolkit (https://megamanual.geosyntec.com/npsmanual/default.aspx)
- USEPA's Soak Up the Rain materials (https://www.epa.gov/soakuptherain)
- USEPA's Green Infrastructure Collaborative (https://www.epa.gov/green-infrastructure/green-infrastructure-federal-collaborative#Green%20Infrastructure%20Collaborative%20Resources)

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.

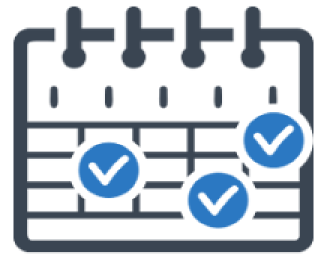


Table FG-1 provides a preliminary schedule for implementation of recommendations provided by this WBP. It is expected that the WBP will be re-evaluated and updated in 2026, or as needed, based on ongoing monitoring results and other ongoing efforts. New projects will be identified through future data analysis and stakeholder engagement and will be included in updates to the implementation schedule.

Table FG-1: Implementation Schedule and Interim Measurable Milestones[13]

Category	Action	Cost Estimate	Year(s)
Monitoring	Perform water quality sampling at key locations along Hinsdale Brook as an expansion of the existing DRWA water quality monitoring program per Element H&I	To be determined	2024 and annually
Western Massachusetts Agricultural Nonpoint Source Program - Outreach	Focus on farm owners who have had previous contact with NRCS and MACD to engage as many as possible to develop conservation plans outlining BMPs to reduce pollutant runoff, and assist farm owners in obtaining access to financial resources for implementation of agricultural BMPs.	$100,000	2021—2023
Western Massachusetts Agricultural Nonpoint Source Program- Agricultural BMPs	Implement agricultural BMPs at two different farms in the watershed	To be determined	2023--2024
Structural BMPs	Identify locations, develop and rank structural BMP concepts	To be determined	2024--2025
Nonstructural BMPs	Document potential pollutant removals from 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.	To be determined	2023—2024
	Evaluate ongoing nonstructural BMPs and determine if modifications can be made to optimize pollutant removals (e.g., increase frequency).	To be determined	2023—2024
	Routinely implement optimized nonstructural BMPs.	To be determined	Annual
Hinsdale Brook Bank Stabilization Assessment	Hire a consultant to conduct a geomorphic engineering assessment of the Hinsdale Brook to determine possible bank stabilization measures to mitigate damages to the environment and nearby infrastructure. Seek funding to implement recommended measures.	>$100,000	2022—2023
Conservation of Attenuation Assets	Conserve land for the purpose of allowing stream meander formation and storage of sediment.	$216.448 (2015 estimate)	To be determined
Public Education and Outreach	MACD will conduct additional outreach and education activities including farm tours highlighting agricultural BMPs.	To be determined	2022—2024
	DRWA and CRC river cleanup and cleanup of invasive species	To be determined	Annually
Adaptive Management and Plan Updates	Establish a working group that includes stakeholders and other interested parties to implement recommendations and track progress. Meet at least twice per year.		2023
	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, August 2026		2026
	Use monitoring results to reevaluate BMP effectiveness at reducing *E. coli* and TP and/or other indicator parameters in Hinsdale Brook and establish additional long-term reduction goal(s), if needed.		**2033**
	Delist Hinsdale Brook from the 303(d) list.		**2038**

[13] Note that goals and milestones of this WBP are intended to be adaptable and flexible. Stakeholders will perform tasks contingent on available resources and funding.

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 interim loading reduction goal is presented in Element B of this WBP. Element C of this plan describes management measures that will be implemented to help achieve this targeted load reduction. The evaluation criteria and monitoring program described below will be used to establish a baseline and measure the effectiveness of the proposed management measures (described in Element C) in improving the water quality of Hinsdale Brook and in making progress toward achieving the water quality goals.

Direct Measurements

Direct measurements are generally expected to be performed as described below. DRWA has been documenting the water quality in the Deerfield River and tributaries intermittently since 1990. The most recent iteration of the DRWA water quality monitoring program has been running since 2017 but does not include any sampling locations in Hinsdale Brook. The DRWA water quality monitoring program is a volunteer program. Before the start of each season, each volunteer is required to attend a training session with the program coordinator. Training sessions are held riverside so that each volunteer can practice under the supervision of the coordinator before going out into the field. The monitoring is conducted under an approved Quality Assurance Project Plan (QAPP). Sites are tested on the Deerfield mainstem and its tributaries in both Vermont and Massachusetts. Volunteers visit these sites on alternate Wednesday mornings from June to September to collect samples that are tested for *E. coli*, TN, TP, turbidity, and conductivity.

It is suggested that water quality monitoring in Hinsdale Brook begin under this program and expanded as described below. MassDEP also provides support for water quality monitoring efforts through its Water Quality Monitoring Grant Program.

River Sampling

Regular sampling will be established to understand the water quality in Hinsdale Brook including determining sources of pollution and tracking achievements toward water quality goals. Key features of the water quality monitoring program will include:

- Analytes: The samples collected should primarily be analyzed for *E. coli* and TP. Additional parameters such as chlorophyll-a, dissolved oxygen, temperature, conductivity, pH, dissolved phosphorus, and flow rate could provide additional data to better understand the health of the watershed and Hinsdale Brook.
- Sampling Frequency: It is recommended that, at a minimum, the current frequency of sampling is continued (i.e., a minimum of five sampling events; alternate Wednesday mornings from June to September). *E. coli* sampling conducted at this frequency aligns with the proposed surface water quality standard revisions and MassDEP assessment requirements and will provide the most value.
- Locations: The water quality monitoring program should be focused on Hinsdale Brook downstream of suspected *E. coli* and/or TP sources. If possible, samples should be collected within Hinsdale Brook directly downstream of implemented BMPs to determine the impact of BMPs within the watershed (samples at these locations prior to BMP implementation should also be collected to establish a baseline). Monitoring locations should ultimately be selected based on accessibility and representativeness and shall be appropriate to quantify water quality improvements in the watershed. BMP performance monitoring locations will be selected after BMPs have been identified for implementation.
- Planning: As noted above, it is suggested that the current DRWA/CRC volunteer water quality monitoring program continue and expand and possibly seek support through the MassDEP Water Quality Monitoring Grant Program.

Indirect Indicators of Load Reduction

Non-Structural 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 swept, or the number of catch basins cleaned. As summarized by **Figure HI-1** and **Figure HI-2**, 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**, it is recommended that potential TP removal from these ongoing actives be estimated. 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.

$$\text{Credit}_{\text{sweeping}} = \text{IA}_{\text{swept}} \times \text{PLE}_{\text{IC-land use}} \times \text{PRF}_{\text{sweeping}} \times \text{AF} \qquad \textbf{(Equation 2-1)}$$

Where:

$\text{Credit}_{\text{sweeping}}$	=	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)
$\text{PLE}_{\text{IC-land use}}$	=	Phosphorus Load Export Rate for impervious cover and specified land use (lb/acre/yr) (see Table 2-1)
$\text{PRF}_{\text{sweeping}}$	=	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 ($\text{PRF}_{\text{sweeping}}$) for sweeping impervious areas

Frequency[1]	Sweeper Technology	$\text{PRF}_{\text{sweeping}}$
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

$$\text{Credit}_{\text{CB}} = \text{IA}_{\text{CB}} \times \text{PLE}_{\text{IC-land use}} \times \text{PRF}_{\text{CB}} \qquad \textbf{(Equation 2-2)}$$

Where:

$\text{Credit}_{\text{CB}}$	=	Amount of phosphorus load removed by catch basin cleaning (lb/year)
IA_{CB}	=	Impervious drainage area to catch basins (acres)
$\text{PLE}_{\text{IC-and use}}$	=	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 Pollutant Reduction Estimates:

Anticipated pollutant load reductions from future BMPs will be estimated and tracked as BMPs are installed. Pollutant load reductions for BMPs installed under the MACD Western Massachusetts Agricultural Nonpoint Program will be included in a final report, required as part of the Section 319 grant, to MassDEP in the Fall of 2024; this information should be included in future iterations of this WBP.

Adaptive Management

As discussed by Element B, the baseline monitoring program will be used to evaluate and establish a long-term (i.e., 15-year) *E. coli* and TP load reduction goal (or other parameter(s) depending on results). Long-term goals will be re-evaluated 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 *E. coli* and TP concentrations and other indicators measured within the watershed, the management measures and loading reduction analysis (Elements A through D) will be revisited and modified accordingly. FRCOG has expressed interest in maintaining this plan and may be able to lead periodic plan evaluations/updates.

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Appendices

Appendix A – Stakeholder Meeting Minutes

Meeting Minutes

SORENSEN

Project Name:	Hinsdale Brook Watershed-Based Plan
Project #:	SP #1078
Location:	Hinsdale Brook (Shelburne, Colrain & Greenfield, MA)

Meeting Date, #:	2021-11-8	Meeting Time:	1:00 PM - 2:00 PM
Prepared By:	Marie Sorensen, RA	Meeting Location:	Zoom video conference per Sorensen Partners invitation
Distribution:	All listed below		

Attendees:

Name	Organization	Contact Information
Michael Leff	Massachusetts Association of Conservation Districts (MACD)	mleffmacd@gmail.com
Matt Reardon	Massachusetts Department of Environmental Protection (MassDEP)	matthew.reardon@mass.gov
Judith Rondeau	MassDEP	judith.rondeau@mass.gov
Meghan Selby	MassDEP	meghan.selby@mass.gov
Julia Keay	Geosyntec Consultants, Inc.	jkeay@geosyntec.com
Emma Williamson	Geosyntec Consultants, Inc.	ewilliamson@geosyntec.com
Marie Sorensen	Sorensen Partners | Architects + Planners, Inc.	msorensen@sorensenpartners.com
Tamsin Flanders	Franklin County Regional Council of Governments (FRCOG)	tflanders@frcog.org
Ryan O'Donnell	CT River Conservancy (CRC)	rodonnell@ctriver.org

"*This project has been financed with Federal Funds from the Environmental Protection Agency (EPA) to the Massachusetts Department of Environmental Protection (the Department) under an s. 319 competitive grant. The contents do not necessarily reflect the views and policies of EPA or of the Department, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.*"

Minutes to be considered final unless comments are received within five (5) business days.

AGENDA

- Greeting – Matt Reardon, MassDEP & Marie Sorensen, Sorensen Partners
- Watershed & Goals Overview (10 min) – Julia Keay, Geosyntec
- s. 319 Grant Project Spotlight (15 min) – Michael Leff, MACD
- Brief Introductions from All Participants (15 min) – All
- Discussion of Completed, Ongoing, and Future Efforts (50 min) – All

Matt Reardon introduced Judith Rondeau. Please reach out to Judith with any project ideas.

Judith Rondeau shared her contact information and invited anyone interested in discussing grant opportunities to reach out to her.

Meghan Selby introduced from 604(b) grant program. She will be working with Geosyntec on WBP projects.

WATERSHED & GOALS OVERVIEW/SECTION 319 GRANT PROJECT SPOTLIGHT

- **Julia Keay** described the purpose of the meeting, to convene the stakeholders for the Hinsdale Brook watershed. As part of the s. 319 grant award, a WBP needs to be completed for the watershed.

- Julia described the goal of creating the watershed-based plan for Hinsdale Brook: to gather data about what's been done in the watershed: Where are potential pollutant sources? Where are projects planned? Where would we want to implement new projects? Where might we want to do monitoring?
- Julia gave an overview of the physical characteristics of the Hinsdale Brook watershed: headwaters in Shelburne, discharges in Greenfield. Mostly forested, with 18.9% agricultural use. There is approximately 2% impervious cover, mostly in Shelburne commercial area. Hinsdale Brook is noted as a Category 5 waterbody in the 2016 MA Integrated List of Waters. The main stem of Hinsdale Brook is impaired with *E. coli.* There are additional issues with erosion, especially on Brook Road, Shelburne.
- Julia showed a new feature of the WBP Tool, http://prj.geosyntec.com/prjMADEPWBP/Home, which is a "BMP hotspot map". Parcels are scored based on various criteria and the map presents the hotspot scores. The higher the score the more suitable for BMP implementation. Julia emphasized this is a planning-level analysis.
- **Michael Leff, s. 319 grantee**, discussed the grant project. This is one of several such projects that MACD has going on. Michael lives in Chesterfield in Hampshire County, Western MA. Also does a lot of work with Franklin County. In this kind of project, MACD contractors do a lot of outreach to farmers to address *E. coli* and other types of nonpoint source pollution. Have already done a lot of this on Palmer River. Also recently got another s.319 from MassDEP, which is a proposal including Franklin and Hampden Hampshire Conservation Districts to have a shared regional outreach coordinator.

BRIEF INTRODUCTIONS FROM ALL PARTICIPANTS

Participants were asked to briefly address the following prompts:

⇒ Name?
⇒ Affiliation
⇒ Your connection to Hinsdale Brook watershed?
⇒ Specific projects, public outreach, and/or monitoring work you do or have done

Julia Keay, Geosyntec, **Water Resources Engineer.** Project Manager for this WBP.

Emma Williamson, Geosyntec. Working with Julia on this WBP.

Marie Sorensen, Sorensen Partners, Planner. Working with Geosyntec and MassDEP to identify stakeholders and landowners who have an advocacy, scientific, or land-ownership interest in the watershed.

Matt Reardon, MassDEP, Nonpoint Source Program Coordinator. The nonpoint source (NPS) program has the 604(b) water quality planning grants and the s.319 grant program, which is more implementation-based. There is funding for potential projects; all participation is voluntary.

Judith Rondeau and **Meghan Selby** of **MassDEP** previously introduced themselves.

Michael Leff, ED, MACD. Grantee for this s.319 grant project. Lives in Chesterfield, MA. Had mostly been working for Franklin Conservation District (FCD) until last fall and now is director of MACD.

Ryan O'Donnell, Water Quality Monitoring Coordinator, CT River Conservancy. Coordinates the program in the Deerfield Watershed. They monitor the Green River, but they do not currently monitor Hinsdale Brook.

Tamsin Flanders, Franklin County Regional Council of Governments (FRCOG), Land Use Planner. Also working on WBPs. Had been looking at Hinsdale Brook watershed also as a potential WBP to undertake. Recommends looking at some details in the 2017 Deerfield River WBP. Participating to understand how MassDEP and Geosyntec are conducting stakeholder meetings. Looking at doing something similar.

DISCUSSION OF COMPLETED, ONGOING, AND FUTURE PROJECTS

A general discussion was held on the following topics:

1. Agricultural or Structural BMP Projects in watershed
2. Pollutant Load Reduction Estimates for BMP projects

3. Monitoring efforts
4. Potential *E. coli* & other nonpoint source pollution sources
5. Public education and outreach
6. Additional grant funding available

Julia Keay. Shares a satellite map of the watershed with placemarkers. Julia has 2005 and 2012 water quality data from MassDEP. Julia marked stations on the map. Any other locations where water quality data is being collected?

Matt Reardon. Used sampling from Mike Kohl, benthic ecologist, used Hinsdale Brook as his reference site for small streams because it's 80% forested. Also, the State is sampling for fish in the Hinsdale Brook watershed and has identified several species.

Ryan O'Donnell. Sent draft of Mike Kohl report, from 2005, to Julia.

Matt Reardon. *E. coli* count was just above the limit.

Julia Keay. 2005 data looked worse than 2012 for *E. coli*. One recommendation would be to implement monitoring. Identified some of the farms in the watershed: Meadow Forge Farm, Wheel View Farm, Pine Hill Orchard. Tamsin also sent information about a small farm north of Pine Hill Orchard.

Tamsin Flanders. Points out location of small farm north of Pine Hill Orchard; there is also a wetland northeast of that spot; there's a brook flowing from that pond into the wetland. Has seen pigs along that brooks and ducks and chickens are fenced in along that pond. The property is for sale, so conditions could change. Aware that Wheel View Farm is still selling meat. Apex Orchard is also a large operation that could be marked.

Ryan O'Donnell. Was at Wheel View Farm a few years ago. They were cutting down their apple trees to increase beef cow production.

Julia Keay. Tamsin, you also mentioned that Brook Road [in Shelburne] is a major concern?

Tamsin Flanders. This was before Hurricane Irene. The Town Highway Department and Planning Board would be the people to talk to. Brook Road is built very close to the natural course of the river and is keeping the river from following its natural course, so they will continue to be in conflict. Aware that the Town is very interested in doing work on Brook Road, based on a 2013 document post-Irene. Tom Miner, a former Planning Board member was a name that came up in FRCOG's research as someone who might be knowledgeable about Brook Road and possibly agriculture.

Ryan O'Donnell. A bridge was washed out during Irene.

Julia Keay. Dornbusch Project – stabilization of the riverbank – on East Branch North River was referenced as a possible example of what could be done for Brook Road.

Michael Leff. The Dornbusch Project was an ecological restoration. *[Note, see East Branch North River Watershed-based Plan for further information on the Dornbusch Project.]*

Julia Keay. Largest commercial use in the watershed is Dhamma Dhara, a meditation center in Shelburne.

Ryan O'Donnell. Meadow Forge Farm appears to be a house with some chickens.

Julia Keay. We could look for structural BMP opportunities closer to the discharge point.

Tamsin Flanders. Has a document listing all the active farms in the region.

Julia Keay. Any thoughts from participants on public education and outreach?

Michael Leff. Plenty of opportunities for library-based outreach.

Matt Reardon. Outlet is Long Island Sound, so there may be opportunities to outreach to individuals who are fertilizing.

Julia Keay. Aware that CT River Conservancy (CRC) does a cleanup day. Has anything been done in this watershed?

Ryan O'Donnell. Doesn't think so. Did one Franklin-County-wide as a larger event. Does not think anyone went out in this sub-watershed but it is possible. Nutrient-wise, one of the most concerning things is the farm pond at Pine Hill is just green all year round. They have a petting zoo. There were also about 50 geese stopping by on their way through, last weekend.

Julia Keay. Michael, have you had any contact with farm owners in this watershed yet?

Michael Leff. Not yet in this watershed.

Judith Rondeau. Looked at Shelburne Town website. They have an Agricultural Commission. Recommends reaching out to them. Also recommends reaching out to any land trusts in the area.

Tamsin Flanders. Thinks Greenfield Agricultural Commission is pretty inactive.

Julia Keay. Does not appear to be any major farm operations in Greenfield. The last item is to discuss any additional grant funding available. As Michael mentioned, this plan could be helpful for future grant funding applications. For future s. 319 or other applications the plan could be helpful.

Matt Reardon. The 604(b) grants are primarily for assessments or coming up with designs. MassDEP has also funded "healthy watershed" type projects that fund erosion, like was identified in this watershed. There is an open RFR currently and there will be another one in April or May 2022. Hopeful there will be another water quality monitoring grant soon, State-funded grants. Any MVP (Municipal Vulnerability Planning) interest? That is another State-funded potential source.

Ryan O'Donnell. The CT River Conservancy (CRC) has a few National Wildlife Federation (NWF) grants to do outreach to landowners for wood turtle habitat, nitrogen reduction into Long Island Sound, and some other topics. Actively on the hunt for restoration projects that would come out of this WBP.

Tamsin Flanders. Also recommends calling UMass Extension services to see what they've done in this area. Will send contact to Julia. Note, Shelburne is not a designated MVP community.

Michael Leff. Recommends Christine Hatch at UMass Extension.

Matt Reardon. There is the Franklin County Land Trust in that area as well.

Judith Rondeau. Did you invite the Franklin Land Trust to participate in this Stakeholder Meeting?

Marie Sorensen. Yes, we invited Alalin Peteroy and Emily Boss of the Franklin Land Trust.

Julia Keay / Matt Reardon / Marie Sorensen. Thanks to all participants for sharing information today.

Contact: Julia Keay, JKeay@geosyntec.com
Adam Questad, AQuestad@geosyntec.com
Matt Reardon, Matthew.Reardon@mass.gov

Appendix B – Select excerpts from the Deerfield River Watershed 2000 Water Quality Assessment Report (MassDEP, 2000) relating to the water quality in the Hinsdale Brook watershed (note: relevant information is included directly from these documents for informational purposes and has not been modified).

Deerfield River Watershed 2000 Water Quality Assessment Report (MA33-21 - Hinsdale Brook)
AQUATIC LIFE Habitat and Flow Hinsdale Brook was sampled by DWM biologists in September 1996 downstream from Greenfield Road in Shelburne (Station VP05HIN) as part of the MA DEP Biocriteria Development Project (MA DEP 1996b). At the time of the survey the brook was roughly 2.5 m wide with depths ranging from 0.25 to 0.5 m. The substrates were comprised primarily of cobble and boulder/gravel. The overall habitat score was 117 (MA DEP 1996b). The instream habitat was limited most by poor bank stability on the right bank, lack of bank vegetative protection, sediment deposition and channel alteration as well as the channel flow status. Biology Hinsdale Brook was sampled by DWM biologists downstream from Greenfield Road in Shelburne (Station VP05HIN) as part of the MA DEP Biocriteria Development Project in September 1996 (MA DEP 1996b). Fish species captured, in order of abundance, included: Atlantic salmon (Salmo salar), slimy sculpin (Cottus cognatus), blacknose dace (Rhinicthys atratulus), brook (Salvelinus fontinalis) and brown trout (Salmo trutta) and an individual each of longnose dace (Rhinicthys cataractae) and golden shiner (Notemigonus crysoleucas) (MA DEP 1996b). Multiple age classes of Atlantic salmon were present. All fish species collected in this brook are fluvial specialists/dependants with the exception of an individual golden shiner. The presence of multiple age classes of Atlantic salmon, dominance by intolerant species, and the general absence of macrohabitat generalists indicated good habitat and water quality conditions as well as stable flow regimes. Chemistry-water In-situ measurements (DO, %saturation, pH, temperature, conductivity, and turbidity) in Hinsdale Brook downstream from Greenfield Road in Shelburne (Station VP05HIN) were taken on 25 September 1996 (Appendix A, Table A8). Although the fish community is indicative of good water quality conditions, because of the lack of additional water quality and biological data, the Aquatic Life Use is not assessed for Hinsdale Brook. This use is, however, identified with an Alert Status due to suboptimal habitat quality. PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS No objectionable deposits, sheens, odors or other conditions were noted in Hinsdale Brook in the stream reach sampled by DWM biologists in September 1996 (MA DEP 1996b). No recent data are available to assess the Recreational and Aesthetic uses, therefore, they are not assessed. The drainage area of this segment is approximately 6.49 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area): Forest 59.3% Agriculture 19.5% Open Land 13.4% MA DFWELE has recommended that Hinsdale Brook be protected as cold water fishery habitat (MassWildlife 2001). **Report Recommendations:** • Conduct water quality and biological monitoring in this segment during the next monitoring year (2005) to assess designated uses. • Hinsdale Brook should be protected as cold water fishery habitat as recommended by MA DFWELE. • The Towns of Shelburne, Colrain, and Greenfield should participate in the Deerfield River Watershed Regional Open Space Plan, which was funded by the Massachusetts Watershed Initiative/Deerfield River Watershed Team and conducted by the Franklin Regional Council of Governments. Through this plan the communities can work cooperatively with other watershed towns to prioritize regional open space and recreational land acquisitions and protection goals, including water resources.

• In order to prevent degradation of water quality in the Hinsdale Brook subwatershed it is recommended that land use planning techniques be applied to direct development, preserve sensitive areas, and maintain or reduce the levels of impervious cover. Shelburne, Colrain, and Greenfield should support recommendations of their recently developed individual municipal open space plans and/or Community Development Plans to protect important open space and maintain their communities' rural character.

• The rural roads that cross over and/or are in close proximity to watercourses should be identified. Field reconnaissance should be performed to evaluate their potential for impacting the water and habitat quality of these adjacent watercourses. Implementation of best management practices, as described in Unpaved Roads BMP Manual (BRPC 2001), should then be encouraged, as appropriate.

Appendix C – Pollutant Load Export Rates (PLERs)

Land Use & Cover[1]	PLERs (lb/acre/year)		
	(TP)	(TSS)	(TN)
AGRICULTURE, HSG A	0.45	7.14	2.59
AGRICULTURE, HSG B	0.45	29.4	2.59
AGRICULTURE, HSG C	0.45	59.8	2.59
AGRICULTURE, HSG D	0.45	91.0	2.59
AGRICULTURE, IMPERVIOUS	1.52	650	11.3
COMMERCIAL, HSG A	0.03	7.14	0.27
COMMERCIAL, HSG B	0.12	29.4	1.16
COMMERCIAL, HSG C	0.21	59.8	2.41
COMMERCIAL, HSG D	0.37	91.0	3.66
COMMERCIAL, IMPERVIOUS	1.78	377	15.1
FOREST, HSG A	0.12	7.14	0.54
FOREST, HSG B	0.12	29.4	0.54
FOREST, HSG C	0.12	59.8	0.54
FOREST, HSG D	0.12	91.0	0.54
FOREST, HSG IMPERVIOUS	1.52	650	11.3
HIGH DENSITY RESIDENTIAL, HSG A	0.03	7.14	0.27
HIGH DENSITY RESIDENTIAL, HSG B	0.12	29.4	1.16
HIGH DENSITY RESIDENTIAL, HSG C	0.21	59.8	2.41
HIGH DENSITY RESIDENTIAL, HSG D	0.37	91.0	3.66
HIGH DENSITY RESIDENTIAL, IMPERVIOUS	2.32	439	14.1
HIGHWAY, HSG A	0.03	7.14	0.27
HIGHWAY, HSG B	0.12	29.4	1.16
HIGHWAY, HSG C	0.21	59.8	2.41
HIGHWAY, HSG D	0.37	91.0	3.66
HIGHWAY, IMPERVIOUS	1.34	1,480	10.2
INDUSTRIAL, HSG A	0.03	7.14	0.27
INDUSTRIAL, HSG B	0.12	29.4	1.16
INDUSTRIAL, HSG C	0.21	59.8	2.41

Land Use & Cover[1]	PLERs (lb/acre/year)		
	(TP)	(TSS)	(TN)
INDUSTRIAL, HSG D	0.37	91.0	3.66
INDUSTRIAL, IMPERVIOUS	1.78	377	15.1
LOW DENSITY RESIDENTIAL, HSG A	0.03	7.14	0.27
LOW DENSITY RESIDENTIAL, HSG B	0.12	29.4	1.16
LOW DENSITY RESIDENTIAL, HSG C	0.21	59.8	2.41
LOW DENSITY RESIDENTIAL, HSG D	0.37	91.0	3.66
LOW DENSITY RESIDENTIAL, IMPERVIOUS	1.52	439	14.1
MEDIUM DENSITY RESIDENTIAL, HSG A	0.03	7.14	0.27
MEDIUM DENSITY RESIDENTIAL, HSG B	0.12	29.4	1.16
MEDIUM DENSITY RESIDENTIAL, HSG C	0.21	59.8	2.41
MEDIUM DENSITY RESIDENTIAL, HSG D	0.37	91.0	3.66
MEDIUM DENSITY RESIDENTIAL, IMPERVIOUS	1.96	439	14.1
OPEN LAND, HSG A	0.12	7.14	0.27
OPEN LAND, HSG B	0.12	29.4	1.16
OPEN LAND, HSG C	0.12	59.8	2.41
OPEN LAND, HSG D	0.12	91.0	3.66
OPEN LAND, IMPERVIOUS	1.52	650	11.3
[1]HSG = Hydrologic Soil Group			

Appendix D – List of Potential Agricultural BMPs with USDA NRCS Code (Provided by FRCOG).

The Massachusetts "Field Office Technical Guide" can be accessed at: https://efotg.sc.egov.usda.gov/#/state/MA/documents/section=4&folder=-3 .Detailed information on each BMP can be found under "Section 4 - Practice Standards and Supporting Documents" > "Conservation Practice Standards & Support Documents"

207-Site Assessment and Soil Testing for Contaminants Activity	656-Constructed Wetland
216-Soil Health Testing	309-Agrichemical Handling Facility
217-Soil and Source Testing for Nutrient Management	311-Alley Cropping
309-Agrichemical Handling Facility	314-Brush Management
311-Alley Cropping	315-Herbaceous Weed Control
313-Waste Storage Facility	338-Prescribed Burning
316-Animal Mortality Facility	350-Sediment Basin
317-Composting Facility	351-Water Well Decommissioning
327-Conservation Cover	356-Dike
328-Conservation Crop Rotation	362-Diversion
329-Residue and Tillage Management, No Till/Strip Till/Direct Seed	367-Roofs and Covers
330-Contour Farming	378-Pond
332-Contour Buffer Strips	380-Windbreak/Shelterbelt Establishment
340-Cover Crop	381-Silvopasture Establishment
342-Critical Area Planting	382-Fence
345-Residue and Tillage Management, Reduced Till	402-Dam
355-Water Well Testing	422-Hedgerow Planting
360-Waste Facility Closure	430-Irrigation Pipeline
366-Anaerobic Digester	441-Irrigation System, Micro irrigation
386-Field Boarder	442-Sprinkler System
390-Riparian Herbaceous Cover	443-Irrigation System, Surface & Subsurface
391-Riparian Forest Buffer	462-Preision Land Forming
393-Filter Strip	464-Irrigation Land Leveling
395-Stream Habitat Improvement and Management	468-Lined Waterway or Outlet
410-Grade Stabilization Structure	484-Mulching
412-Grassed Waterway	511-Forage Harvest Management
436-Irrigation Reservoir	512-Forage and Biomass Planting
449-Irrigation Water Management	516-Livestock Pipeline
472-Access Control	558-Roof Runoff Structure
528-Prescribed Grazing	560-Access Road
561-Heavy Use Area Protection	574-Spring Development
575-Trails and Walkways	578-Stream Crossing
580-Streambank and Shoreline Protection	582-Open Channel
590-Nutrient Management	585-Stripcropping
600-Terrace	587-Structure for Water Control
601-Vegetative Barrier	595-Integrated Pest Management
612-Tree/Shrub Establishment	603-Herbaceous Wind Barriers
629-Waste Treatment	607-Surface Drain, Field Ditch
634-Waste Transfer	608-Surface Drain, Main or Lateral
635-Vegetative Treatment Area	614-Watering Facility
638-Water and Sediment Control Basin	620-Underground Outlet
632-Solid/Liquid Waste Separation Facility	650-Windbreak/Shelterbelt Renovation
642-Water Well	657-Wetland Restoration
643-Restoration and Management of Declining Habitats	658-Wetland Creation
644-Wetland Wildlife Habitat Mangement	659-Wetland Enhancement