CENTRAL VERMONT – STORMWATER MASTER PLAN

CALAIS, EAST MONTPELIER, AND WOODBURY, VERMONT

FINAL REPORT
April 30, 2019

CVRPC
CENTRAL VERMONT REGIONAL PLANNING COMMISSION

WATERSHED CONSULTING

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I. Disclaimer

The intent of this report is to present the data collected, evaluations, analyses, designs, and cost estimates for subwatersheds in Calais, East Montpelier, and Woodbury under a contract between the Central Vermont Regional Planning Commission and Watershed Consulting Associates, LLC. Funding for the project was provided by the Vermont Department of Environmental Conservation's Clean Water Fund Grant. The plan presented is intended to provide the watershed's stakeholders a means by which to identify and prioritize future stormwater management efforts. This planning study presents a recommended collection of Best Management Practices (BMPs) that would address specific concerns that have been raised for these areas. In particular, there is great need to reduce stormwater impacts including phosphorus and sediment from stormwater runoff to receiving waters within the municipalities and the greater Lake Champlain Basin in light of current and future regulation under the Lake Champlain Total Maximum Daily Load requirements. Although there are other BMP strategies that could be implemented in the watershed, those presented in this document are the sites and practices that project stakeholders believe will have the greatest impact and probability of implementation. These practices do not represent a regulatory obligation at this time, nor is any property owner within the watershed obligated to implement them. However, it should be noted that for properties with three or more acres of impervious cover without a current State stormwater permit, forthcoming regulations will require management of existing impervious areas. This stormwater master plan, and therefore its resultant strategies, will be one of the actions in the upcoming Winooski Tactical Basin Plan. This will put the BMP strategies in queue for state funding for implementation.

II. Glossary of Terms

Best Management Practice (BMP)- BMPs are practices that manage stormwater runoff to improve water quality and reduce stormwater volume and velocity. Examples of BMPs include detention ponds, gravel wetlands, infiltration trenches, and bioretention practices.

Buffers- Protective vegetated areas (variable width) along stream banks that stabilize stream banks, filter sediment, slow stormwater runoff velocity, and shade streams to keep waters cool in the summer months.

Channel Protection Volume (CPv)- The stormwater volume generated from the one-year, 24-hour rainfall event. Management of this event targets preventing stream channel erosion.

Check Dam- A small dam, often constructed in a swale, that decreases the velocity of stormwater and encourages the settling and deposition of sediment. They are often constructed from wood, stone, or earth.

Detention BMP- A BMP that stores stormwater for a defined length of time before it eventually drains to the receiving water body. Stormwater is not retained in the practice. The objective of a detention BMP is to reduce the peak discharge from the BMP to reduce channel erosion and settle out pollutants from the stormwater. Some of these practices also include additional water quality benefits. Examples include gravel wetlands, detention ponds, and non-infiltration-dependent bioretention practices.

Drainage Area- The area contributing runoff to a specific point. Generally, this term is used for the area that drains to a BMP or other feature like a stormwater pipe.

Hydrologic Soil Group- A Natural Resource Conservation Service classification system for soils. They are categorized into four groups (A, B, C, and D) with "A" having the highest permeability and "D" having the lowest.

Infiltration/Infiltration Rate- Stormwater percolating into the ground surface. The rate at which this occurs (infiltration rate) is generally presented as inches per hour.

Infiltration BMP- A BMP that allows for the infiltration of stormwater into the subsurface soil as groundwater, which returns to the stream as baseflow. Mapped soils of Hydrologic Group A or B (sandy, well-drained soils) are an indicator of infiltration potential. Infiltration reduces the amount of surface storage required. Typical Infiltration BMP practices include infiltration trenches, bioretention practices, subsurface infiltration chambers, infiltration basins, and others.

Outfall- The point where stormwater discharges from a system like a pipe.

Sheet Flow- Stormwater runoff flowing over the ground surface in a thin layer.

Stabilization- Vegetated or structural practices that prevent erosion from occurring.

Stormwater/Stormwater Runoff- Precipitation and snowmelt that runs off the ground surface.

Stormwater Master Plan (SWMP)- A comprehensive plan to identify and prioritize stormwater management opportunities to address current, and prevent future, stormwater related problems.

Stormwater Permit- A permit issued by the State for the regulated discharge of stormwater.

Swale- An open vegetated channel used to convey runoff and to provide pre-treatment by filtering out pollutants and sediments.

Total Maximum Daily Load (TMDL)- A TMDL is a calculation of the maximum pollutant loading that a water body can accommodate and still meet Vermont Water Quality Standards. The term TMDL also refers to the regulated management plan, which defines how the water body will be regulated and returned to its acceptable condition. This includes the maximum loading, sources of pollution, and criteria for determining if the TMDL is met.

Total Phosphorus (TP)- The total phosphorus present in stormwater. This value is the sum of particulate and dissolved phosphorus. It includes both organic and inorganic forms.
Total Suspended Solids (TSS)- The total soil particulate matter suspended in the water column.

Watershed- The area contributing runoff to a specific point. For watersheds like the Kingsbury Branch, this includes all of the area draining to the point where the river discharges to the Winooski River.

Water Quality Volume (WQv)- The stormwater volume generated from the first inch of runoff. This runoff is known as the 90th percentile rainfall event and contains the majority of pollutants.

1 Introduction

1.1 The Problem with Stormwater

Stormwater runoff is any precipitation including melting snow and ice that runs off the land. In undeveloped areas, much of the precipitation is soaked into the ground, taken up by plants, or evaporated back into the atmosphere. However, when human development limits or completely prevents this natural sponge-like effect of the land, generally through the introduction of impervious areas such as roads, parking lots, or buildings, the volume of stormwater runoff increases, sometimes dramatically. In addition to the increased volume of stormwater runoff, the runoff is also frequently laden with pollutants such as sediment, nutrients, oils, and pathogens. These stormwater runoff related issues decrease aquatic habitat health, increase flooding and erosion, threaten infrastructure, and prevent use and enjoyment of our water resources. Traditionally, stormwater management techniques have relied heavily upon gray infrastructure, where stormwater is collected and conveyed in a network of catchbasins and pipes, prior to discharging to surface waters (i.e. streams, rivers, ponds, lakes, and coastal waters). Although this approach is effective in removing stormwater from developed areas, it does not eliminate the problem and has proved to worsen negative stormwater effects such as erosion, flooding, and nutrient pollution. It is clear that something has to change. This is where stormwater master planning comes into play. Funding is limited to implement projects that will improve water quality and reduce the negative impacts of uncontrolled stormwater runoff. As such, creating a plan of where and how to best use these funds to provide the greatest benefit to our water resources is key.

1.2 What is Stormwater Master Planning?

In the wake of rapid urban development and increasing rainfall intensity, stormwater management that seeks to mimic the undeveloped environment and treat stormwater runoff as close to the source as possible has become the focus of efforts to mitigate flooding and maintain the health of our waterways. Given the complexity of current stormwater issues, the development of the Stormwater Master Planning process provides communities with a range of possibilities for stormwater mitigation from small-scale (i.e. individual parcels), to large-scale (i.e.

community-wide). Stormwater rarely follows political or parcel boundaries and tackling this problem from a strategic perspective is key to preventing future problems and addressing current sources of water quality degradation. This process was developed because many of the developed areas within the State of Vermont predate regulatory requirements for stormwater management, but these distributed and unmanaged areas are contributing to the impairments of our surface waters including Lake Champlain. These unmanaged stormwater discharges can be identified and addressed through this Stormwater Master Planning process. The process allows for assessment and prioritization of the areas most in need of mitigation while acknowledging that, for many areas, these types of stormwater retrofits are voluntary. Public awareness of both stormwater problems and stormwater management practices are critical to the Stormwater Master Planning process. As such, working with municipal officials, project stakeholders, and community members is key to implementation of and support for these plans. Stormwater Master Planning involves analysis of current and anticipated future conditions, and seeks to prioritize stormwater solutions, maximizing the potential for water quality improvement, flood mitigation, erosion reduction, and pollution prevention using a variety of best management practices (BMPs) and allocating limited funds in a planned and methodical way.

2 Project Overview

In May 2013, the State of Vermont Department of Environmental Conservation (VT DEC) issued a document titled *Vermont Stormwater Master Planning Guidelines*, designed to provide VT communities with a standardized guideline and series of templates. The document assists communities in planning for future stormwater management practices and programs. Our Plan is a combination of Templates 2A: Hybrid site & community retrofit approach with green stormwater infrastructure (GSI) stormwater management, and 3A: Large watershed or regional approach with planned build out analysis and traditional (end of pipe or centralized) stormwater management.

Vermont has had stormwater regulations in place since 1978, with updates concerning unified sizing criteria made in 2002 and again in 2017. Recognizing that stormwater management can be a costly endeavor, the new guidelines are written to help identify the appropriate practices for each watershed, community, and site, in order to maximize the use of limited funds.

The guidelines encourage each stormwater master plan (SWMP) to follow the same procedures, and include:

- Problem Definition
- Collection of Existing Data
- Development of New Data
- Existing and Proposed Program, Procedure, or Practice Evaluation
- Summary and Recommendations

In keeping with these guidelines, we have prepared the following report. The report is broken up into three chapters, one for each municipality covered by this plan. The chapters are titled with the municipality name: Calais, East Montpelier, and Woodbury (Figure 1).

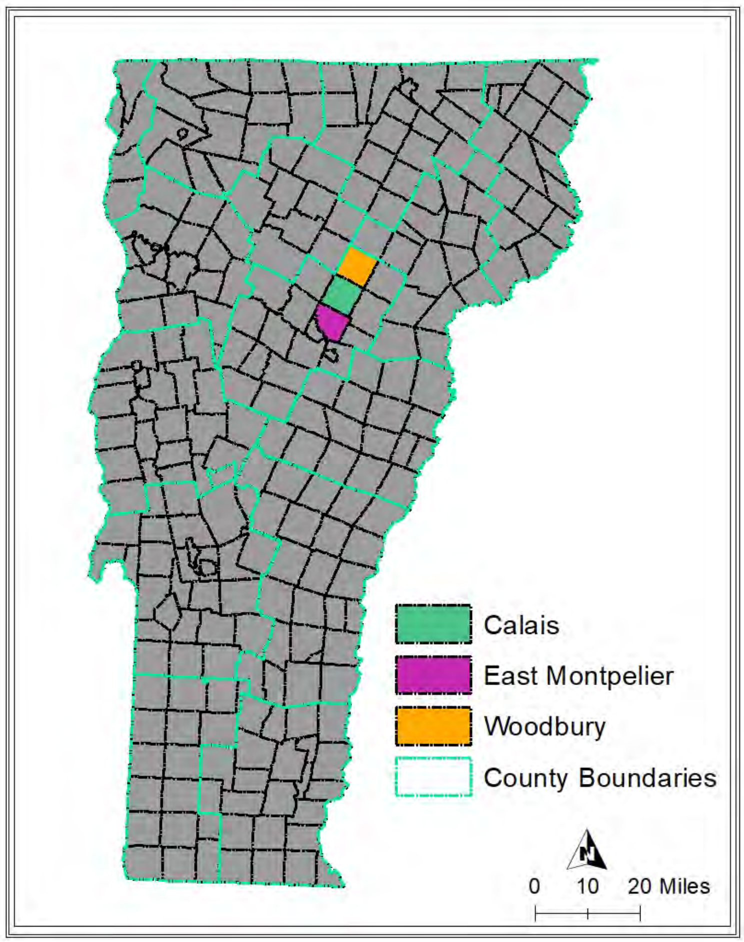

Figure 1. Calais, East Montpelier, and Woodbury are located in central Vermont within Washington County.

A. Chapter 1: Calais

1 Background

1.1 Problem Definition

The Town of Calais is located in Washington County primarily within the Kingsbury Branch watershed, though small portions fall within four other watersheds including the Sodom Pond Brook and the North Branch Winooski River watersheds (Figure A1). Each of these watersheds is within the larger Winooski River watershed, which drains to Lake Champlain. The Winooski River has numerous reaches that are adversely impacted by stormwater runoff and development.

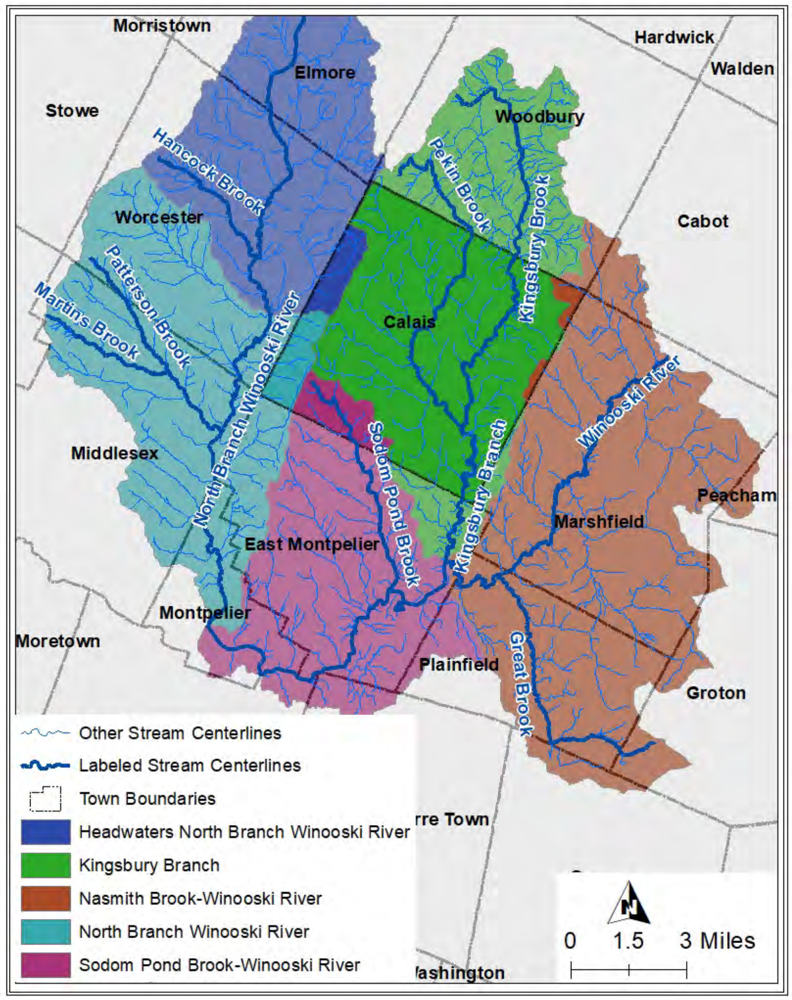

Figure A1. Calais is located primarily within the Kingsbury Branch watershed.

As noted in the Pekin Brook Corridor Plan (2010, Bear Creek Environmental, LLC), Pekin Brook, a tributary of the Kingsbury Branch, has several major stressors including lack of riparian buffer, encroachments by roads, straightening of the channel, and undersized structures. These stressors have resulted in four mass failures, aggradation, widening, and planform adjustment.

Kingsbury Branch and Pekin Brook were assessed as part of the Kingsbury Branch River Corridor Plan (2008, Bear Creek Environmental, LLC). Overall, the reaches within the Town of Calais were primarily in "Fair" condition with several reaches in "Good" condition. The active adjustment processes for these reaches was a combination of aggradation, planform change, and widening. As these waters flow through Calais, they are subject to constrictions limiting their ability to adjust their planform. In many areas they lack a riparian buffer, which is critical for stream health and stability. Sections of the waters have also been channelized in the past which can cause a lack of dynamic equilibrium.

Calais has experienced increased development along Route 14, with expanding areas of impervious surfaces. Route 14 closely parallels the Kingsbury Branch, with areas of development falling in or close to the river corridor. This development has constrained the river along both banks in certain areas. In addition to expanding development along this corridor, Calais experiences erosion as a result of steep slopes and unstable soils, further contributing to sediment and nutrient loading in surface waters.

The human-influenced stressors in the watersheds include construction of roads, residential development, and clearing of previously forested areas. Additionally, in part due to historic straightening of water bodies in the area, associated incision of stream channels, and limited floodplain access, nuisance flooding and potentially more extreme flood events can occur. Unmanaged stormwater runoff, particularly from impervious surfaces and landscaped pervious areas, exacerbate this flooding. The Winooski River watershed and its tributaries have experienced extreme flooding in the past, and these flood events are expected to occur more frequently due to the predicted increased frequency and intensity of extreme weather events associated with climate change. These heavy rains and easily erodible soils have contributed to erosion issues throughout the area. The stormwater management practices investigated seek to protect local river resources as well as the larger Lake Champlain Basin, which currently has a Total Maximum Daily Load (TMDL) in place, requiring reductions in phosphorus loading to Lake Champlain via its tributaries through reductions in stormwater and agricultural runoff pollution.

1.2 Existing Conditions

The Town of Calais spans approximately 24,671 acres in Washington County, VT (Figure A2) and is primarily forested (77%) with 10% agricultural and 4% urban land use. Of that area, there are 333 acres (1%) of impervious cover. Much of the development in Calais parallels Kingsbury Branch, with several commercial and many residential areas falling within the River Corridor. Route 14 closely parallels Kingsbury Branch and Pekin Brook Rd closely parallels Pekin Brook. There are also several large lakes and ponds in Calais, and development has occurred along several of these lakeshores.

Much of the Town of Calais is rural and residential, and this area contains roads that are generally unpaved with open roadside ditches. Many of these roads have steep slopes and traverse large areas. This predisposes these areas to erosion and sediment transport. Much of the older development within the Town was constructed before current stormwater standards were developed and were constructed without any or with only minimal stormwater management. This has resulted in untreated stormwater draining from developed lands directly to surface waters.

Soils analyses indicate that of the 24,671 total acres in the Town, 91% are classified as either potentially highly-erodible, or highly-erodible by the latest Natural Resources Conservation Service (NRCS) soil mapping data. Additionally, the majority of the soils in the watershed have very low infiltration potential as indicated by NRCS Hydrologic Soil Group classifications where soils are classified from group A (highest infiltration potential) to group D (lowest infiltration potential). In the Town, the majority of areas belong to either Hydrologic Soil Group C (38%) or D (47%), while only 5% are in group A, and 7% are in group B. The remainder is not classified or comprised of water. This combination of steep slopes with limited infiltration capacity and a highly erodible surface make the area particularly susceptible to erosion. Maps depicting existing watershed conditions can be found in Appendix A1 – Map Atlas. Note that a map with parcels with ≥3 acres of impervious cover is not included as the only parcels that meet that criteria are roads. Maps include:

- river corridors, wetlands, and hydric soils,
- impervious cover,
- soil infiltration potential,
- soil erodibility,
- land cover,
- slope, and
- stormwater infrastructure and stormwater permits.

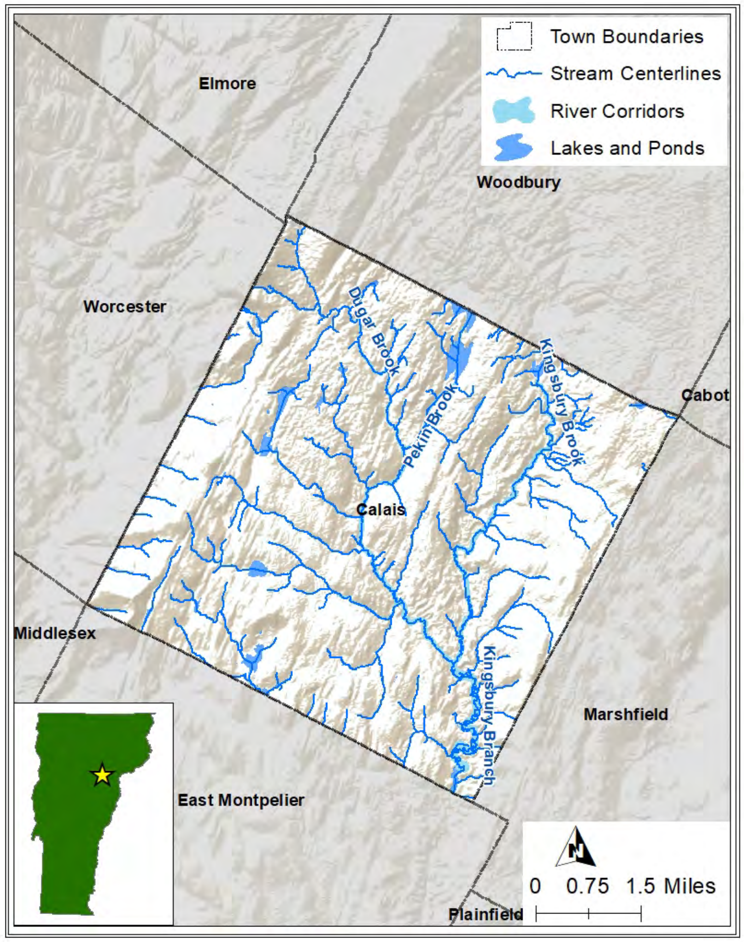

Figure A2. Calais is located in Washington County, VT.

2 Methodology

2.1 Identification of All Opportunities

2.1.1 Initial Data Collection and Review:

All relevant prior watershed studies and any studies that could inform planning in the project area were assembled and reviewed in the context of this SWMP study. These reports include the Water Quality Management Plan, geomorphic studies including the River Corridor Management Plan, aquatic life studies, and stormwater infrastructure mapping and prioritization.

Relevant Geographic Information System (GIS) data was drawn from a variety of public resources including the Agency of Natural Resource's Atlas, Vermont Center for Geographic Information Open Geodata Portal, and data created by the University of Vermont's Spatial Analysis Lab. A file geodatabase was created to ensure organization and for ease of use. These data represent the "best available" data at the time of data collection (2018). The information collected and reviewed for the creation of this SWMP as well as a summary memo are included as Appendix A2 – Data Review.

The project team met with Town of Calais stakeholders and the Central Vermont Regional Planning Commission (CVRPC) on November 16, 2017 to discuss the SWMP and solicit information on problem areas from the Town. Meeting minutes from this meeting are included in Appendix A3. A second meeting was held on January 29, 2018 to identify a list of problem areas including particular parcels and general areas of importance. These areas were noted and added to the list of sites identified during the desktop assessment (see section 2.1.2).

2.1.2 Desktop Assessment and Digital Map Preparation

2.1.2.1 Desktop Assessment

A desktop assessment was completed in order to identify additional potential sites for stormwater BMP implementation. This process involved a thorough review of existing GIS resources and associated attribute data. Data included, but was not limited to, storm sewer infrastructure, soils classifications, parcel data, wetlands, and river corridors. This data was used to identify and map stormwater subwatersheds with particularly high impervious cover, stormwater subwatersheds that are more directly connected to water bodies (direct pipes to streams or via overland flow), areas where infill development may occur, areas that may have worsening stormwater impacts in the future, and parcels with ≥3 acres of impervious cover without a current stormwater permit as these areas will be subject to a permit in the future. A point location was created for each identified site or area for assessment in the field.

A 'green streets' assessment was also conducted to identify any road segments in the Town potentially appropriate for green stormwater infrastructure (GSI) retrofit opportunities. Streets were evaluated and scored according to width, slope, and soil permeability utilizing a methodology adapted from the "Promoting Green Streets" report published by the River Network (July 2016; included as Appendix A4).

The methodology was modified to better fit specific conditions found in the study area. The analysis utilized two prerequisites and one secondary consideration.
Prerequisites:

1. Road Slope
   - 1-5% Slope = Ideal (Score: 2 points)
   - 5-7.5% Slope = Potential (Score: 1 point)
   - > 7.5% Slope = Unsuitable (Score: 0 points; discarded from further analysis)
2. Road Right-of-Way Width
   - ≥ 50 ft = Ideal (Score: 2 points)
   - 46-50 ft = Potential (Score: 1 point)
   - < 46 ft = Unsuitable (Score: 0 points; discarded from further analysis)

Secondary Consideration:

3. Hydrologic Soil Group (indication of infiltration potential)
   - A/B (highest infiltration potential) = Ideal (Score: 2 points)
   - B/C (moderate infiltration potential) = Potential (Score: 1 point)
   - C/D (lowest infiltration potential) = Unsuitable (Score: 0 points; **not** discarded from further analysis)

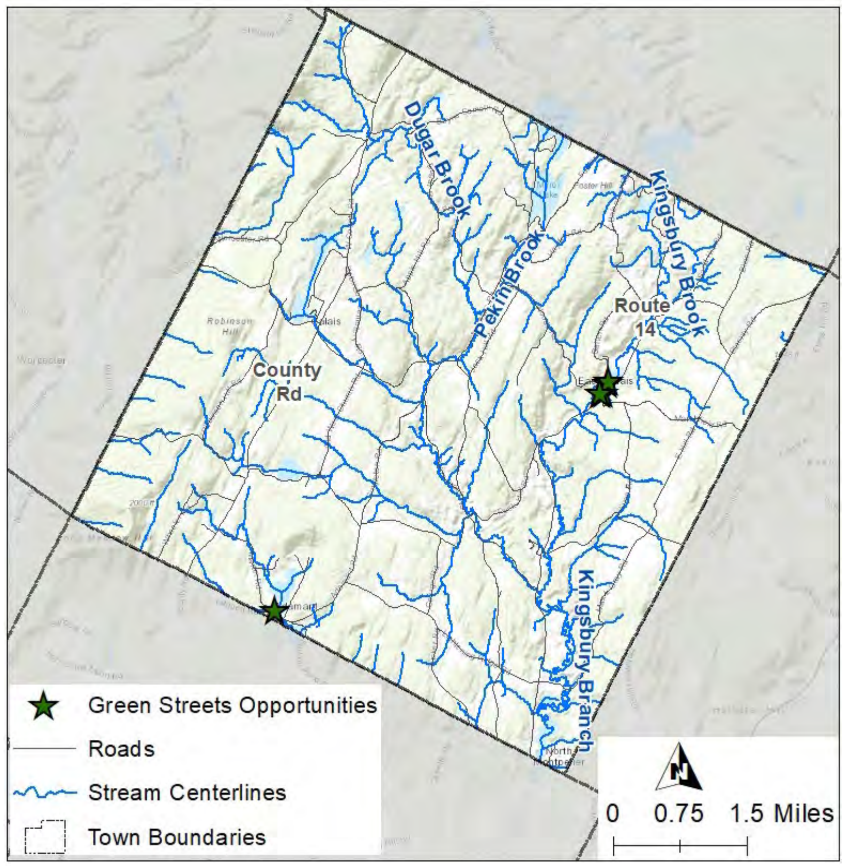

Figure A3. The 6 locations identified as potential green streets opportunities are shown with green stars.

The scores from each of the three criteria were added, and a score was assigned for each road segment where higher scores indicated a greater potential for GSI suitability. In total, 6 sites with potential were noted for assessment in the field (Figure A3).

A total of 72 locations, including the Green Streets sites, were identified for stormwater retrofit potential.

2.1.2.2 Basemap and Mobile App Creation

In order to maximize efficiency in the field and better understand site-specific conditions, digital base maps were created for the Town. The maps show parcel boundaries, public parcels, stormwater infrastructure, hydrologic soils groups, river corridors, hydric soils, and wetlands. This information was used in the field to assess potential feasibility issues for proposed practices and to better identify preliminary BMP locations.

The base layers were pre-loaded into a project-specific mobile app that was customized for this project using the Fulcrum platform. The app was also pre-loaded with the 72-point locations for the potential BMP sites, which included both general Town-wide sites and green streets locations. These points allowed for easy site location and data collection in the field (Figure A4).

The app was used to collect information including site suitability, photographic documentation, follow-up notes, and other pertinent data. All collected data was securely uploaded to the Cloud for later use.

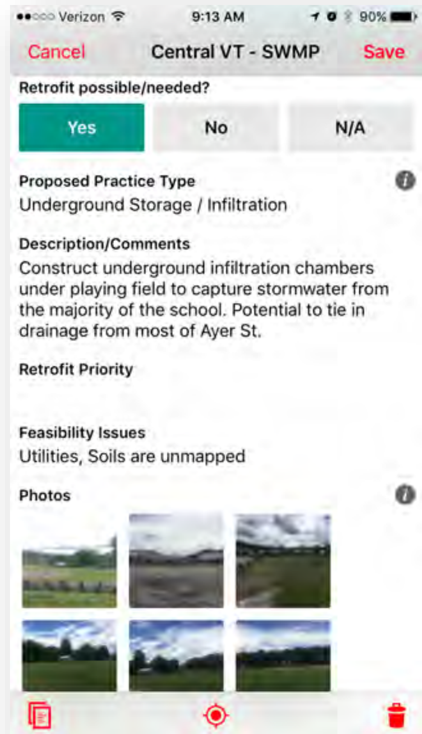

Figure A4. Example screen from data collection app.

2.1.3 Field Data Collection:

Each of the 72 previously identified potential BMP locations were evaluated in the field during the Summer of 2018 (Figure A5). Data was collected about each site in the mobile app. A large map of these sites with associated site names, and a list of these sites including potential BMP options and site notes can be found in Appendix A5 - Initial Site Identification.

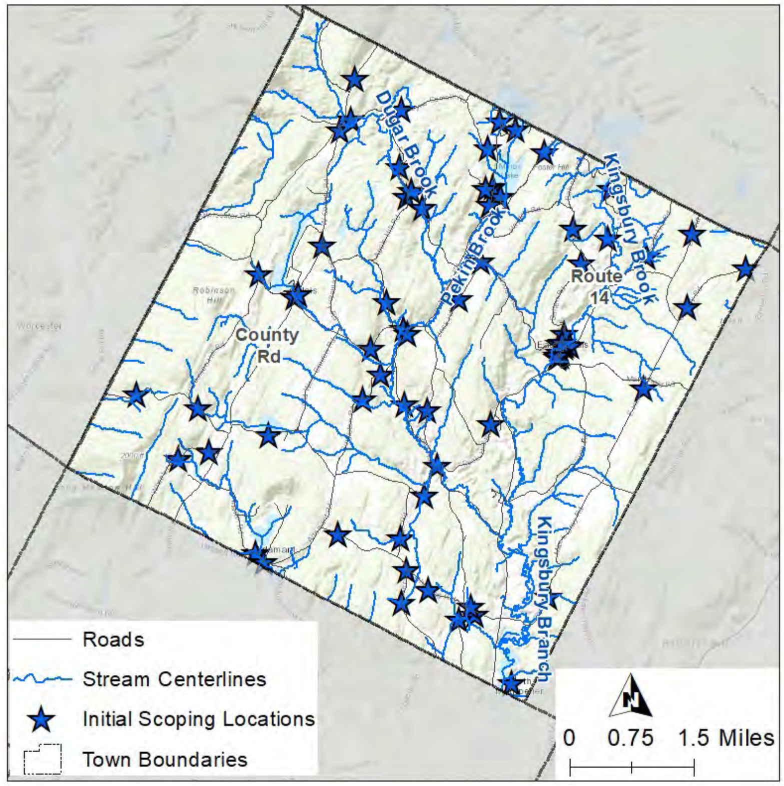

Figure A5. 72 potential sites for BMP implementation were identified for field investigation.

Through the course of these field visits, additional stormwater retrofit sites were identified that had not been included in the initial assessment. A total of 86 sites in Calais were assessed as part of this plan. Some site locations that seemed like potential opportunities for BMP implementation were excluded from further analysis due to specific, prohibitive site conditions. Following this process, a total of 72 sites in Calais remained as potential BMP opportunities (Figure A6).

2.2 Preliminary BMP Ranking

After the initial field visits were completed and the project list was updated, a preliminary ranking system was utilized to prioritize these 72 projects (Figure A6). The goal of this ranking was to identify the 20 sites that would provide the greatest water quality benefit and have a high likelihood of implementation. This prioritization was accomplished by completing an assessment of project feasibility and benefits including drainage area size, pollutant load reduction potential, proximity to water, land ownership, and feasibility issues. See Appendix A6 - Preliminary Site Ranking for the complete list of factors utilized in the preliminary ranking. Also included in Appendix A6 is the completed ranking for each potential site, one-page field data summary sheets with initial ranking information, and a memo detailing this ranking process.

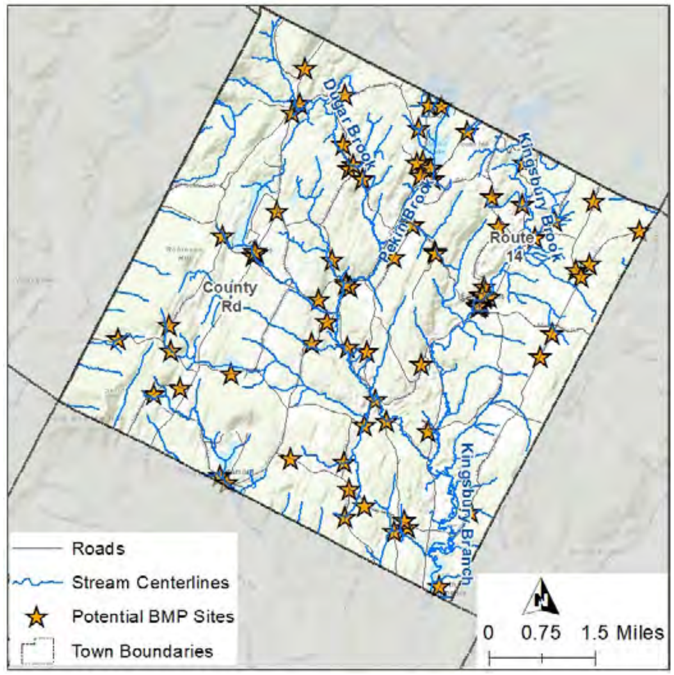

Figure A6. Following field investigations, the list of potential BMP sites was refined to 72. Point locations are shown for each site.

The draft Top 20 list was distributed to Calais stakeholders and the CVRPC. As part of this process, the project team met with the stakeholders on September 11, 2018 to discuss the proposed Top 20 project sites. Following feedback from the Town, the list was refined to reflect the Town's knowledge of potentially unwilling landowners and the Town's priorities. These Top 20 sites are listed in Table A1. Point locations are shown in Figure A7.

Table A1. Top 20 BMPs selected for the Calais SWMP.

Site ID	Proposed Practice Type
Calais Post Office	Underground Storage / Infiltration, Ditch / Swale Improvements
Moscow Woods Gully	Gully Stabilization, Infiltration Basin, Ditch / Swale Improvements
Marshfield Rd	Ditch / Swale Improvements, Check Dams, Gully Stabilization
Calais Town Garage	Infiltration Basin, Check Dams, Salt Management
Calais Elementary School	Bioretention, Sand Filter
Franks Farm	Filter Strip / Buffer Enhancement, Cistern, Sand Filter, Cow Management
Calais Rt 14 Infiltration	Dry Wells, Underground Storage / Infiltration
Route 14 Infiltration	Underground Storage / Infiltration
Blachly Rd and Bliss Rd	Check Dams, Ditch / Swale Improvements, Turnouts, Sediment Trap
Calais Town Clerk	Bioretention, Ditch / Swale Improvements
Pekin Brook Rd and Kent Hill Buffer	Filter Strip / Buffer Enhancement
Bliss Pond Rd	Filter Strip / Buffer Enhancement, Ditch / Swale Improvements, Bioretention
Adamant Rd and Haggett Rd	Filter Strip / Buffer Enhancement, Bioretention
N Calais Rd	Ditch / Swale Improvements, Check Dams, Filter Strip / Buffer Enhancement
George Rd N	Ditch / Swale Improvements, Check Dams, Filter Strip / Buffer Enhancement
Maple Corner Store	Stormwater Planter, Sand Filter, Bioretention, Filter Strip / Buffer Enhancement
Mirror Lake Access Point	Filter Strip / Buffer Enhancement, Bioretention
Memorial Hall	Filter Strip / Buffer Enhancement, Bioretention
Marshfield Rd & Church	Bioretention
Peck Hill Rd S	Ditch / Swale Improvements, Regrade Road

2.3 Modeling and Concept Refinement for Top 20 BMPs

Modeling was completed for each of the Top 20 sites. This modeling allowed for accurate sizing of the proposed practices as well as an understanding of the water quality and quantity benefits. The contributing drainage area of each of the BMPs was defined and landuse/landcover was digitized using the best available topographic data and aerial imagery. Drainage areas were refined based on field observations. Each of the sites was modeled in HydroCAD to determine the appropriate BMP size and resultant stormwater volume reductions (see Appendix A8 - Top 20 Sites Modeling for modeling reports).

Each of these sites was also modeled using the Source Loading and Management Model for Windows (WinSLAMM) to determine the annual total suspended solids (TSS) and total phosphorus (TP) loading from the drainage area of each site. Pollutant load reductions from each of the BMPs were then calculated using one of two sources, depending on the practice type. WinSLAMM was used when possible, and, for those practices that WinSLAMM does not model well (generally non-infiltration-based practices; based on experience and literature), pollutant removal rates published by the University of New Hampshire Stormwater Center were applied to the initial pollutant loading modeled with WinSLAMM for the site's current conditions. This yielded expected pollutant removal loads (lbs) and rates (%). The modeled volume and pollutant loading reductions are shown in Table A2. Complete modeling results are provided in Appendix A8 - Top 20 Sites Modeling.

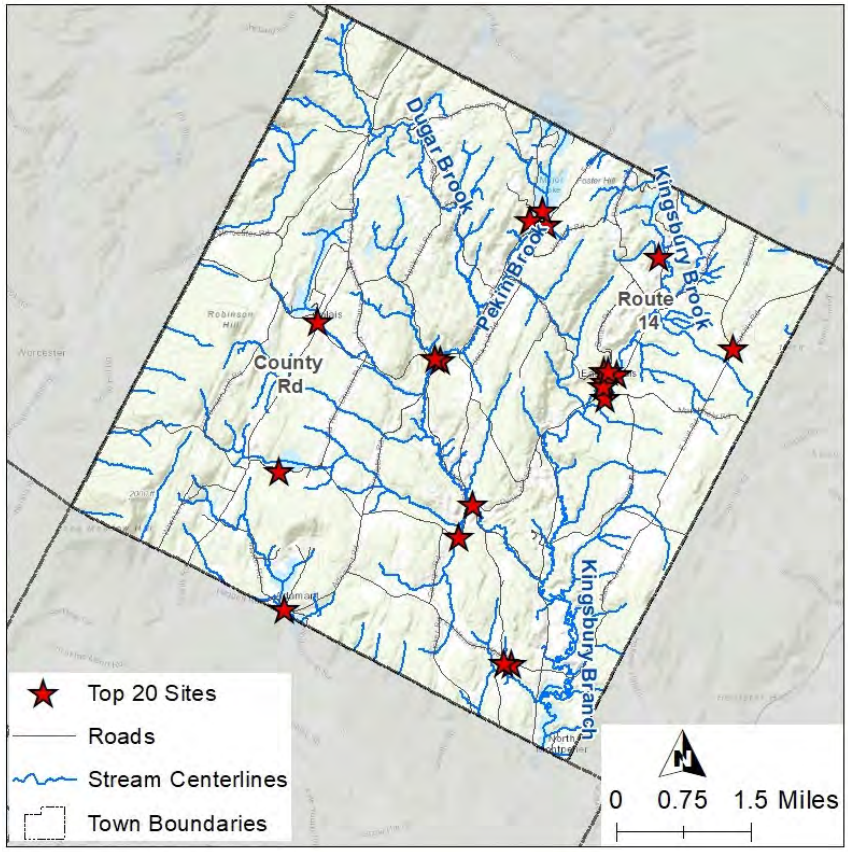

Figure A7. The Top 20 project locations are shown.

Table A2. Modeled volume and pollutant load reductions for the Top 20 BMPs.

Site ID	Volume Managed (ac-ft)	Volume Infiltrated (ac-ft)	Total Suspended Solids Removal (lbs)	Total Suspended Solids Removal (%)	Total Phosphorus Removal (lbs)	Total Phosphorus Removal (%)
Calais Post Office	0.09	0.09	1,190	99.6%	4.62	99.6%
Moscow Woods Gully	0.056	0.046	424,246	93.49% (Fellows Rd); 69.9% (Gully)	111.46	95.95% (Fellows Rd); 68.9% (Gully)
Marshfield Rd	0.016	0	32,928	65% (Road); 49.3% (Gully)	10.08	20% (Road); 44.3% (Gully)
Calais Town Garage	0.059	0.035	3,683	65% (Swale improvements); 98.64% (Infiltration Basin); 23.2% (sand storage improvements)	1.94	20% (Swale improvements); 98.86% (Infiltration Basin); 25.2% (sand storage improvements)
Calais Elementary School	0.019	0	506	88.67% (Sand Filter); 92.68% (Bioretention)	0.60	78.32% (Sand Filter); 83.25% (Bioretention)
Franks Farm	0.315	0	5,375	60.0%	2.21	20.0%
Calais Rt 14 Infiltration	0.199	0.199	2,496	100.0%	1.49	100.0%
Route 14 Infiltration	0.228	0.228	3,169	85.1%	2.63	85.0%
Blachly Rd and Bliss Rd	0.171	0	5,195	65.0%	1.00	20.0%
Calais Town Clerk	0.016	0	433	54.8%	0.57	50.8%
Pekin Brook Rd and Kent Hill Buffer	0.088	0	1,726	60.0%	0.67	20.0%
Bliss Pond Rd	0.010	0	321	14.0%	0.20	13.9%
Adamant Rd and Haggett Rd	0.001	0	1,213	60% (Buffer); 89.67% (Bioretention)	0.41	20% (Buffer); 83.37% (Bioretention)
N Calais Rd	0.023	0	614	65.0%	0.14	20.0%
George Rd N	0.021	0	508	65.0%	0.13	20.0%
Maple Corner Store	0.012	0	568	69.4%	0.31	61.4%
Mirror Lake Access Point	0.004	0	656	60% (Buffer); 95.83% (Bioretention)	0.19	20% (Buffer); 90.44% (Bioretention)
Memorial Hall	0.011	0	252	100% (Roof); 60% (Buffer)	0.11	100% (Roof); 20% (Buffer)
Marshfield Rd & Church	0.004	0	361	100.0%	0.10	100.0%
Peck Hill Rd S	0.023	0	488	65.0%	0.14	20.0%

2.4 Final Ranking Methodology

A prioritization matrix was utilized to quantitatively rank each of the Top 20 projects. Considerations that factored into the ranking of BMP projects included:

- Impervious area managed
- Ease of operation and maintenance
- Volume managed
- Volume infiltrated
- Permitting restrictions
- Land availability
- Flood mitigation
- TSS removed
- TP removed
- Other project benefits
- Project cost

Each of these criteria are listed and explained in Appendix A9 - Top 20 Site Final Ranking. The scores associated with each of the categories are also provided in this table.

2.4.1 Project Cost Estimation

Project cost, listed as one of the criteria considered, was calculated for each project using a spreadsheet-based method. The methodology for determining these planning level costs was first developed for the City of South Burlington by the Horsley Witten (HW) Group as part of the Centennial Brook Flow Restoration Plan development. The HW Memorandum describing this methodology is provided in Appendix A10. Note that a variation of this method was used for this plan. The criteria used in this cost estimation can be found in Appendix A9 - Top 20 Site Final Ranking. This methodology provides consistent budgetary cost estimates across BMPs.

Cost estimates are based on average costs for conceptual level projects and deviation from these estimates are expected as projects move forward with engineering design. There are differences between project cost estimates presented in the plan and actual project bid costs. The BMP cost estimates presented in the plan are based on limited site investigation. This methodology, while providing consistency in budget cost estimating, may fail to accurately reflect project cost impacts associated with actual site conditions and constraints. Therefore, the BMP cost estimates presented are suitable for planning purposes only, and not detailed program budgeting. The BMP cost estimates were developed based on the following assumptions:

Design Control Volumes: Design control volumes were based on the estimated runoff volume associated with the Channel Protection volume (CPv) or Water Quality volume (WQv) storm events for off-line, underground, or GSI-type practices. Off-line stormwater management systems are designed to manage storm events by diverting a percentage of stormwater from a storm drainage system. Underground systems and GSI-type practices were conceptually designed as offline practices that only accept runoff from the target storm event. Runoff volumes for all storm events were determined based on HydroCAD model results that rely on the Soil Conservation Service (SCS) TR-55 and TR-20 hydrologic methods.

Unit Costs and Site Adjustment Factors: Unit cost for each BMP and site adjustment factors were derived from research by the Charles River Watershed Association and Center for Watershed Protection, as well as from experience with actual construction[1] and modified for this project to reflect the newest cost estimates available. Underground filtration chamber systems were typically designed using Stormtech MC-4500™ chamber systems. Cost adjustment factors were used to account for site-specific differences typically related to project size, location, and complexity. The values used to estimate BMP costs are summarized in Table A3 below.

Table A3. BMP unit costs and adjustment factors modified to reflect newer information.

BMP Type	Base Cost ($/ft^3)
Porous Asphalt	$5.32
Infiltration Basin	$6.24
Underground Chamber (infiltration or detention)	$6.25
Detention Basin / Dry Pond	$6.80
Gravel Wetland	$8.78
Infiltration Trench	$12.49
Bioretention	$15.46
Sand Filter	$17.94
Porous Concrete	$18.07
Site Type	**Cost Multiplier**
Existing BMP retrofit or simple BMP	0.25
Large above-ground basin projects	0.5
New BMP in undeveloped area	1
New BMP in partially developed area	1.5
New BMP in developed area	2
Difficult installation in highly urban settings	3

Site-Specific Costs: Cost of significant utility or other work related to the construction of the BMP itself. Site-specific costs are variable based on past experience.

Base Construction Cost: Calculated as the product of the design control volume, the unit cost, and the site adjustment factor.

Permits and Engineering Costs: Used either 20% for large above-ground projects, or 35% for smaller or complex projects.

[1] Horsley Witten Group, Inc. 2014. Centennial Brook Watershed: Flow Restoration VTBMPDSS Modeling Analysis and BMP Supporting Information. Memorandum dated January 9th, 2014.

Total Project Cost: Calculated as the sum of the base construction cost, permitting and engineering costs, and land acquisition costs.

Cost per Impervious Acre: Calculated as the construction costs plus the permitting and engineering costs, divided by the impervious acres managed by the BMP.

Operation and Maintenance: The annual operation and maintenance (O&M) was calculated as 3% of the base construction costs, with a maximum of $10,000.

Minimum Cost Adjustment: After total project costs were determined for each proposed BMP based on the HW methodology, costs were reviewed and adjusted so that projects involving a simple BMP such as a small rain garden were assigned a minimum cost of $10,000 and more complex projects were assigned a minimum cost of $25,000.

2.4.2 Final Ranking Scoring

Each of the factors noted in Appendix A9 - Top 20 Site Final Ranking were scored, and scores were totaled for each of the criteria. Projects were assigned a rank from 1 to 20 with those projects receiving the highest scores assigned the highest rank. In the case of a tie between two projects, the TP removed (lbs) by the practice was used as a tiebreaker.

2.5 Final Modeling and Prioritization

A summary of the practices and their assigned rank are shown in Table A4. The comprehensive matrix used to rank the proposed BMP projects is provided in Appendix A9 - Top 20 Site Final Ranking. If future funding becomes available for further implementation, this prioritization matrix can be utilized in selecting additional projects for implementation.

Table A4. Top 20 potential BMP sites for Calais.

Rank	Site ID	Address	Proposed Practice Type
1	Calais Post Office	12 Batten Rd, Calais, VT	Underground Storage / Infiltration, Ditch / Swale Improvements
2	Moscow Woods Gully	101-121 Moscow Woods Rd, Calais, VT	Gully Stabilization, Infiltration Basin, Ditch / Swale Improvements
3	Marshfield Rd	Marshfield Rd, Calais, VT	Ditch / Swale Improvements, Check Dams, Gully Stabilization
4	Calais Town Garage	6011 VT-14, Calais, VT	Infiltration Basin, Check Dams, Salt Management
5	Calais Elementary School	321 Lightening Ridge Rd, Calais, VT	Bioretention, Sand Filter
6	Franks Farm	398 Lightening Ridge Rd, Calais, VT	Filter Strip / Buffer Enhancement, Cistern, Sand Filter, Cow Management
7	Calais Rt 14 Infiltration	4513 VT Route 14, Calais, VT	Dry Wells, Underground Storage / Infiltration
8	Route 14 Infiltration	4662 VT Route 14, Calais, VT	Underground Storage / Infiltration
9	Blachly Rd and Bliss Rd	3146-3156 E Hill Rd, Calais, VT	Check Dams, Ditch / Swale Improvements, Turnouts, Sediment Trap
10	Calais Town Clerk	3120 Pekin Brook Rd, Calais, VT	Bioretention, Ditch / Swale Improvements
11	Pekin Brook Rd and Kent Hill Buffer	3109 Pekin Brook Rd, Calais, VT	Filter Strip / Buffer Enhancement
12	Bliss Pond Rd	731-267 Bliss Pond Rd, Calais, VT	Filter Strip / Buffer Enhancement, Ditch / Swale Improvements, Bioretention
13	Adamant Rd and Haggett Rd	1313 Haggett Rd, Calais, VT	Filter Strip / Buffer Enhancement, Bioretention
14	N Calais Rd	2-24 N Calais Rd, Calais, VT	Ditch / Swale Improvements, Check Dams, Filter Strip / Buffer Enhancement
15	George Rd N	George Rd, Calais, VT	Ditch / Swale Improvements, Check Dams, Filter Strip / Buffer Enhancement
16	Maple Corner Store	31 W County Rd, Calais, VT	Stormwater Planter, Sand Filter, Bioretention, Filter Strip / Buffer Enhancement
17	Mirror Lake Access Point	150 Nelson Pond Rd, Calais, VT	Filter Strip / Buffer Enhancement, Bioretention
18	Memorial Hall	207 Gar Rd, Calais, VT	Filter Strip / Buffer Enhancement, Bioretention
19	Marshfield Rd & Church	4406–4498 VT Route 14, Calais, VT	Bioretention
20	Peck Hill Rd S	1206-1386 Peck Hill Rd, Calais, VT	Ditch / Swale Improvements, Regrade Road

2.6 Selection of Top 5 Potential BMPs

Selection of the Town's Top 5 sites considered the results from initial site investigations and preliminary modeling and ranking as well as input from municipal officials concerning project priorities. The location of the sites within the Town are shown in Figure A8. In the final ranking, these 5 sites were awarded additional points in the site scoring to reflect the Town's priorities and the high probability for implementation. The Top 5 sites are listed in Table A5 in order of rank.

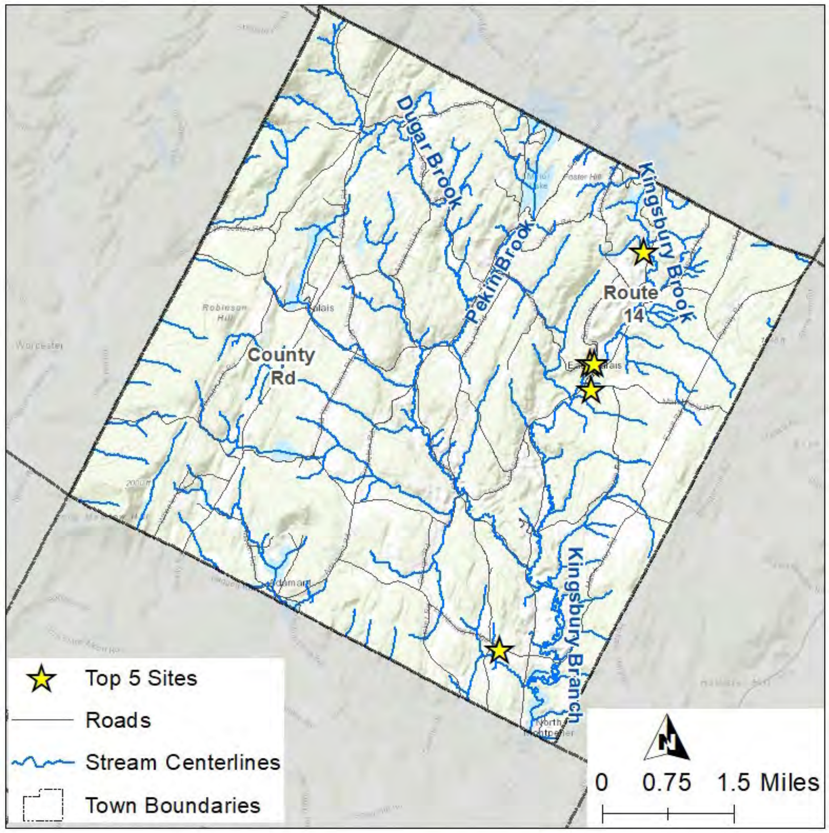

Figure A8. Top 5 sites for the Calais SWMP.

Table A5. Top 5 BMP sites for Calais.

Rank	Site ID	Address	Proposed Practice Type
1	Calais Post Office	12 Batten Rd, Calais, VT	Underground Storage / Infiltration, Ditch / Swale Improvements
2	Moscow Woods Gully	101-121 Moscow Woods Rd, Calais, VT	Gully Stabilization, Infiltration Basin, Ditch / Swale Improvements
3	Marshfield Rd	Marshfield Rd, Calais, VT	Ditch / Swale Improvements, Check Dams, Gully Stabilization
4	Calais Town Garage	6011 VT-14, Calais, VT	Infiltration Basin, Check Dams, Salt Management
5	Calais Elementary School	321 Lightening Ridge Rd, Calais, VT	Bioretention, Sand Filter

3 Priority BMPs

The selected Top 5 BMP implementation sites are briefly described below. These opportunities are located on Town owned and privately owned properties. A memo describing these sites and updated field data sheets are provided in Appendix A11.

Site: 1
Project Name: Calais Post Office
Description: The site includes the Post Office building and associated partially paved parking lot as well as the roadside ditch running south down the western side of Batten Rd. Stormwater is currently collected in a series of culverts that drain to the Kingsbury Branch. The concept for this site includes redirecting drainage from Batten Rd to an underground storage and infiltration chamber system located in the greenspace by the flagpole (see Figure A9). Soils are mapped as being very good at this site (Hydrologic Group A), so an analysis was conducted to evaluate the potential for an infiltration practice. Soils were found to be generally sandy.

Figure A9. The Calais Post Office with greenspace to the left of photo by flagpole.

Outreach: Owners of the Post Office parcel, the Calais Recreation Association, have expressed their willingness to proceed with further design. The United States Post Office has been contacted to inquire about willingness to proceed, but permission has not yet been granted.

Site: 2

Project Name: Moscow Woods Gully

Description: The site includes Moscow Woods Rd and Fellows Rd. Stormwater currently collects at the intersection and is drained by a cross culvert under Moscow Woods Rd to the large eroded gully across the street. The gully eventually drains to the Kingsbury Branch. The concept for this site includes constructing an infiltration basin in the existing greenspace at the intersection of Moscow Woods Rd and Fellows Rd and stabilizing the gully near where it enters Kingsbury Branch (see Figure A10). Soils are mapped as being very good at this site (Hydrologic Group A), so an analysis was conducted to evaluate the potential for an infiltration practice. Soils were found to be generally sandy.

Figure A10. Greenspace at intersection of Moscow Woods Rd and Fellows Rd where an infiltration basin would be located.

Outreach: The landowner where the gully stabilization is proposed, John Risse, has expressed his willingness to proceed with further design. Additional outreach should be carried out to ensure that all impacted property owners by the proposed Fellows Rd infiltration basin are amenable to the retrofit.

Site: 3

Project Name: Marshfield Road

Description: The site includes Marshfield Rd and the culvert that outlets west of the 111 Marshfield Rd driveway. Stormwater currently collects in roadside ditching along Marshfield Rd and is drained by a cross culvert under Marshfield Rd to a large eroded gully across the street. The gully eventually drains to the Kingsbury Branch by VT-14. The concept for this site includes improvements to the roadside ditching and stabilizing the gully below the culvert outlet (Figure A11). Soils are mapped as being very good at this site (Hydrologic Group A), so an analysis was conducted to evaluate the potential for an infiltration practice. Soils were found to be generally loamy with a high percentage of silt.

Outreach: Owners of the adjacent house have expressed their willingness to proceed with further design.

Figure A11. Gully erosion below the culvert outlet draining Marshfield Rd.

Site: 4
Project Name: Calais Town Garage
Description: The site includes the garage building, tank and salt sheds, equipment and materials storage areas, and a large sand pile. Stormwater currently sheet flows through this area to a tributary of the Kingsbury Branch. The concept for this site includes constructing an infiltration basin in the parking lot and improving the ditching below the salt shed to the tributary (Figure A12). Soils are mapped as being very good at this site (Hydrologic Group A), so an analysis was conducted to evaluate the potential for an infiltration practice. Soils were found to be generally sandy.
Outreach: This site is owned by the Town, and as such, no additional outreach was carried out.

Figure A12. An infiltration basin is proposed for the Calais Town Garage site.

Site: 5
Project Name: Calais Elementary School
Description: The site includes the school building and associated gravel driveway and parking lots. Stormwater currently sheet flows through this area with the northwestern portion draining towards the cow pasture and the eastern portion draining towards Lightening Ridge Rd. The concept for this site includes construction of a sand filter along the perimeter of the parking lot by the cow pasture, and a bioretention in the greenspace east of the eastern driveway (Figure A13). Soils are mapped as being poor and very poor at this site (Hydrologic Group C and D), so an analysis was not conducted to evaluate the potential for an infiltration practice.

Figure A13. A sand filter and bioretention are proposed for the Calais Elementary School.

Outreach: The School expressed their willingness to proceed with further design.

When implemented, these five BMPs would treat approximately 22.3 acres, 4 acres (18%) of which is impervious. Modeled pollutant reductions for each of the projects, shown below in Table A6, indicate that these BMPs will prevent nearly 460,000 lbs of total suspended solids and more than 125 lbs of total phosphorus from reaching receiving waters annually.

Table A6. Pollutant reductions and select ranking criteria for Top 5 projects.

Site ID	Volume Managed (ac-ft)	Volume Infiltrated (ac-ft)	Total Suspended Solids Removal (lbs)	Total Suspended Solids Removal (%)	Total Phosphorus Removal (lbs)	Total Phosphorus Removal (%)
Calais Post Office	0.09	0.09	1,190	99.6%	4.62	99.6%
Moscow Woods Gully	0.056	0.046	424,246	93.49% (Fellows Rd); 69.9% (Gully)	111.46	95.95% (Fellows Rd); 68.9% (Gully)
Marshfield Rd	0.016	0	32,928	65% (Road); 49.3% (Gully)	10.08	20% (Road); 44.3% (Gully)
Calais Town Garage	0.059	0.035	3,683	65% (Swale improvements); 98.64% (Sediment Trap); 23.2% (sand storage improvements)	1.94	20% (Swale improvements); 98.86% (Sediment Trap); 25.2% (sand storage improvements)
Calais Elementary School	0.019	0	506	88.67% (Sand Filter); 92.68% (Bioretention)	0.60	78.32% (Sand Filter); 83.25% (Bioretention)

Site surveys were completed for each of the Top 5 sites, and existing conditions plans were developed. These plans were used as the basis for the 30% proposed condition plans that were created for each site. See Appendix A12 - Existing Conditions Plans for these plans.

4 30% Designs

30% engineering designs were completed for each of the Top 5 sites. Site-specific concepts are discussed in the following sections. All 30% designs can be found in Appendix A13 - 30% Designs.

Soils conditions were assessed at 4 of the top 5 sites where infiltration-based practices are proposed. Pits were either excavated manually using a shovel and hand auger, or with Town-owned and operated equipment. Analysis at these sites included documentation of the depth to water table (if applicable), horizon breaks, soil structure, type, moisture, color, presence or absence of redoximorphic features, and size and quantity of roots and coarse fragments. Any other notes considered to be important were recorded during this time. The soil profiles with photos can be found in Appendix A14.

4.1 Calais Post Office

4.1.1 30% Concept Design Description

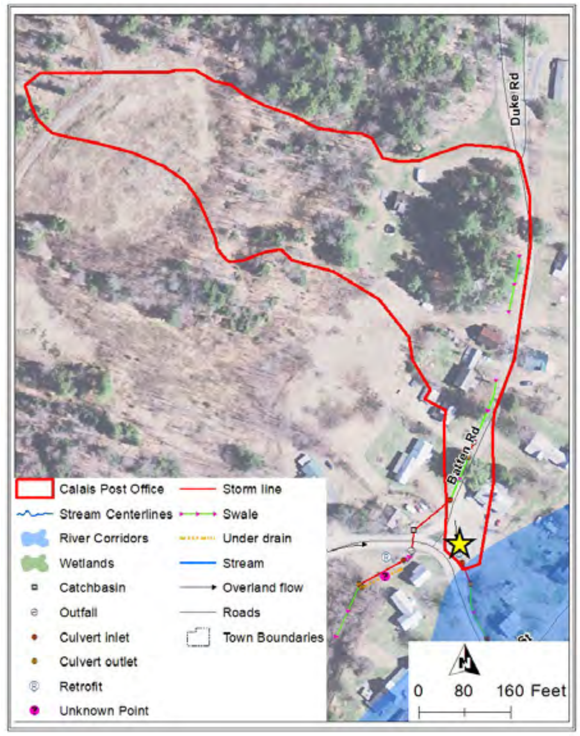

Figure A14. The proposed BMP drainage area is shown in red for the Calais Post Office. The recommended BMP location is shown with a star.

The Calais Post Office is located at the intersection of Batten Rd and Moscow Woods Rd northwest of VT-14. The site includes the Post Office building and associated partially paved parking lot, as well as the roadside ditch running south down the western side of Batten Rd. The Post Office site currently drains to a culvert located in the southern end of the greenspace separating the parking lot and Moscow Woods Rd. The culvert drains to the ditch along Moscow Woods Rd and eventually discharges to the Kingsbury Branch, towards the intersection with VT-14, without treatment. The ditch along Batten Rd directs drainage to a culvert which passes under Moscow Woods Rd and outlets to the greenspace west of the white house across from the Post Office. Drainage then enters another culvert which outlets to an eroding gully and eventually flows to the Kingsbury Branch. Erosion was observed below the culvert outlet in the gully. This area was noted by the Town as being a stormwater problem area.

The proposed retrofit for this site is to implement a subsurface infiltration chamber system under the greenspace between the Post Office's parking lot and Moscow Woods Rd (see starred location in Figure A14). The 5.5-acre drainage area for the proposed BMP is shown with a thick red line in the map above (Figure A14). It is recommended that an educational sign is installed in conjunction with this system to educate Post Office patrons and the general public. A new pipe connection is proposed to direct drainage from the ditch along Batten Rd to the system. The system will overflow to the existing ditch along Moscow Woods Rd. There is potential to regrade the parking lot to better direct runoff to system. Construction should be planned so that one entrance to the Post Office parking lot remains open at all times during business hours. See the photos and associated descriptions in Figure A15. The Calais Recreation Association, who own the property where the Post Office is located, have expressed their preliminary willingness to proceed with further design. Additional coordination with the Calais Recreation Association and a formal agreement will need to be obtained during the Final Design phase. Permission has been requested from the United States Post Office and is currently pending.

Stormwater from the Post Office runs over the pavement into a culvert, down a ditch along Moscow Woods Rd and into the Kingsbury Branch.

Drainage from Batten Rd flows down a ditch along the west side of the road and is discharged to an eroding gully across from the intersection of Batten Rd and Moscow Woods Rd.

Proposed location for a subsurface chamber system. A new pipe connection will direct drainage from the ditch along Batten Rd to the system.

The chamber system will outlet to the existing ditch along Moscow Woods Rd.

Figure A15. The Calais Post Office retrofit is described in the above photos.

Soils are mapped as being very good at this site (Hydrologic Group A), so an analysis was conducted to evaluate the potential for an infiltration practice. Soils were assessed using a hand auger (Figure A16) and were found to be generally sandy and appropriate for infiltration (Figure A17). The soil profile with photos can be found in Appendix A14.

Figure A16. Soils were assessed in the greenspace adjacent to the Post Office where the proposed infiltration practice would be located.

Figure A17. Soils at the Calais Post Office were generally sandy.

Once the practice has been installed, the lawn area can be reseeded. There should not be any notable impact either aesthetically or functionally for the area once the new grass has been established. Construction can be completed in such a way that at least one entrance to the Post Office remains open at all times.

A rendering of the proposed stormwater improvements was created to bring a concept to life in ways that engineering plans cannot. This rendering is one possible configuration for this site. This graphically engaging rendering visually communicates the plans and can be used by the Town and the CVRPC to help advance designs toward implementation. This rendering can be found in Appendix A16 - Site Renderings.

The design standard used for this retrofit was full infiltration of the Channel Protection volume (CPv, or 2.02 inches of rain in a 24-hour period), equal to 3,920 ft^3 of runoff.

An updated BMP summary sheet is included in Appendix A11 - Top 5 Sites. A 30% design plan is provided in Appendix A13 - 30% Designs.

4.1.2 Pollutant Removal and Other Water Quality Benefits

This practice has the potential to prevent 1,190 lbs of total suspended solids (TSS) and 4.62 lbs of total phosphorus (TP) from entering receiving waters (Table A7). This project will provide a significant benefit to water quality. Additionally, the stormwater from this drainage area currently flows to an eroding gully. This project will help to reduce the volume of erosive stormwater that enters the gully.

Table A7. Calais Post Office benefit summary table.

TSS Removed	1,190 lbs
TP Removed	4.62 lbs
Impervious Treated	0.6 acres
Total Drainage Area	5.5 acres

4.1.3 Cost Estimates

The total estimated cost for this project is $34,000. These preliminary costs can be found in Table A8. This amount differs from the amount initially projected for this site as design-specific amounts and costs were used. Note that it is recommended that an educational sign be installed at this site. This cost is not reflected in the estimated project cost itemized below. It is recommended that approximately $500 should be budgeted for this sign.

- The cost per pound of phosphorus treated is $7,359.
- The cost per impervious acre treated is $56,667.
- The cost per cubic foot of runoff treated is $8.67.

Table A8. Calais Post Office project initial construction cost projection.

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
Site Preparation					
N/A	MOBILIZATION	LS	1	$ 500.00	$ 500.00
653.55	PROJECT DEMARCATION FENCE	LF	300	$ 1.17	$ 351.00
649.51	GEOTEXTILE FOR SILT FENCE	SY	70	$ 4.13	$ 289.10
N/A	CONSTRUCTION STAKING	HR	5	$ 125.00	$ 625.00
				Subtotal:	$ 1,765.10
Chambers - Excavation and Materials					
	EXCAVATION				
203.15	COMMON EXCAVATION	CY	150	$ 9.86	$ 1,479.00
	CHAMBERS - COST FOR CHAMBERS / STONE / FABRIC / PIPING				
N/A	MC3500	EACH	8	$ 400.20	$ 3,201.60
N/A	MC3500 PLAIN END CAP	EACH	2	$ 300.15	$ 600.30
N/A	MC3500 24B END CAP	EACH	2	$ 404.23	$ 808.45
N/A	12" 90 BEND	EACH	2	$ 57.10	$ 114.20
N/A	12" COUPLER	EACH	4	$ 8.29	$ 33.17
N/A	12" N12 AASHTO FOR MANIFOLD	LF	20	$ 7.75	$ 155.02
N/A	24" N12 AASHTO FOR ISOLATOR ROW	LF	20	$ 22.54	$ 450.80
N/A	315WTM FOR SCOUR PROTECTION	SY	500	$ 0.74	$ 370.00
N/A	601TG TO WRAP SYSTEM	SY	2000	$ 0.82	$ 1,633.00
	CONVEYANCE STRUCTURES & PIPING				
203.15	COMMON EXCAVATION	CY	15	$ 9.86	$ 147.90
601.0915	18" CPEP	LF	45	$ 64.04	$ 2,881.80
604.18	PRECAST REINFORCED CONCRETE DROP INLET WITH CAST IRON GRATE	EACH	2	$ 4,009.29	$ 8,018.58
	PAVEMENT REPLACEMENT (ABOVE CHAMBERS IN PAVED AREAS)				
401.10	AGGREGATE SURFACE COURSE	CY	24	$ 43.60	$ 1,046.40
				Subtotal:	$ 20,940.21
Subtotal:					$ 22,705.31
	Construction Oversight**	HR	6	$ 125.00	$ 750.00
	Construction Contingency - 10%**				$ 2,270.53
	Incidentals to Construction - 5%**				$ 1,135.27
	Minor Additional Design Items - 5%**				$ 1,135.27
	Final Design	HR	45	$ 125.00	$ 5,625.00
				Total (Rounded to nearest $1,000)	**$ 34,000.00**

4.1.4 Next Steps

As this site is owned by the Calais Recreation Association, it is recommended that the Town proceed with further design of this retrofit after obtaining a formal memorandum of understanding with the landowner and formal approval from the United States Post Office. Currently, permission has been requested from the United States Post Office, but permission has not yet been granted. Further design will involve refinement of the retrofit design with respect to size, outlet design, and routing to ensure that the target volume can be completely managed and that larger storms bypass the system safely.

4.1.5 Permit Needs

A project readiness screening worksheet has been completed for this project and is included in Appendix A15 - Permit Review Sheets. In summary:

Stormwater Permit
It is not anticipated that this site will need a stormwater permit at this time.

The site should qualify for an Erosion Prevention and Sediment Control permit (3-9020) under the Low Risk categorization if the following guidelines are followed:

- Less than 2 acres of disturbance at any one time.
- All soils must be stabilized (temporary or final) within 7 days.
- Runoff from the site must pass through a 50’ vegetated buffer prior to entering any Water of the State.

Local Permitting
No local permits are anticipated.

Other Permits
This project should be reviewed by a River Scientist prior to final design due to the project's close proximity to the river corridor. However, it should be noted that this project will not result in any net fill within the river corridor. No Act 250 permitting or wetlands concerns are anticipated for this project.

4.2 Moscow Woods Gully

4.2.1 30% Concept Design Description

This site is located at the intersection of Moscow Woods Rd and Fellows Rd and includes drainage from both roads. Stormwater currently collects at the intersection and is drained by a cross culvert under Moscow Woods Rd to a large eroded gully across the street. Erosion was observed under the culvert outlet and the gully eventually drains to the Kingsbury Branch. This site was noted by the Town as a stormwater problem area.

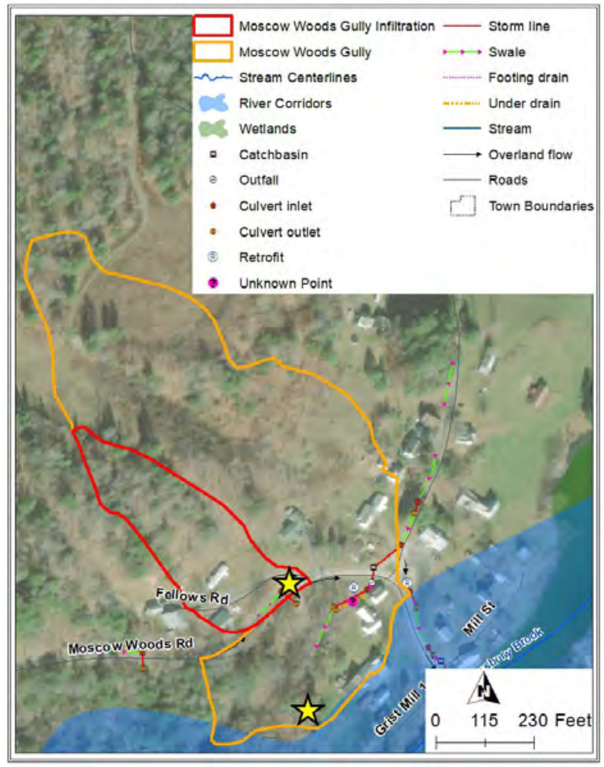

Figure A18. The drainage area for the proposed BMP is shown in red. The recommended locations for the BMPs are shown with stars.

The main concept for this site includes two practices. The first is to construct an infiltration basin west of the intersection of Fellows Rd and Moscow Woods Rd and add a dry well in the bottom of the basin (see starred location within the red drainage area on the map in Figure A18). The dry well will both provide additional storage and allow drainage to infiltrate when the ground surface is frozen and infiltration is not possible in the basin. As part of this proposed design, Moscow Woods Rd would be regraded to elevate the south side to better direct runoff to basin. The ditching along the north side of Moscow Woods Rd should be formalized and stabilized with stone. The eroding ditch along south side of Fellows Rd should also be stabilized and lined with stone. This ditch will also be directed to the basin. The second part of this design includes stabilizing gully erosion below the culvert outlets. (see starred location within the orange drainage area on the map in Figure A18). The infiltration practice would also reduce the volume of stormwater that is directed to this eroding gully. See the photos and associated descriptions in Figure A19. The landowner where the gully stabilization is proposed, John Risse, has expressed his willingness to proceed with further design. Additional outreach should be carried out to ensure that all impacted property owners by the proposed Fellows Rd infiltration basin are amenable to the retrofit.

Proposed location for an infiltration basin. Stormwater collects in this area and is piped across the street to an eroding gully.

Drainage from Moscow Woods Rd is causing erosion in the same gully that receives drainage from Batten Rd by the Post Office (pictured).

Drainage flowing through the eroding gully eventually drains to the Kingsbury Branch.

Figure A19. The proposed retrofits are described in the above photos

Figure A21. An excavator was used to assess soil conditions and infiltration potential.

Soils are mapped as being very good at this site (Hydrologic Group A), so an analysis was conducted to evaluate the potential for an infiltration practice. Soils were assessed using an excavator (Figure A21) and were found to be generally sandy (Figure A20). Soils conditions observed during analysis were appropriate for an infiltration-based practice. The soil profile with photos can be found in Appendix A14.

Figure A20. Soils were generally sandy.

A rendering of the proposed stormwater improvements was created to bring a concept to life in ways that engineering plans cannot. This rendering is one possible configuration for this site. This graphically engaging rendering visually communicates the plans and can be used by the Town and the CVRPC to help advance designs toward implementation. This rendering can be found in Appendix A16 - Site Renderings.

The design standard used for the infiltration basin retrofit was infiltration of the Channel Protection volume (CPv, or 2.02 inches of rain in a 24-hour period), equal to 2,004 ft^3 of runoff.

An updated BMP summary sheet is included in Appendix A11 - Top 5 Sites. A 30% design plan is provided in Appendix A13 - 30% Designs.

4.2.2 Pollutant Removal and Other Water Quality Benefits

A retrofit of this site has the potential to prevent more than 424,000 lbs of total suspended solids (TSS) and 111 lbs of total phosphorus (TP) from entering receiving waters (Table A9).

Table A9. Moscow Woods Gully benefit summary table.

TSS Removed	424,246 lbs
TP Removed	111.5 lbs
Impervious Treated	1.2 acres
Total Drainage Area	12.9 acres

4.2.3 Cost Estimates

The total estimated cost for this project is $33,000. Note that these costs are very preliminary. Cost projections can be found in Table A10. This amount differs from the amount initially projected for this site as design-specific amounts and costs were used.

- The cost per pound of phosphorus treated is $296.
- The cost per impervious acre treated is $27,500.
- The cost per cubic foot of runoff treated is $16.47.

Table A10. Moscow Woods Gully project initial construction cost projection.

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
	Site Preparation				
N/A	MOBILIZATION	LS	1	$ 500.00	$ 500.00
201.30	THINNING AND TRIMMING	ACRE	0.06	$ 11,670.04	$ 700.20
653.55	PROJECT DEMARCATION FENCE	LF	483	$ 1.17	
649.51	GEOTEXTILE FOR SILT FENCE	SY	30	$ 4.13	$ 123.90
N/A	CONSTRUCTION STAKING	HR	4	$ 125.00	$ 500.00
				Subtotal:	$ 1,824.10
	Infiltration Basin & Ditching				
	EXCAVATION				
203.15	COMMON EXCAVATION (Basin)	CY	100	$ 9.86	$ 986.00
204.15	COMMON EXCAVATION (Ditching)	CY	65	$ 9.86	$ 640.90
	MATERIALS				
613.10	STONE FILL, TYPE I (Lining Basin)	CY	55	$ 43.91	$ 2,415.05
613.11	STONE FILL, TYPE II (Lining Ditches)	CY	35	$ 42.49	$ 1,487.15
	DRY WELL				
N/A	DRY WELL STRUCTURE	EACH	1	$ 2,300.00	$ 2,300.00
629.54	CRUSHED STONE BEDDING (SMALLER BACKFILL AROUND DRY WELL)	TON	4.5	$ 34.04	$ 153.18
613.10	STONE FILL, TYPE I (BACKFILL AROUND STRUCTURE)	CY	4	$ 43.91	$ 175.64
				Subtotal:	$ 8,157.92
	Gully Stabilization				
	EXCAVATION				
613.11	STONE FILL, TYPE II (Lower Gulley)	CY	185	$ 42.49	$ 7,860.65
614.11	STONE FILL, TYPE II (Outfall Splash Pad)	CY	7.5	$ 42.49	$ 318.68
				Subtotal:	$ 8,179.33
	Road Re-Shaping				
	RE-SHAPING				
401.10	AGGREGATE SURFACE COURSE	CY	60	$ 43.60	$ 2,616.00
				Subtotal:	$ 2,616.00
				Subtotal:	$ 20,777.35
	Construction Oversight**	HR	12	$ 125.00	$ 1,500.00
	Construction Contingency - 10%**				$ 2,077.73
	Incidentals to Construction - 5%**				$ 1,038.87
	Minor Additional Design Items - 5%**				$ 1,038.87
	Final Design	HR	50	$ 125.00	$ 6,250.00
				Total (Rounded to nearest $1,000)	**$ 33,000.00**

4.2.4 Next Steps

The site where the gully restoration is proposed is owned by John Risse, a willing landowner, so it is recommended that the Town proceed with further design of this retrofit after obtaining a formal memorandum of understanding with the landowner. The site where the infiltration basin is proposed is owned by the Town of Calais and private landowners. It is recommended that further outreach is completed for these landowners and a memorandum of understanding be completed with these landowners. Further design will involve refinement of the retrofit design with respect to size, outlet design, and routing to ensure that the target volume can be completely managed and that larger storms bypass the system safely.

4.2.5 Permit Needs

A project readiness screening worksheet has been completed for this project and is included in Appendix A15 - Permit Review Sheets. In summary:

Stormwater Permit
It is not anticipated that this site will need a stormwater permit at this time.

The site should qualify for an Erosion Prevention and Sediment Control permit (3-9020) under the Low Risk categorization if the following guidelines are followed:

- Less than 2 acres of disturbance at any one time.
- All soils must be stabilized (temporary or final) within 7 days.
- Runoff from the site must pass through a 50’ vegetated buffer prior to entering any Water of the State.

Local Permitting
No local permits are anticipated.

Other Permits
This project should be reviewed by the River Scientist prior to final design due to the close proximity to the river corridor. No Act 250 or Wetlands permitting is anticipated for this project.

4.3 Marshfield Road

4.3.1 30% Concept Design Description

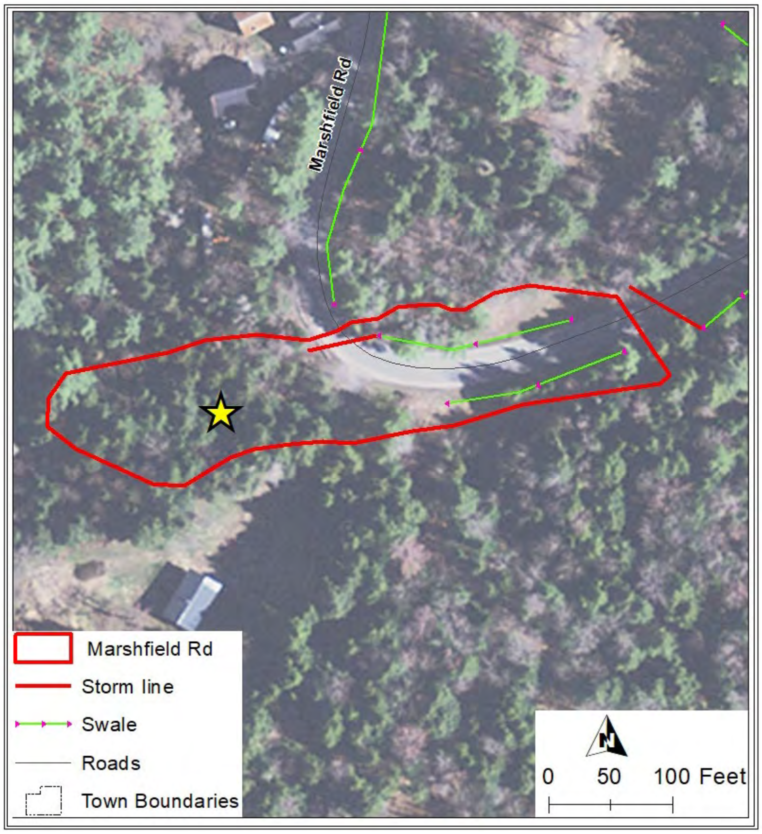

Figure A22. The Marshfield Rd drainage area is shown outlined in red. The recommended location for the proposed gully stabilization is shown with a star.

Marshfield Rd is a steep, winding, paved road that heads down into the village by the general store. Runoff from Marshfield Rd is collected in roadside ditching, some of which has caused an eroded gully to form below the culvert outlet west of the 111 Marshfield Rd driveway. Drainage flows through the gully down to a cross culvert under VT-14, and directly into the Kingsbury Branch without treatment. This area was noted by the Town as a stormwater problem area.

The proposed retrofit includes improving ditching with check dams above culvert inlet. Stabilize gully below culvert outlet including a series of step pools (see starred location in Figure A22). See the photos and associated descriptions in Figure A23. Owners of the adjacent house have expressed their willingness to proceed with further design.

Marshfield Rd is steep and winding. Stormwater is collected in roadside ditching.

A roadside ditch, right of the white line, conveys drainage to a cross culvert which outlets west of the 111 Marshfield Rd driveway.

Culvert outlet located west of driveway. Stormwater is causing gully erosion at the culvert outlet.

Proposed location of gully stabilization.

Figure A23. The proposed retrofits are described in the above photos

Figure A25. A hand auger and shovel were used to assess soil conditions and infiltration potential.

Soils are mapped as being very good at this site (Hydrologic Group A), so an analysis was conducted to evaluate the potential for an infiltration practice. Soils were assessed using a shovel and hand auger (Figure A25) and were found to be generally loamy with a high percentage of silt (Figure A24). Soils conditions observed during analysis prompted a need to alter the proposed retrofit design and resulted in the removal of proposed dry wells due to the presence of ledge and high groundwater. See Appendix A14 for this site's complete soil log.

Figure A24. Soils were generally loamy.

A rendering of the proposed stormwater improvements was created to bring a concept to life in ways that engineering plans cannot. This rendering is one possible configuration for this site. This graphically engaging rendering visually communicates the plans and can be used by the Town and the CVRPC to help advance designs toward implementation. This rendering can be found in Appendix A16 - Site Renderings.

The drainage area for this proposed BMP is 1 acre, approximately 17% of which is classified as impervious. This practice will provide a significant water quality benefit (see Table A11). The design standard used for this retrofit was management of the Water Quality volume (WQv, or 1 inch of rain in a 24-hour period), equal to 697 ft^3 of runoff.

An updated BMP summary sheet is included in Appendix A11 - Top 5 Sites. A 30% design plan is provided in Appendix A13 - 30% Designs.

4.3.2 Pollutant Removal and Other Water Quality Benefits

A retrofit of this site has the potential to prevent nearly 33,000 lbs of total suspended solids (TSS) and 10.1 lbs of total phosphorus (TP) from entering receiving waters annually (Table A11).

Table A11. Marshfield Rd benefit summary table.

TSS Removed	32,928 lbs
TP Removed	10.1 lbs
Impervious Treated	0.2 acres
Total Drainage Area	1.0 acres

4.3.3 Cost Estimates

The estimated cost for implementation of this project is $7,000. Note that these costs are very preliminary. Cost projections can be found in Table A12. This amount differs from the amount initially projected for this site as design-specific amounts and costs were used.

- The cost per pound of phosphorus treated is $693.
- The cost per impervious acre treated is $35,000.
- The cost per cubic foot of runoff treated is $10.04.

Table A12. Marshfield Rd initial construction cost projection.

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
Site Preparation					
N/A	MOBILIZATION	LS	1	$ 500.00	$ 500.00
				Subtotal:	$ 500.00
Ditching / Outfall Stablization					
DICH RE-SHAPING					
203.25	CHANNEL EXCAVATION OF EARTH (DITCH RE-SHAPING)	CY	90	$ 13.59	$ 1,223.10
613.11	STONE FILL, TYPE II	CY	2	$ 42.49	$ 84.98
653.25	STONE CHECK DAM, TYPE I	CY	7	$ 44.10	$ 308.70
653.20	TEMPORARY EROSION MATTING	SY	50	$ 2.20	$ 110.00
				Subtotal:	$ 1,726.78
				Subtotal:	$ 2,226.78
	Construction Oversight**	HR	4	$ 125.00	$ 500.00
	Construction Contingency - 10%**				$ 222.68
	Final Design	HR	30	$ 125.00	$ 3,750.00
Total (Rounded to nearest $1,000)					**$ 7,000.00**

4.3.4 Next Steps

As this site is owned by private landowners (Mark and Tegan Brown) and the Town of Calais, it is recommended that the Town proceed with further design of this retrofit after obtaining a formal memorandum of understanding with the landowner. Further design will involve refinement of the retrofit design with respect to size, outlet design, and routing to ensure that the target volume can be completely managed and that larger storms bypass the system safely.

4.3.5 Permit Needs

A project readiness screening worksheet has been completed for this project and is included in Appendix A15 - Permit Review Sheets. In summary:

Stormwater Permit
It is not anticipated that this site will need a stormwater permit at this time.

The site should qualify for an Erosion Prevention and Sediment Control permit (3-9020) under the Low Risk categorization if the following guidelines are followed:

- Less than 2 acres of disturbance at any one time.
- All soils must be stabilized (temporary or final) within 7 days.
- Runoff from the site must pass through a 50' vegetated buffer prior to entering any Water of the State.

Local Permitting
No local permits are anticipated.

Other Permits
No Act 250, Wetlands, or River Corridor permitting is anticipated for this project.

4.4 Calais Town Garage

4.4.1 30% Concept Design Description

The Calais Town Garage is located off of VT-14 between Balentine Rd and Lamberton Camp Rd. This site includes the garage building, tank shed, salt shed, equipment and materials storage, and a large sand pile. Tributaries run south and east of the site and eventually pass through a cross culvert under VT-14 and into a tributary of the Kingsbury Branch without treatment. Stormwater from the garage building collects in a low point in the gravel parking lot and over the bank to a tributary. Stormwater from the area around the salt shed drains along the eastern edge of the driveway to a tributary. Erosion was observed where runoff flows from the driveway into the stream. Salt residue was also observed around the front of the salt shed.

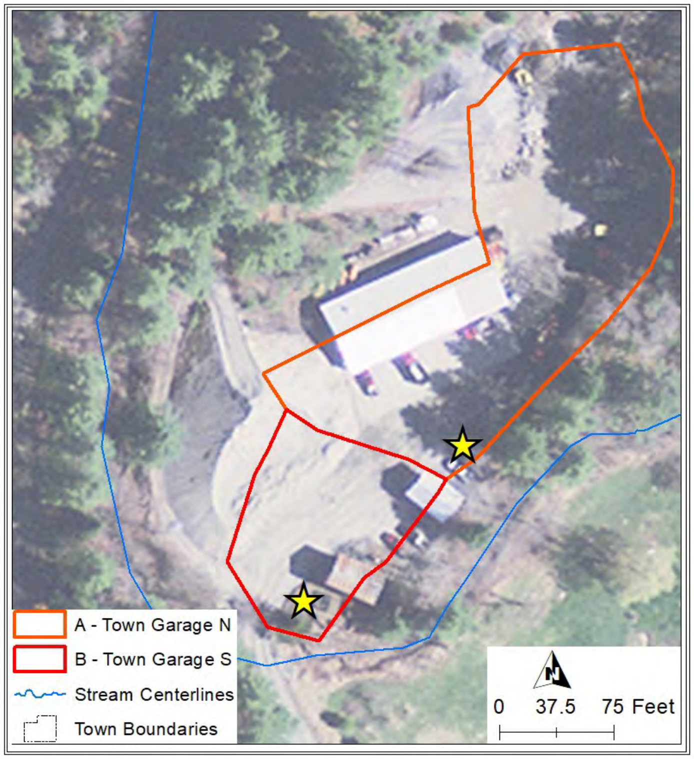

Figure A26. Drainage areas for the Calais Town Garage site are shown outlined in orange (infiltration basin) and red (ditch improvements and potential dry well). The recommended location for each BMP is shown with a star.

The concept for this site includes moving pipes (currently stored in this location) and formalizing the existing depressed area as an infiltration basin in the parking lot, burying a perforated pipe along the bottom of the basin and creating a stone lip along the easternmost edge of the basin for overflow (see starred location on the right in Figure A26). Regrading the parking lot to better direct drainage to the basin as necessary is also recommended as well as regrading and resurfacing the driveway with Staymat. A swale should be formalized along the eastern edge of the driveway below the salt shed, lining it with stone, and adding check dams. Additionally, a paved apron is recommended for the salt shed in order to facilitate cleanup of salt spills. There is existing erosion where runoff currently enters the stream (see starred location on the left in Figure A28) that should be stabilized. It is also recommended that a retaining wall along the stream west of the sand pile be added to prevent sand spillage and sediment transport. See the photos and associated descriptions in Figure A27.

Stormwater from the Calais Town Garage is directed to a low point in the gravel parking lot and flows over the bank to a tributary of the Kingsbury Branch.

An infiltration basin is proposed for the location of the existing low point (pictured between pipe storage and white vehicle).

Proposed location of ditch formalization and improvement. Stormwater from the salt shed (pictured left) flows along the right side of the driveway and into a tributary of the Kingsbury Branch.

Location where runoff is eroding the edge of the driveway as it flows to the tributary.

Figure A27. The proposed retrofits are described in the above photos.

Figure A28. An excavator was used to assess soil conditions and infiltration potential.

Soils are unmapped at this site, but surrounding soils are mapped as being very good (Hydrologic Group A), so an analysis was conducted to evaluate the potential for an infiltration practice. Soils were assessed using an excavator (Figure A28) and were found to be generally sandy (Figure A29). Soils conditions observed during analysis did not prompt a need to alter the proposed retrofit design. Note that the buried garbage will need to be removed from this location or the basin will need to be lined. See Appendix A14 for this site's complete soil log.

Figure A29. Soils were generally sandy.

A rendering of the proposed stormwater improvements was created to bring a concept to life in ways that engineering plans cannot. This rendering is one possible configuration for this site. This graphically engaging rendering visually communicates the plans and can be used by the Town and the CVRPC to help advance designs toward implementation. This rendering can be found in Appendix A16 - Site Renderings.

This practice will provide a significant water quality benefit (Table A13). The design standard used for this infiltration retrofit was infiltration of the CPv (or 2.02 inches of rain in a 24-hour period), equal to 2,570 ft^3 of runoff.

An updated BMP summary sheet is included in Appendix A11 - Top 5 Sites. A 30% design plan is provided in Appendix A13 - 30% Designs.

4.4.2 Pollutant Removal and Other Water Quality Benefits

A retrofit of this site has the potential to prevent more than 3,500 lbs of total suspended solids (TSS) and nearly 2 lbs of total phosphorus (TP) from entering receiving waters annually (Table A13).

Table A13. Calais Town Garage benefit summary table.

TSS Removed	3,683 lbs
TP Removed	1.94 lbs
Impervious Treated	1 acre
Total Drainage Area	1.1 acres

4.4.3 Cost Estimates

The estimated cost for implementation of this project is $34,000. Note that these costs are very preliminary. Cost projections can be found in Table A14. This amount differs from the amount initially projected for this site as design-specific amounts and costs were used.

- The cost per pound of phosphorus treated is $17,526.
- The cost per impervious acre treated is $34,000.
- The cost per cubic foot of runoff treated is $13.23.

Table A14. Calais Town Garage project initial construction cost projection.

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
	Site Preparation				
N/A	MOBILIZATION	LS	1	$ 500.00	$ 500.00
653.55	PROJECT DEMARCATION FENCE	LF	375	$ 1.17	*$ 438.75*
649.51	GEOTEXTILE FOR SILT FENCE	SY	32	$ 4.13	$ 132.16
N/A	CONSTRUCTION STAKING	HR	4	$ 125.00	$ 500.00
				Subtotal:	$ 1,570.91
	Infiltration Basin / Ditch Rehabilitation				
	EXCAVATION				
203.15	COMMON EXCAVATION	CY	175	$ 9.86	$ 1,725.50
613.10	STONE FILL, TYPE I (Swale Lining)	CY	16	$ 43.91	$ 702.56
613.11	STONE FILL, TYPE II (Basin Outlet)	CY	19	$ 42.49	$ 807.31
601.0905	12" CPEP	LF	20	$ 39.24	$ 784.80
605.11	*8 INCH UNDERDRAIN PIPE*	*LF*	*40*	*$ 27.04*	*$ 1,081.60*
649.41	*GEOTEXTILE FOR UNDERDRAIN TRENCH LINING*	*SY*	*5*	*$ 4.04*	*$ 20.20*
604.18	PRECAST REINFORCED CONCRETE DROP INLET WITH CAST IRON GRATE	EACH	1	$ 4,009.29	$ 4,009.29
N/A	*18" BEEHIVE GRATE*	*EACH*	*1*	*$ 615.00*	*$ 615.00*
653.25	*STONE CHECK DAM, TYPE I*	*CY*	*2*	*$ 44.10*	*$ 88.20*
651.15	SEED	LB	2	$ 7.66	$ 15.32
653.20	TEMPORARY EROSION MATTING	SY	40	$ 2.20	$ 88.00
				Subtotal:	$ 9,937.78
	Driveway Resurface				
401.10	AGGREGATE SURFACE COURSE	CY	125	$ 43.60	$ 5,450.00
				Subtotal:	$ 5,450.00
	Sand Pile Retaining Wall				
621.45	CONCRETE MEDIAN BARRIER	LF	80	$110.00	$ 8,800.00
				Subtotal:	$ 8,800.00
				Subtotal:	$ 25,758.69
	Construction Oversight**	HR	4	$ 125.00	$ 500.00
	Construction Contingency - 10%**				$ 2,575.87
	Final Design	HR	40	$ 125.00	$ 5,000.00
				Total (Rounded to nearest $1,000)	**$ 34,000.00**

4.4.4 Next Steps

As this site is owned and operated by the Town of Calais, it is recommended that the Town proceed with further design of this retrofit. Further design will involve refinement of the retrofit design with respect to size, outlet design, and routing to ensure that CPv can be completely infiltrated and that larger storms bypass the system safely.

4.4.5 Permit Needs

A project readiness screening worksheet has been completed for this project and is included in Appendix A15 - Permit Review Sheets. In summary:

Stormwater Permit
It is not anticipated that this site will need a stormwater permit at this time.

The site should qualify for an Erosion Prevention and Sediment Control permit (3-9020) under the Low Risk categorization if the following guidelines are followed:

- Less than 2 acres of disturbance at any one time.
- All soils must be stabilized (temporary or final) within 7 days.
- Runoff from the site must pass through a 50' vegetated buffer prior to entering any Water of the State.

Local Permitting
No local permits are anticipated.

Other Permits
This project should be reviewed by a River Scientist prior to final design due to the project's close proximity to the river corridor and surface waters. However, it should be noted that this project will not result in any net fill within the river corridor. No Act 250 permitting or wetlands concerns are anticipated for this project.

4.5 Calais Elementary School

4.5.1 30% Concept Design Description

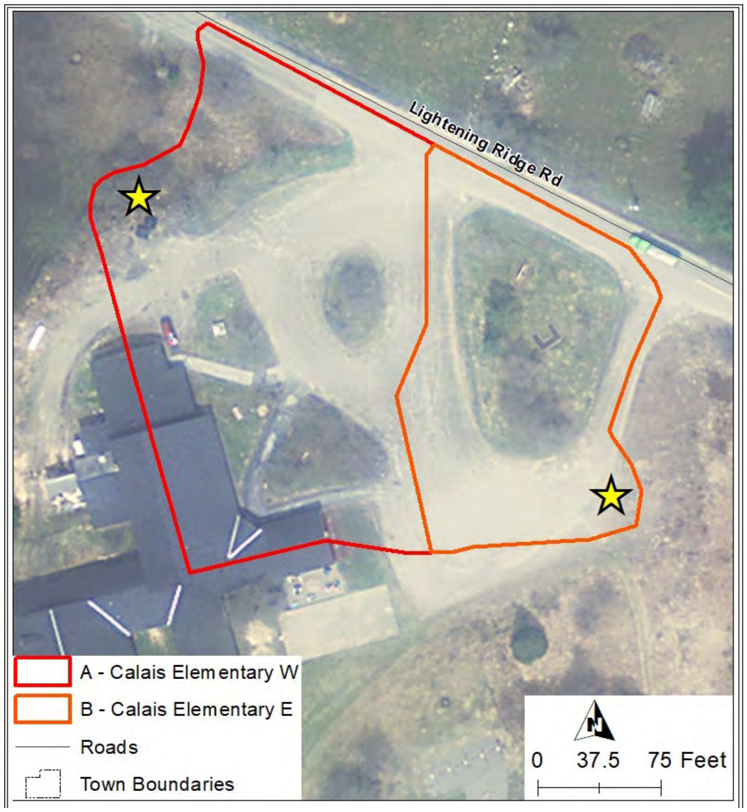

Figure A30. It is proposed that runoff from the western half of the school property, shown in red, is directed to a sand filter, and the eastern half, shown in orange, is directed to a bioretention.

The Calais Elementary School is located at 321 Lightening Ridge Rd. The site is bordered by a cow pasture to the northwest, and a wetland to the south. This area includes the school building and associated gravel driveway and parking lots. Stormwater currently sheet flows through this area. The northwestern portion drains to a ditch located between the parking lot and the cow pasture. This drainage flows through the ditch and eventually to the wetland south of the school. The eastern half of the site drains to the low area located in the greenspace near the eastern intersection of the driveway and Lightening Ridge Rd. This drainage flows down along the road. The school was noted by the Town as being a good potential candidate to be included in the plan as a high priority site.

The proposed stormwater improvements for this site include removing an existing grader berm and constructing a sand filter along the perimeter of the parking lot parallel to the ditch by the cow pasture (see starred location in Figure A30). Regrade the driveway and parking lot to better direct drainage to the sand filter. Construct a bioretention with educational components in the greenspace east of the eastern driveway. Regrade the surrounding parking lot and driveway to better direct drainage to the feature. Install an educational sign in conjunction with the bioretention for students and the general public. See the photos and associated descriptions in Figure A31. The School has expressed their willingness to proceed with further design.

Stormwater from the western half of the Calais Elementary School site flows over the gravel parking lot to a ditch running parallel to the cow pasture. The ditch eventually drains to a wetland south of the school.

Greenspace along perimeter of parking lot is the proposed location of a sand filter.

Stormwater from the eastern half of the school site flows east to the low point by Lightening Ridge Rd. This low point is the proposed location of a bioretention including educational components for the students.

Figure A31. The proposed retrofits are described in the above photos.

Soils are mapped as being poor and very poor at this site (Hydrologic Group C/D), so an analysis was not conducted to evaluate the potential for an infiltration practice.

A rendering of the proposed stormwater improvements was created to bring a concept to life in ways that engineering plans cannot. This rendering is one possible configuration for this site. This graphically engaging rendering visually communicates the plans and can be used by the Town and the CVRPC to help advance designs toward implementation. This rendering can be found in Appendix A16 - Site Renderings.

This practice will provide a significant water quality benefit (Table A15) but is also a high visibility site within the Town. This practice could spur additional retrofits and awareness of stormwater issues in the area. It is recommended that an educational sign be installed in conjunction with the retrofit.

The design standard used for this retrofit was filtration and slow release of the Water Quality volume (WQv, or 1 inch of rain in a 24-hour period), equal to 823 ft^3 of runoff.

An updated BMP summary sheet is included in Appendix A11 - Top 5 Sites. A 30% design plan is provided in Appendix A13 - 30% Designs.

4.5.2 Pollutant Removal and Other Water Quality Benefits

A retrofit of this site has the potential to prevent 506 lbs of total suspended solids (TSS) and 0.6 lbs of total phosphorus (TP) from entering receiving waters annually (Table A15).

Table A15. Calais Elementary School benefit summary table.

TSS Removed	506 lbs
TP Removed	0.6 lbs
Impervious Treated	1 acre
Total Drainage Area	1.8 acres

4.5.3 Cost Estimates

The total estimated cost for this project is $18,000. Note that these costs are very preliminary. Cost projections can be found in Table A16. This amount differs from the amount initially projected for this site as design-specific amounts and costs were used. Note that it is recommended that an educational sign be installed at this site. This cost is not reflected in the estimated project cost itemized below. It is recommended that approximately $500 should be budgeted for this sign.

- The cost per pound of phosphorus treated is $30,000.
- The cost per impervious acre treated is $18,000.
- The cost per cubic foot of runoff treated is $21.87.

Table A16. Calais Elementary School project initial construction cost projection.

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
Site Preparation					
N/A	MOBILIZATION	LS	1	$ 500.00	$ 500.00
653.55	PROJECT DEMARCATION FENCE	LF	450	$ 1.17	*$ 526.50*
653.20	TEMPORARY EROSION MATTING	SY	55	$ 2.20	*$ 121.00*
649.51	GEOTEXTILE FOR SILT FENCE	SY	26	$ 4.13	*$ 107.38*
N/A	CONSTRUCTION STAKING	HR	4	$ 125.00	*$ 500.00*
				Subtotal:	$ 1,754.88
Sand Filter					
203.15	COMMON EXCAVATION	CY	260	$ 9.86	$ 2,563.60
605.11	8 INCH UNDERDRAIN PIPE	LF	95	$ 27.04	$ 2,568.80
649.41	*GEOTEXTILE FOR UNDERDRAIN TRENCH LINING*	*SY*	*10*	*$ 4.04*	*$ 40.40*
N/A	*30 MM PVC LINER*	*SY*	*230*	*$ 5.40*	*$ 1,242.00*
203.31	SAND BORROW	CY	50	$ 19.54	$ 977.00
651.15	STONE FILL, TYPE I	CY	17	$ 43.91	$ 746.47
651.15	SEED	LB	1	$ 7.66	$ 7.66
651.29	STRAW MULCH	TON	0.5	$ 455.33	$ 227.67
				Subtotal:	$ 8,373.60
Bioretention System					
203.15	COMMON EXCAVATION	CY	82	$ 9.86	$ 808.52
651.35	TOPSOIL (BIORETENTION MEDIA)	CY	34	$ 30.96	$ 1,052.64
NA	PLANTING PLAN	LS	1	$ 500.00	$ 500.00
651.29	STRAW MULCH	TON	0.5	$ 455.33	$ 227.67
				Subtotal:	$ 2,588.83
				Subtotal:	$ 10,128.48
	Construction Oversight**	HR	8	$ 125.00	$ 1,000.00
	Construction Contingency - 10%**				$ 1,012.85
	Incidentals to Construction - 5%**				$ 506.42
	Minor Additional Design Items - 5%**				$ 506.42
	Final Design	HR	40	$ 125.00	$ 5,000.00
				Total (Rounded to nearest $1,000)	**$ 18,000.00**

4.5.4 Next Steps

As this site is owned and operated by the Town of Calais, it is recommended that the Town proceed with further design of this retrofit. Further design will involve refinement of the retrofit design with respect to size, outlet design, and routing to ensure that the target volume can be completely managed and that larger storms bypass the system safely.

4.5.5 Permit Needs

A project readiness screening worksheet has been completed for this project and is included in Appendix A15 - Permit Review Sheets. In summary:

Stormwater Permit
It is not anticipated that this site will need a stormwater permit at this time.

The site should qualify for an Erosion Prevention and Sediment Control permit (3-9020) under the Low Risk categorization if the following guidelines are followed:

- Less than 2 acres of disturbance at any one time.
- All soils must be stabilized (temporary or final) within 7 days.
- Runoff from the site must pass through a 50’ vegetated buffer prior to entering any Water of the State.

Local Permitting
No local permits are anticipated.

Other Permits
This project should be reviewed by a wetland ecologist prior to final design due to the close proximity of hydric soils and assumed wetlands (unmapped). No Act 250 permitting or River Corridor concerns are anticipated for this project.

B. Chapter 2: East Montpelier

1 Background

1.1 Problem Definition

The Town of East Montpelier is located in Washington County primarily within the Sodom Pond Brook – Winooski River watershed with portions in the Kingsbury Branch and North Branch Winooski River watersheds. These watersheds are tributaries of the Winooski River, which is located just south of the Town (Figure B1). The Winooski River has numerous reaches that are adversely impacted by stormwater runoff and development.

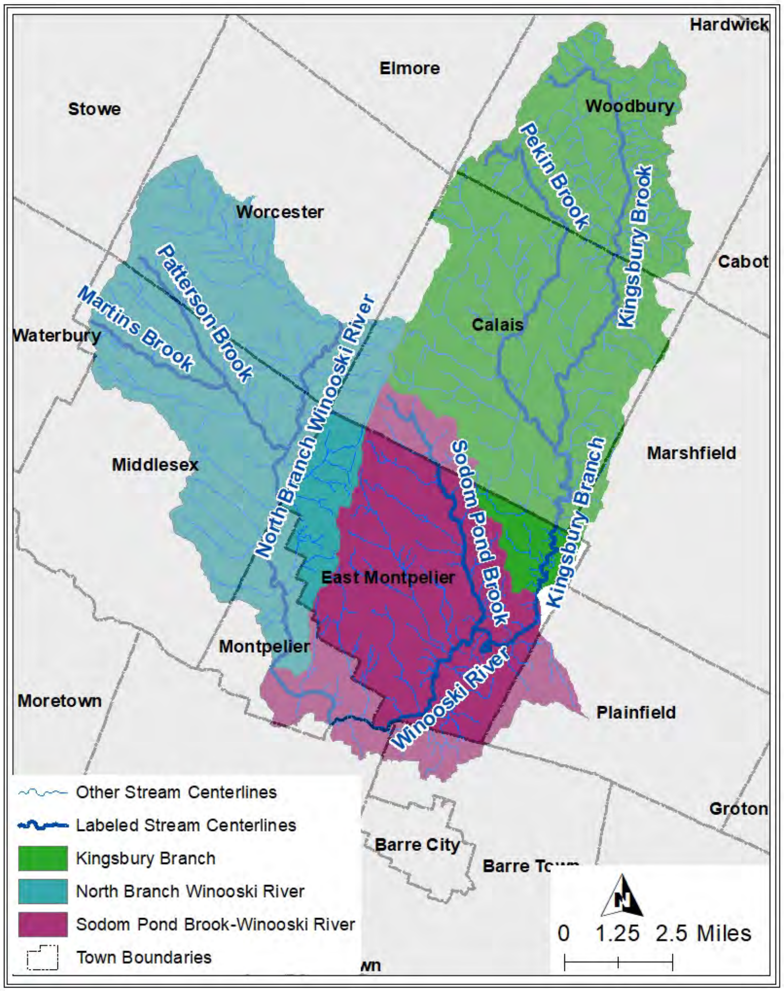

Figure B1. East Montpelier is located within the Sodom Pond Brook – Winooski River, Kingsbury Branch, and North Branch Winooski River watersheds.

The Winooski River south of the Kingsbury Branch watershed is on the 2016 stressed waters list due to streambank erosion, channel instability, and road runoff. Kingsbury Branch from the outlet of North Montpelier Pond south to the mouth of the river is also on the 2016 stressed waters list due to warm water discharges from the pond. North Montpelier Pond is an on-stream impoundment created by a dam. As the river passes through the more developed sections of Town, it is subject to multiple constrictions and lack of riparian buffer.

East Montpelier has experienced increased development along Routes 2, and 14, with expanding areas of impervious surfaces. Route 2 closely parallels the Winooski River, and Route 14 parallels the Kingsbury Branch until its confluence with the Winooski River. Both Routes have areas of increased development falling in or close to the river corridors. This development has constrained both rivers along both banks in some locations. In addition to expanding development along these corridors, East Montpelier experiences erosion as a result of steep slopes and unstable soils, further contributing to sediment and nutrient loading in surface waters.

The human-influenced stressors in the watersheds include commercial development and associated parking areas, construction of roads, agricultural practices, residential development, and clearing of previously forested areas. Additionally, in part due to likely historic straightening of rivers in the area, associated incision of stream channels, and limited floodplain access, both nuisance flooding and more extreme flood events can and do occur. Unmanaged stormwater runoff, particularly from impervious surfaces and landscaped pervious areas, exacerbate this flooding. The Winooski River watershed and its tributaries have experienced extreme flooding in the past, and these flood events are only expected to occur more frequently due to the predicted increased frequency and intensity of extreme weather events associated with climate change. These heavy rains and easily erodible soils have contributed to erosion issues throughout the area. The stormwater management practices investigated seek to protect local river resources as well as the larger Lake Champlain Basin, which currently has a Total Maximum Daily Load (TMDL) in place. The TMDL requires reductions in phosphorus loading to Lake Champlain via its tributaries through reductions in stormwater and agricultural runoff pollution.

1.2 Existing Conditions

The Town of East Montpelier spans approximately 20,475 acres in Washington County, VT (Figure B2) and is primarily forested (57%) with 28% of the Town classified as agricultural and 8% of the Town is classified as urban. Of that area, there are 530 acres (3%) of impervious cover. East Montpelier is located to the northeast of more densely developed Montpelier and is bordered by several more rural communities such as Calais and Plainfield (Figure B2). The Town of East Montpelier is more developed to the southeast, particularly along Route 14. Development is less concentrated and more residential in the western portion of the Town.

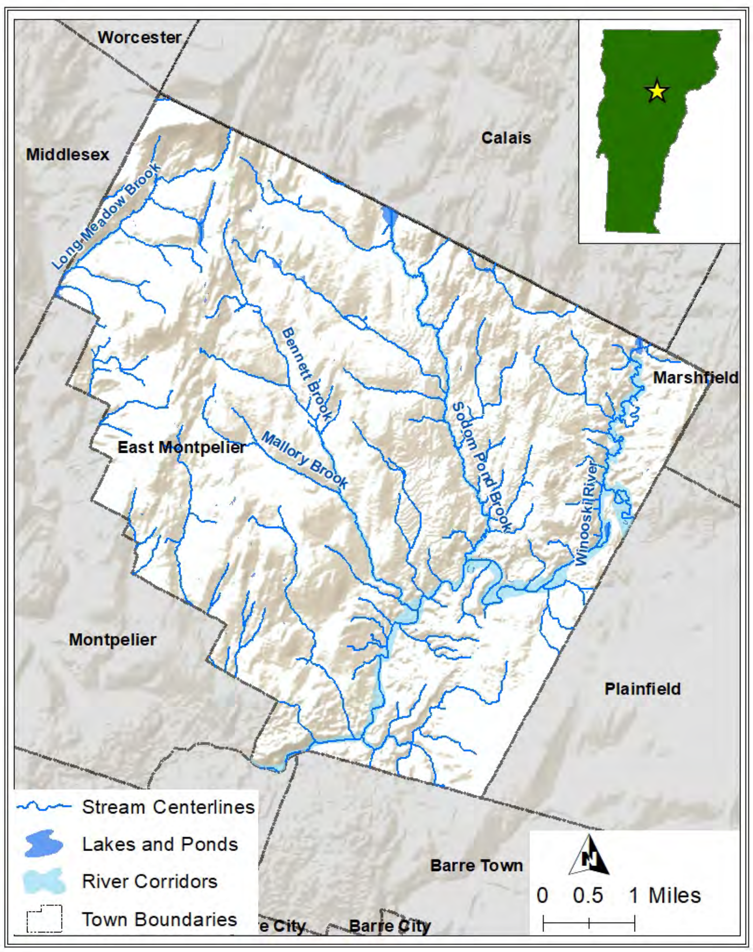

Figure B2. The Town of East Montpelier is located in Washington County, VT.

Many of the older developments within the Town were constructed before current stormwater standards were developed, and they were constructed without any or with only minimal stormwater management. This has resulted in significant amounts of untreated stormwater draining from developed lands discharging directly to surface waters.

Surrounding the developed lands, areas are more residential and rural. The area contains roads that are generally unpaved with open roadside ditches. Many of these roads have steep slopes and traverse large areas. This predisposes these areas to erosion and sediment transport.

Soils analyses indicate that of the 20,475 total acres in the Town, 92% are classified as either potentially highly-erodible, or highly-erodible by the latest Natural Resources Conservation Service (NRCS) soil mapping data. Additionally, the majority of the soils in the watershed have very low infiltration potential as indicated by NRCS Hydrologic Soil Group classifications where soils are classified from group A (highest infiltration potential) to group D (lowest infiltration potential). In the Town, the majority of areas belong to either Hydrologic Soil Group C (43%) or D (38%), while only 4% are in group A, and 14% are in group B. The remainder is not classified or comprised of water. This combination of steep slopes with limited infiltration capacity and a highly-erodible surface make the area particularly susceptible to erosion. Maps depicting existing watershed conditions can be found in Appendix B1 – Map Atlas. Maps include:

- river corridors, wetlands, and hydric soils,
- impervious cover,
- soil infiltration potential,
- soil erodibility,
- land cover,
- slope,
- stormwater infrastructure and stormwater permits,
- and parcels with ≥3 acres of impervious cover.

2 Methodology

2.1 Identification of All Opportunities

2.1.1 Initial Data Collection and Review:

All relevant prior watershed studies and any studies that could inform planning in the project area were assembled and reviewed in the context of this SWMP study. These reports include the Water Quality Management Plan, geomorphic studies including the River Corridor Management Plan, aquatic life studies, and stormwater infrastructure mapping and prioritization.

Relevant Geographic Information System (GIS) data was drawn from a variety of public resources including the Agency of Natural Resource’s Atlas, Vermont Center for Geographic Information Open Geodata Portal, and data created by the University of Vermont’s Spatial Analysis Lab. A file geodatabase was created to ensure organization and for ease of use. These data represent the “best available” data at the time of data collection (2018). The information collected and reviewed for the creation of this SWMP as well as a summary memo are included as Appendix B2 – Data Review.

The project team met with Town of East Montpelier stakeholders and the Central Vermont Regional Planning Commission (CVRPC) on November 16, 2017 to discuss the SWMP and solicit information on problem areas from the Town. Meeting minutes from this meeting are included in Appendix B3. A second meeting was held on January 26, 2018 to identify a list of problem areas including particular parcels and general areas of importance. These areas were noted and added to the list of sites identified during the desktop assessment (see section 2.1.2).

2.1.2 Desktop Assessment and Digital Map Preparation

2.1.2.1 Desktop Assessment

A desktop assessment was completed to identify additional potential sites for stormwater best management practice (BMP) implementation. This process involved a thorough review of existing GIS resources and associated attribute data. Data included, but was not limited to, storm sewer infrastructure, soils classifications, parcel data, wetlands, and river corridors. This data was used to identify and map stormwater subwatersheds with particularly high impervious cover, stormwater subwatersheds that are more directly connected to water bodies (direct pipes to streams or via overland flow), areas where infill development may occur, areas that may have worsening stormwater impacts in the future, and parcels with ≥3 acres of impervious cover without a current stormwater permit as these areas will be subject to a permit in the future. A point location was created for each identified site or area for assessment in the field.

A ‘green streets’ assessment was also conducted to identify any road segments in the Town potentially appropriate for green stormwater infrastructure (GSI) retrofit opportunities. Streets were evaluated and scored according to width, slope, and soil permeability utilizing a methodology adapted from the “Promoting Green Streets” report published by the River Network (July 2016; included as Appendix B4).

The methodology was modified to better fit specific conditions found in the study area. The analysis utilized two prerequisites and one secondary consideration.
Prerequisites:

1. Road Slope
   - 1-5% Slope = Ideal (Score: 2 points)
   - 5-7.5% Slope = Potential (Score: 1 point)
   - > 7.5% Slope = Unsuitable (Score: 0 points; discarded from further analysis)
2. Road Right-of-Way Width
   - ≥ 50 ft = Ideal (Score: 2 points)
   - 46-50 ft = Potential (Score: 1 point)
   - < 46 ft = Unsuitable (Score: 0 points; discarded from further analysis)

Secondary Consideration:

3. Hydrologic Soil Group (indication of infiltration potential)
   - A/B (highest infiltration potential) = Ideal (Score: 2 points)
   - B/C (moderate infiltration potential) = Potential (Score: 1 point)
   - C/D (lowest infiltration potential) = Unsuitable (Score: 0 points; **not** discarded from further analysis)

The scores from each of the three criteria were added, and a score was assigned for each road segment where higher scores indicated a greater potential for GSI suitability. In total, 7 sites with potential were noted for assessment in the field (Figure B3).

A total of 66 locations, including the Green Streets sites, were identified for stormwater retrofit potential

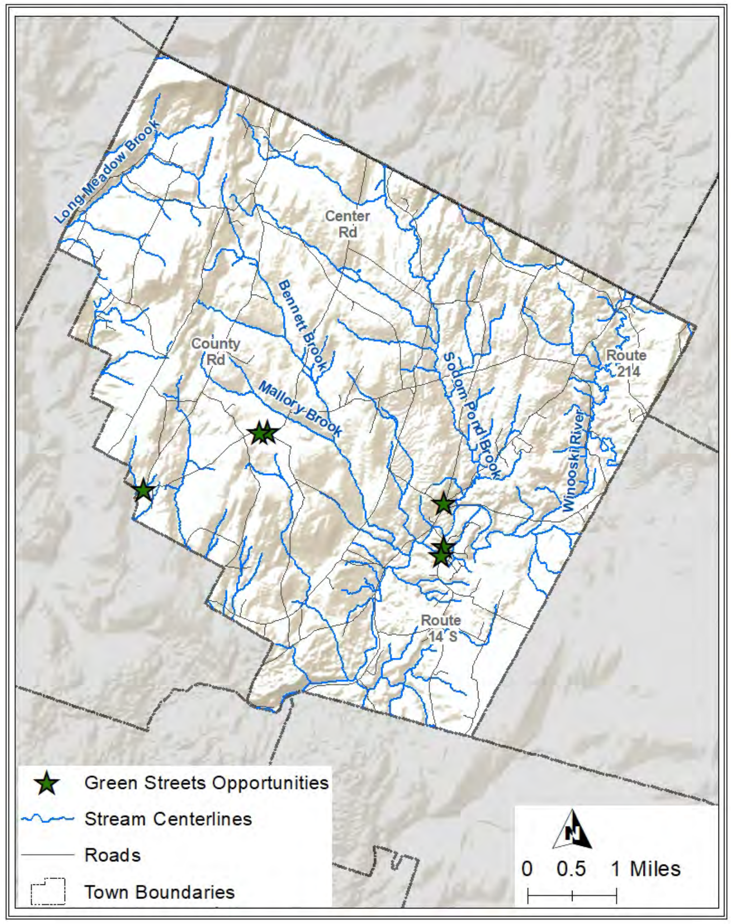

Figure B3. The 7 locations identified as potential green streets opportunities are shown with green stars.

2.1.2.2 Basemap and Mobile App Creation

In order to maximize efficiency in the field and better understand site-specific conditions, digital base maps were created for the Town. The maps show parcel boundaries, public parcels, stormwater infrastructure, hydrologic soils groups, river corridors, hydric soils, and wetlands. This information was used in the field to assess potential feasibility issues for proposed practices and to better identify preliminary BMP locations.

The base layers were pre-loaded into a project-specific mobile app that was customized for this project using the Fulcrum platform. The app was also pre-loaded with the 66 point locations for the potential BMP sites, which included Town problem areas, general Town-wide sites, and green streets locations. These points allowed for easy site location and data collection in the field (Figure B4).

The app was used to collect information including site suitability, photographic documentation, follow-up notes, and other pertinent data. All collected data was securely uploaded to the Cloud for later use.

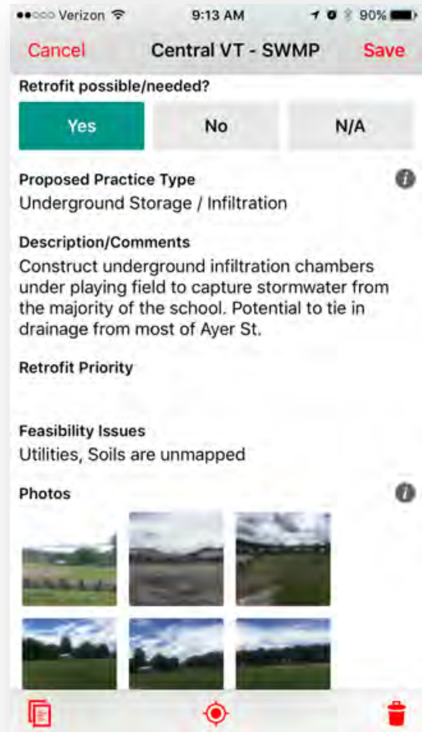

Figure B4. Example screen from data collection app.

2.1.3 Field Data Collection:

Each of the 66 previously identified potential BMP locations were evaluated in the field during the Summer of 2018 (Figure B38). Data was collected for each site in the mobile app. A large map of these sites with associated site names and a list of these sites including potential BMP options and site notes can be found in Appendix B5 - Initial Site Identification.

Through the course of these field visits, additional stormwater retrofit sites were identified that had not been included in the initial assessment. A total of 66 sites in East Montpelier were assessed as part of this plan. Some site locations that seemed like potential opportunities for BMP implementation were excluded from further analysis due to specific, prohibitive site conditions. Following this process, a total of 36 sites in East Montpelier remained as potential BMP opportunities.

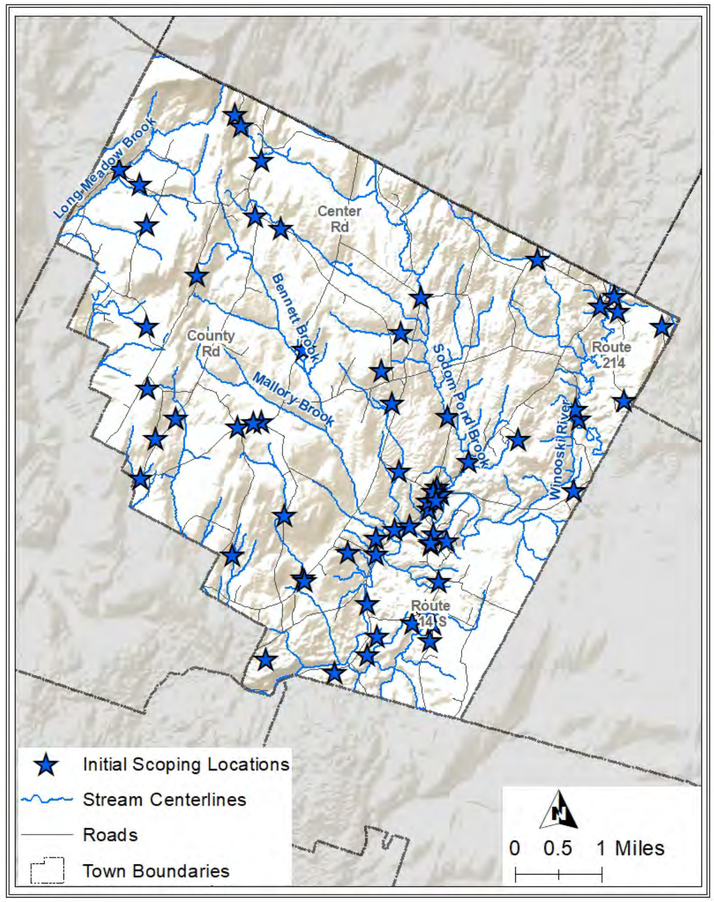

Figure B5. 66 potential sites for BMP implementation were identified for field investigation.

2.2 Preliminary BMP Ranking

After the initial field visits were completed and the project list was updated, a preliminary ranking system was utilized to prioritize these 36 projects (Figure B6). The goal of this ranking was to identify the 20 sites that would provide the greatest water quality benefit, and have a high likelihood of implementation. This prioritization was accomplished by completing an assessment of project feasibility and benefits including drainage area size, pollutant load reduction potential, proximity to water, land ownership, and feasibility issues. See Appendix B6 - Preliminary Site Ranking for the complete list of factors utilized in the preliminary ranking. Also included in Appendix B6 is the completed ranking for each potential site, one-page field data summary sheets with initial ranking information, and a memo detailing this ranking process.

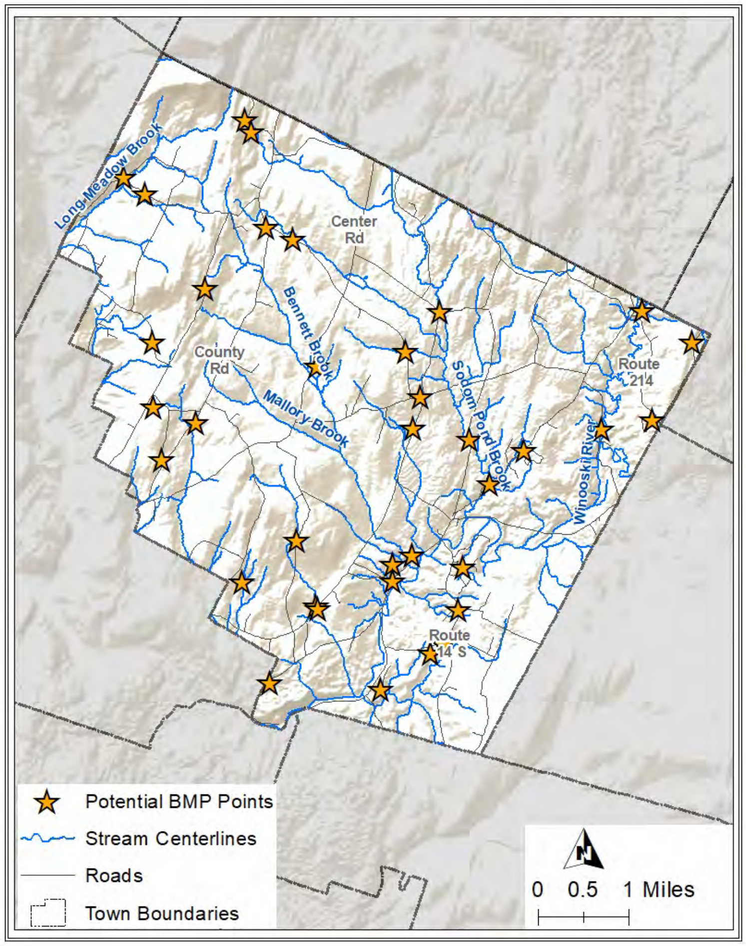

Figure B6. Following field investigations and stakeholder feedback, the list of potential BMP sites was revised to include 34 projects. Point locations are shown for each site.

The draft Top 20 list was distributed to East Montpelier stakeholders and the CVRPC. As part of this process, the project team met with East Montpelier's Selectboard on September 10, 2018 to discuss the proposed Top 20 project sites. Following feedback from the Town, the list was refined to reflect the Town's knowledge of potentially unwilling landowners and the Town's priorities. The number of projects in East Montpelier was reduced from 36 to 34 based on this feedback. These Top 20 sites are listed in Table B1. Point locations within the Town are shown in Figure B7.

Table B1. Top 20 BMPs selected for the East Montpelier SWMP.

Site ID	Proposed Practice Type
U-32 High School Southeast	Gravel Wetland
U-32 High School West	Gravel Wetland
Morse Farm Maple Sugarworks	Gravel Wetland, Ditch / Swale Improvements, Filter Strip / Buffer Enhancement
Town Garage and Fire Station	Ditch / Swale Improvements, Sediment Trap, Salt Management
East Montpelier Elementary School	Cistern / Rain Barrel, Ditch / Swale Improvements, Bioretention
Washington Electric Cooperative	Infiltration Basin
Crossroads Church & Pine State Trading	Infiltration Basin
Sodom Pond Brook and Route 14	Filter Strip / Buffer Enhancement, Infiltration Basin, Cistern / Rain Barrel
Anderson Equipment	Check Dams, Ditch / Swale Improvements, Infiltration Basin
Town Hill Rd Materials	Filter Strip / Buffer Enhancement, Cistern / Rain Barrel, Sand Filter
Cummings and County	Sand Filter, Ditch / Swale Improvements, Sediment Trap
Mekkelsen RVs	Sand Filter, Cistern / Rain Barrel, Hydrodynamic Separator
Brazier Rd	Ditch / Swale Improvements, Check Dams, Turnouts
Green Rd	Ditch / Swale Improvements, Check Dams, Turnouts, Filter Strip / Buffer Enhancement, Sediment Trap
Sanders Cir	Filter Strip / Buffer Enhancement, Ditch / Swale Improvements, Check Dams, Turnouts
Goddard College Maintenance Garage	Dry Wells, Culvert may be undersized
Doner Rd Farm	Filter Strip / Buffer Enhancement
Coburn Rd	Ditch / Swale Improvements, Check Dams, Turnouts, Sand Filter
Pine Ridge Rd	Ditch / Swale Improvements, Filter Strip / Buffer Enhancement, Infiltration Trench, Dry Well
Route 2 Pull-Off	Filter Strip / Buffer Enhancement

2.3 Modeling and Concept Refinement for Top 20 BMPs

Modeling was completed for each of the Top 20 sites. This modeling allowed for accurate sizing of the proposed practices, as well as an understanding of the water quality and quantity benefits. The contributing drainage area of each of the BMPs was defined and landuse/landcover was digitized using the best available topographic data and aerial imagery. Drainage areas were refined based on field observations. Each of the sites was modeled in HydroCAD to determine the appropriate BMP size and resultant stormwater volume reductions (see Appendix B8 - Top 20 Sites Modeling for modeling reports).

Each of these sites was also modeled using the Source Loading and Management Model for Windows (WinSLAMM) to determine the annual total suspended solids (TSS) and total phosphorus (TP) loading from the drainage area of each site. Pollutant load reductions from each of the BMPs were then calculated using one of two sources, depending on the practice type. WinSLAMM was used when possible, and, for those practices that WinSLAMM does not model well (generally non-infiltration-based practices; based on experience and literature), pollutant removal rates published by the University of New Hampshire Stormwater Center were applied to the initial pollutant loading modeled with WinSLAMM for the site's current conditions. This yielded expected pollutant removal loads (lbs) and rates (%). The modeled volume and pollutant loading reductions are shown in Table B2. Complete modeling results are provided in Appendix B8 - Top 20 Sites Modeling.

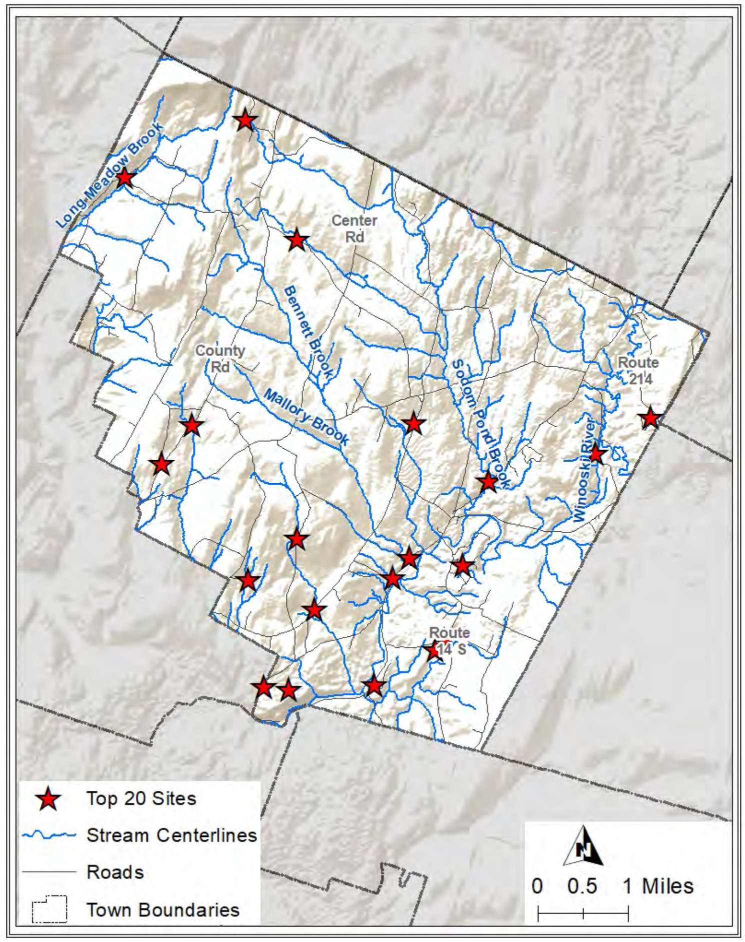

Figure B7. The Top 20 project locations are shown.

Table B2. Modeled volume and pollutant load reductions for the Top 20 BMPs.

Site ID	Volume Managed (ac-ft)	Volume Infiltrated (ac-ft)	Total Suspended Solids Removal (lbs)	Total Suspended Solids Removal (%)	Total Phosphorus Removal (lbs)	Total Phosphorus Removal (%)
U-32 High School Southeast	0.974	0	3,691	96.00%	4.96	58.00%
U-32 High School West	0.297	0	11,882	96.00%	1.58	58.00%
Morse Farm Maple Sugarworks	0.088	0	11,988	96% (Gravel Wetland); 60% (Buffer)	6.67	58% (Gravel Wetland); 20% (Buffer)
Town Garage and Fire Station	0.085	0	4,829	37.2% (Sediment Trap 1); 39.37% (Sediment Trap 2); 70.8% (sand pile)	4.95	45.72% (Sediment Trap 1); 50.52% (Sediment Trap 2); 49.8% (sand pile)
East Montpelier Elementary School	0.122	0	1,036	96.00%	1.11	58.00%
Washington Electric Cooperative	0.525	0.525	9,294	95.87% (NW Basin); 98.44% (E Basin)	5.30	98.2% (NW Basin); 99.04% (E Basin)
Crossroads Church & Pine State Trading	0.308	0.308	3,768	95.39%	2.79	96.84%
Sodom Pond Brook and Route 14	0.072	0.072	2,681	89.1% (Sand Filter); 60% (Buffer)	1.87	90.24% (Sand Filter); 20% (Buffer)
Anderson Equipment	0.104	0.104	3,541	85.90%	3.73	89.83%
Town Hill Rd Materials	0.191	0	6,762	60% (Sand Filter); 60% (Buffer)	2.90	20% (Sand Filter); 20% (Buffer)
Cummings and County	0.022	0	1,026	44.20%	1.03	47.51%
Mekkelsen RVs	0.103	0	7,753	61.91% (Filter Strip); 50% (Swirl Separators); 96% (Gravel Wetland)	3.25	47.61% (Filter Strip); 10% (Swirl Separators); 58% (Gravel Wetland)
Brazier Rd	0.071	0	2,923	65.00%	0.74	20.00%
Green Rd	0.340	0	717	31.22%	0.85	40.50%
Sanders Cir	0.047	0	1,534	60.00%	0.48	20.00%
Goddard College Maintenance Garage	0.043	0.043	290	38.73%	0.26	41.68%
Doner Rd Farm	0.038	0	1,437	60.00%	0.59	20.00%
Coburn Rd	0.011	0	396	60.00%	0.13	20.00%
Pine Ridge Rd	0.036	0.036	382	79.11%	0.32	73.51%
Route 2 Pull-Off	0.006	0	122	60.00%	0.04	20.00%

2.4 Final Ranking Methodology

A prioritization matrix was utilized to quantitatively rank each of the Top 20 projects. Considerations that factored into the ranking of BMP projects included:

- Impervious area managed
- Ease of operation and maintenance
- Volume managed
- Volume infiltrated
- Permitting restrictions
- Land availability
- Flood mitigation
- TSS removed
- TP removed
- Other project benefits
- Project cost

Each of these criteria are listed and explained in Appendix B9 - Top 20 Site Final Ranking. The scores associated with each of the categories are also provided in this table.

2.4.1 Project Cost Estimation

Project cost, listed as one of the criteria considered, was calculated for each project using a spreadsheet-based method. The methodology for determining these planning level costs was first developed for the City of South Burlington by the Horsley Witten (HW) Group as part of the Centennial Brook Flow Restoration Plan development. The HW Memorandum describing this methodology is provided in Appendix B10. Note that a variation of this method was used for this plan. The criteria used in this cost estimation can be found in Appendix B9 - Top 20 Site Final Ranking. This methodology provides consistent budgetary cost estimates across BMPs.

Cost estimates are based on average costs for conceptual level projects and deviation from these estimates are expected as projects move forward with engineering design. There are differences between project cost estimates presented in the plan and actual project bid costs. The BMP cost estimates presented in the plan are based on limited site investigation. This methodology, while providing consistency in budget cost estimating, may fail to accurately reflect project cost impacts associated with actual site conditions and constraints. Therefore, the BMP cost estimates presented are suitable for planning purposes only, and not detailed program budgeting. The BMP cost estimates were developed based on the following assumptions:

Design Control Volumes: Design control volumes were based on the estimated runoff volume associated with the Channel Protection volume (CPv) or Water Quality volume (WQv) storm events for off-line, underground, or GSI-type practices. Off-line stormwater management systems are designed to manage storm events by diverting a percentage of stormwater from a storm drainage system. Underground systems and GSI-type practices were conceptually designed as offline practices that only accept runoff from the target storm event. Runoff volumes for all storm events were determined based on HydroCAD model results that rely on the Soil Conservation Service (SCS) TR-55 and TR-20 hydrologic methods.

Unit Costs and Site Adjustment Factors: Unit cost for each BMP and site adjustment factors were derived from research by the Charles River Watershed Association and Center for Watershed Protection, as well as from experience with actual construction[2] and modified for this project to reflect the newest cost estimates available. Underground filtration chamber systems were typically designed using Stormtech MC-4500™ chamber systems. Cost adjustment factors were used to account for site-specific differences typically related to project size, location, and complexity. The values used to estimate BMP costs are summarized in Table B3 below.

Table B3. BMP unit costs and adjustment factors modified to reflect newer information.

BMP Type	Base Cost ($/ft³)
Porous Asphalt	$5.32
Infiltration Basin	$6.24
Underground Chamber (infiltration or detention)	$6.25
Detention Basin / Dry Pond	$6.80
Gravel Wetland	$8.78
Infiltration Trench	$12.49
Bioretention	$15.46
Sand Filter	$17.94
Porous Concrete	$18.07
Site Type	**Cost Multiplier**
Existing BMP retrofit or simple BMP	0.25
Large aboveground basin projects	0.5
New BMP in undeveloped area	1
New BMP in partially developed area	1.5
New BMP in developed area	2
Difficult installation in highly urban settings	3

Site-Specific Costs: Cost of significant utility or other work related to the construction of the BMP itself. Site-specific costs are variable based on past experience.

Base Construction Cost: Calculated as the product of the design control volume, the unit cost, and the site adjustment factor.

[2] Horsley Witten Group, Inc. 2014. Centennial Brook Watershed: Flow Restoration VTBMPDSS Modeling Analysis and BMP Supporting Information. Memorandum dated January 9th, 2014.

Permits and Engineering Costs: Used either 20% for large aboveground projects or 35% for smaller or complex projects.

Total Project Cost: Calculated as the sum of the base construction cost, permitting and engineering costs, and land acquisition costs.

Cost per Impervious Acre: Calculated as the construction costs plus the permitting and engineering costs, divided by the impervious acres managed by the BMP.

Operation and Maintenance: The annual operation and maintenance (O&M) was calculated as 3% of the base construction costs, with a maximum of $10,000.

Minimum Cost Adjustment: After total project costs were determined for each proposed BMP based on the HW methodology, costs were reviewed and adjusted so that projects involving a simple BMP such as a small rain garden were assigned a minimum cost of $10,000 and more complex projects were assigned a minimum cost of $25,000.

2.4.2 Final Ranking Scoring

Each of the factors noted in Appendix B9 - Top 20 Site Final Ranking were scored, and scores were totaled for each of the criteria. Projects were assigned a rank from 1 to 20 with those projects receiving the highest scores assigned the highest rank. In the case of a tie between two projects, the TP removed (lbs) by the practice was used as a tiebreaker.

2.5 Final Modeling and Prioritization

A summary of the practices with their assigned rank are shown below in Table B4. The comprehensive ranking matrix used to rank the proposed BMP projects is provided in Appendix B9 - Top 20 Site Final Ranking. If future funding becomes available for further implementation, this prioritization matrix can be utilized in selecting additional projects for implementation.

Table B4. Top 20 potential BMP sites for the Town of East Montpelier.

Rank	Site ID	Address	Proposed Practice Type
1	U-32 High School Southeast	930 Gallison Hill Rd, East Montpelier, VT	Gravel Wetland
2	U-32 High School West	930 Gallison Hill Rd, East Montpelier, VT	Gravel Wetland
3	Morse Farm Maple Sugarworks	County Rd (south of Barnes Rd), East Montpelier, VT	Gravel Wetland, Ditch / Swale Improvements, Filter Strip / Buffer Enhancement
4	Town Garage and Fire Station	325 Templeton Rd, East Montpelier, VT	Ditch / Swale Improvements, Sediment Trap, Salt Management
5	East Montpelier Elementary School	665 Vincent Flats Rd, East Montpelier, VT	Cistern / Rain Barrel, Ditch / Swale Improvements, Bioretention
6	Washington Electric Cooperative	344 Fassett Rd, East Montpelier, VT	Infiltration Basin
7	Crossroads Church & Pine State Trading	230 Fassett Rd, East Montpelier, VT	Infiltration Basin
8	Sodom Pond Brook and Route 14	628 VT Route 14 N, East Montpelier, VT	Filter Strip / Buffer Enhancement, Infiltration Basin, Cistern / Rain Barrel
9	Anderson Equipment	290 Packard Rd, East Montpelier, VT	Check Dams, Ditch / Swale Improvements, Infiltration Basin
10	Town Hill Rd Materials	2368 Towne Hill Rd, East Montpelier, VT	Filter Strip / Buffer Enhancement, Cistern / Rain Barrel, Sand Filter
11	Cummings and County	34–652 Cummings Rd, East Montpelier, VT	Sand Filter, Ditch / Swale Improvements, Sediment Trap
12	Mekkelsen RVs	2419 US Route 2, East Montpelier, VT	Sand Filter, Cistern / Rain Barrel, Hydrodynamic Separator
13	Brazier Rd	801–1099 Brazier Rd, East Montpelier, VT	Ditch / Swale Improvements, Check Dams, Turnouts
14	Green Rd	1–299 Green Rd, East Montpelier, VT	Ditch / Swale Improvements, Check Dams, Turnouts, Filter Strip / Buffer Enhancement, Sediment Trap
15	Sanders Cir	842–1198 Sanders Cir, East Montpelier, VT	Filter Strip / Buffer Enhancement, Ditch / Swale Improvements, Check Dams, Turnouts
16	Goddard College Maintenance Garage	601–857 Vermont Route 214, East Montpelier, VT	Dry Wells, Culvert may be undersized
17	Doner Rd Farm	320 Fitch Rd, East Montpelier, VT	Filter Strip / Buffer Enhancement
18	Coburn Rd	1–627 Coburn Rd, East Montpelier, VT	Ditch / Swale Improvements, Check Dams, Turnouts, Sand Filter
19	Pine Ridge Rd	110 Pine Ridge Rd, East Montpelier, VT	Ditch / Swale Improvements, Filter Strip / Buffer Enhancement, Infiltration Trench, Dry Well
20	Route 2 Pull-Off	Route 2 and Towne Hill Rd, East Montpelier, VT	Filter Strip / Buffer Enhancement

2.6 Selection of Top 5 Potential BMPs

Selection of the Town's Top 5 sites considered the results from initial site investigations and preliminary modeling and ranking, input from municipal officials concerning project priorities, and the willingness of select private landowners to voluntarily participate in this plan. The location of the sites within the Town are shown in Figure B8. In the final ranking, these 5 sites were awarded additional points in the scoring to reflect the Town's priorities and high probability for implementation. The Top 5 sites are listed in Table B5.

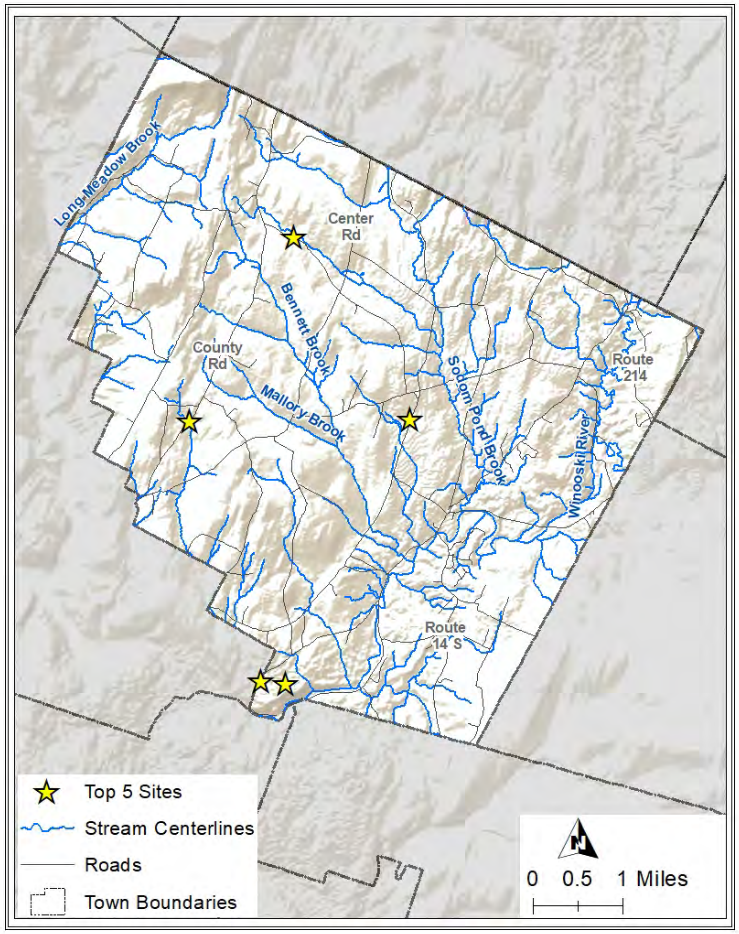

Figure B8. Top 5 sites for the East Montpelier SWMP.

Table B5. Top 5 BMP sites for the Town of East Montpelier.

Rank	Site ID	Address	Proposed Practice Type
1	U-32 High School Southeast	930 Gallison Hill Rd, East Montpelier, VT	Gravel Wetland
2	U-32 High School West	930 Gallison Hill Rd, East Montpelier, VT	Gravel Wetland
3	Morse Farm Maple Sugarworks	County Rd (south of Barnes Rd), East Montpelier, VT	Gravel Wetland, Ditch / Swale Improvements, Filter Strip / Buffer Enhancement
4	Town Garage and Fire Station	325 Templeton Rd, East Montpelier, VT	Ditch / Swale Improvements, Sediment Trap, Salt Management
5	East Montpelier Elementary School	665 Vincent Flats Rd, East Montpelier, VT	Cistern / Rain Barrel, Ditch / Swale Improvements, Bioretention

3 Priority BMPs

The selected Top 5 BMP sites are briefly described below. These opportunities are located on Town property and private property. Brief descriptions of each site are provided below. A memo describing these sites and updated field data sheets are provided in Appendix B11.

Site: 1
Project Name: U-32 High School Southeast
Description: The site includes school buildings, associated parking lots, and athletic fields. Stormwater collects in a series of swales and stormlines that drain to a vegetated area southeast of the track (see Figure B9). The concept for this site includes constructing a gravel wetland south of the track by the tree line. The swales would be redirected to this system. Soils are mapped as being poor at this site (Hydrologic Group C), so an analysis was not conducted to evaluate the potential for an infiltration practice.
Outreach: School officials expressed their willingness to further design.

Figure B9. Stormwater draining to the pictured greenspace will be treated in a gravel wetland.

Site: 2
Project Name: U-32 High School West
Description: The site includes roof drains from school buildings and two parking lots. Stormwater currently drains via a swale and a stormline to a vegetated area west of the School (see Figure B10). The concept for this site includes constructing a gravel wetland west of the School's raised garden beds and installing a hydrodynamic separator in the stormline. Soils are mapped as being very poor at this site (Hydrologic Group D), so an analysis was not conducted to evaluate the potential for an infiltration practice.
Outreach: School officials expressed their willingness to further design.

Figure B10. Stormwater draining from the pictured swale will be treated in a gravel wetland.

Site: 3
Project Name: Morse Farm Maple Sugarworks
Description: The site includes several buildings and associated driveways and parking lots. Stormwater currently drains via overland flow to a tributary located in the adjacent cow pasture southwest of the lower driveway. The concept for this site includes general drainage improvements, the construction of a gravel wetland west of the lower driveway, and a buffer restoration along the tributary (see Figure B11). Soils are mapped as being poor at this site (Hydrologic Group C), so an analysis was not conducted to evaluate the potential for an infiltration practice.

Figure B11. A gravel wetland will treat stormwater runoff from the Morse Farm Maple Sugarworks property.

Outreach: The owner of Morse Farm has expressed willingness to further design.

Site: 4
Project Name: Town Garage and Fire Station
Description: The site includes the garage building, salt shed, equipment and materials storage areas, and a large sand pile. Stormwater currently travels via overland flow to Chapels Pond just east of the site. The concept for this site includes general site improvements, expansion of the existing sediment trap west of the fire station, and construction of a sediment trap east of the fire station (see Figure B12). Soils are mapped as being poor and very poor at this site (Hydrologic Group C and D), so an analysis was not conducted to evaluate the potential for an infiltration practice.
Outreach: The Town of East Montpelier owns the areas where the proposed retrofits are located, and as such no additional outreach was conducted.

Figure B12. Sediment traps are proposed at the Town Garage and Fire Station site.

Site: 5

Project Name: East Montpelier Elementary School

Figure B13. Stormwater draining to the pictured greenspace will be treated in a bioretention.

Description: The site includes the school building and associated driveways and parking lots. Stormwater currently sheet flows through this area to catchbasins and swales and eventually drains to a wetland by the Town's recreation fields. The concept for this site includes a rain barrel for the building by the upper parking lot, general drainage improvements for the upper parking lot, and construction of a bioretention in the existing greenspace by the turnaround in front of the School (see Figure B13). Soils are mapped as being good at this site (Hydrologic Group B), so an analysis was conducted to evaluate the potential for an infiltration practice. Soils were found to be generally loamy with a higher percentage of silt and clay.

Outreach: School officials expressed their willingness to further design.

When implemented, these five BMPs would treat approximately 71.8 acres, 13.6 acres (19%) of which is impervious. Modeled pollutant reductions for each of the projects, shown below in Table B6, indicate that these BMPs will prevent nearly 24,000 lbs of TSS and more than 19 lbs of TP from reaching receiving waters annually.

Table B6. Pollutant reductions and select ranking criteria for Top 5 projects.

Site ID	Volume Managed (ac-ft)	Volume Infiltrated (ac-ft)	Total Suspended Solids Removal (lbs)	Total Suspended Solids Removal (%)	Total Phosphorus Removal (lbs)	Total Phosphorus Removal (%)
U-32 High School Southeast	0.974	0	3,691	96%	4.96	58.00%
U-32 High School West	0.297	0	11,882	96%	1.58	58.00%
Morse Farm Maple Sugarworks	0.088	0	11,988	96% (Gravel Wetland); 60% (Buffer)	6.67	58% (Gravel Wetland); 20% (Buffer)
Town Garage and Fire Station	0.085	0	4,829	37.2% (Sediment Trap 1); 39.37% (Sediment Trap 2); 70.8% (sand pile storage improvements)	4.95	45.72% (Sediment Trap 1); 50.52% (Sediment Trap 2); 49.8% (sand pile storage improvements)
East Montpelier Elementary School	0.122	0	1,036	96%	1.11	58.00%

Site surveys were completed for each of the Top 5 sites, and existing conditions plans were developed. These plans were used as the basis for the 30% proposed condition plans that were created for each site. See Appendix B12 - Existing Conditions Plans for these plans.

4 30% Designs

30% engineering designs were completed for each of the Top 5 sites. Site-specific concepts are discussed in the following sections. All 30% designs can be found in Appendix B13 - 30% Designs.

Soils conditions were assessed at 1 of the top 5 sites where an infiltration-based practice is proposed. The pit was dug prior to Watershed's arrival onsite with what was assumed to be a shovel. Analysis at this site included documentation of horizon breaks, soil structure, type, moisture, color, presence or absence of redoximorphic features, and size and quantity of roots and coarse fragments. Any other notes considered to be important were recorded during this time. The soil profile and photos can be found in Appendix B14.

4.1 U-32 High School Southeast

4.1.1 30% Concept Design Description

Union High School District No. 32 (aka U-32) is located at 930 Gallison Hill Rd in Montpelier, VT. The site includes associated buildings, parking lots, and athletic fields. This area currently drains via a series of swales and a closed catchbasin and pipe system to a vegetated low point beyond the tree line, southeast of the track. The drainage is notably turbid and drainage is well channelized (see photo second from right in Figure B15). Drainage from this area travels south and discharges to the Winooski River by VT-2 without treatment. This area was noted by the Town as being a good potential candidate for inclusion as a high-priority site within this plan.

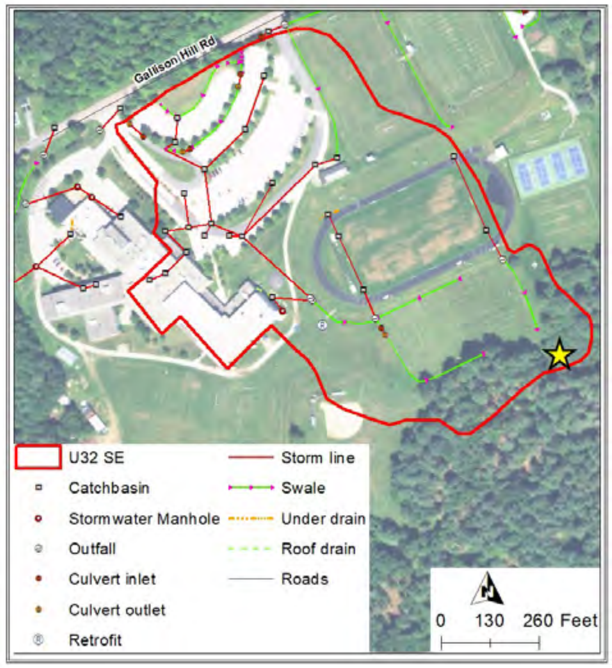

Figure B14. The proposed BMP drainage area is shown in red. The BMP location is shown with a star.

The proposed BMP for this site would be to install a two-cell gravel wetland with a pre-treatment forebay south of the track by the tree line (see starred location in Figure B14). The system will outlet to the woods southeast of the wetland. The retrofit would also include rerouting the snowshoe trail through or around the new feature. Drainage will be directed from the eastern and western swales to wetland. It is recommended that an educational sign be installed in conjunction with this gravel wetland for students and the general public. See the photos and associated descriptions in Figure B15. The school officials have expressed their willingness to proceed with further design.

Stormwater from the school is directed to a series of swales south of the track. Drainage from the swales flows to a low point beyond the tree line.

Drainage from the building, parking lot, and athletic fields is directed to the swales.

Turbid stormwater at a culvert outlet during a precipitation event.

A two-cell gravel wetland is proposed in the existing low point beyond the tree line southeast of the track.

Figure B15. The proposed retrofits are described in the above photos.

Soils are mapped as being poor at this site (Hydrologic Group C), so an analysis was not conducted to evaluate the potential for an infiltration practice.

A rendering of the proposed stormwater improvements was created to bring a concept to life in ways that engineering plans cannot. This rendering is one possible configuration for this site. This graphically engaging rendering visually communicates the plans and can be used by the Town and the CVRPC to help advance designs toward implementation. This rendering can be found in Appendix B16 - Site Renderings.

The design standard used for this retrofit was filtration and slow release of the Channel Protection volume (CPv, or 2.02 inches of rain in a 24-hour period), equal to 42,429 ft^3 of runoff.

An updated BMP summary sheet is included in Appendix B11 - Top 5 Sites. A 30% design plan is provided in Appendix B13 - 30% Designs.

4.1.2 Pollutant Removal and Other Water Quality Benefits

This practice has the potential to prevent more than 3,500 lbs of total suspended solids (TSS) and nearly 5 lbs of total phosphorus (TP) from entering receiving waters (Table B7).

Table B7. U-32 High School Southeast benefit summary table.

TSS Removed	3,691 lbs
TP Removed	4.96 lbs
Impervious Treated	5.8 acres
Total Drainage Area	18.3 acres

4.1.3 Cost Estimates

The total estimate cost for this project is $108,000. Note that these costs are very preliminary. Cost projections can be found in Table B8. It is recommended that an educational sign be installed at this site. This cost is not reflected in the estimated project cost itemized below. It is recommended that approximately $500 should be budgeted for this sign.

- The cost per pound of phosphorus treated is $21,774.
- The cost per impervious acre treated is $18,621.
- The cost per cubic foot of runoff treated is $2.55.

Table B8. U-32 High School Southeast project initial construction cost projection.

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
Site Preparation					
N/A	MOBILIZATION	LS	1	$ 500.00	$ 500.00
653.55	PROJECT DEMARCATION FENCE	LF	600	$ 1.17	$ 702.00
649.51	GEOTEXTILE FOR SILT FENCE	SY	210	$ 4.13	$ 867.30
N/A	CONSTRUCTION STAKING	HR	7	$ 125.00	$ 875.00
				Subtotal:	$ 2,944.30
Gravel Wetland - Excavation and Materials					
	EXCAVATION				
203.15	COMMON EXCAVATION	CY	2035	$ 9.86	$ 20,065.10
	MATERIALS				
	GRAVEL LAYERING				
651.35	TOPSOIL (MUCK SOIL)	CY	119	$ 30.96	$ 3,684.24
629.54	CRUSHED STONE BEDDING (3/4" - 1 1/2" STONE)	TON	230	$ 34.04	$ 7,829.20
301.26	SUBBASE OF CRUSHED GRAVEL, FINE GRADED	CY	320	$ 40.03	$ 12,809.60
	PIPING				
605.13	12 INCH UNDERDRAIN PIPE	LF	130	$ 47.00	$ 6,110.00
649.41	GEOTEXTILE FOR UNDERDRAIN TRENCH LINING	SY	50	$ 4.04	$ 202.00
601.0905	12" CPEP	LF	30	$ 39.24	$ 1,177.20
601.0915	18" CPEP (Outlet)	LF	20	$ 64.04	$ 1,280.80
601.0920	24" CPEP (stand pipe)	LF	50	$ 61.37	$ 3,068.50
	STRUCTURES AND APPURTENANCES				
604.18	PRECAST REINFORCED CONCRETE DROP INLET WITH CAST IRON GRATE	EACH	1	$ 4,009.29	$ 4,009.29
N/A	18' ANTI-SEEP COLLAR	EACH	3	$ 250.00	$ 750.00
N/A	18" BEEHIVE GRATE	EACH	8	$ 615.00	$ 4,920.00
N/A	30 MM PVC LINER	SY	1475	$ 5.40	$ 7,965.00
	OVERFLOWS AND TRANSFER WEIRS				
613.10	STONE FILL, TYPE I	CY	14	$ 43.91	$ 614.74
	PLANTING				
N/A	WETLAND PLANT SEEDS	LBS	10	$ 125.00	$ 1,250.00
				Subtotal:	$ 75,735.67
	GRASS REPLACEMENT				
653.20	TEMPORARY EROSION MATTING	SY	500	$ 2.20	$ 1,100.00
651.29	STRAW MULCH	TON	1	$ 455.33	$ 455.33
651.15	SEED	LB	10	$ 7.66	$ 76.60
				Subtotal:	$ 1,631.93
Subtotal:					$ 80,311.90
	Construction Oversight**	HR	16	$ 125.00	$ 2,000.00
	Construction Contingency - 10%**				$ 8,031.19
	Incidentals to Construction - 5%**				$ 4,015.60
	Minor Additional Design Items - 5%**				$ 4,015.60
	Final Design	HR	60	$ 125.00	$ 7,500.00
	Permit Review and Applications (exclusive of permit fees)	HR	16	$ 125.00	$ 2,000.00
				Total (Rounded to nearest $1,000)	**$ 108,000.00**

4.1.4 Next Steps

As this site is owned and operated by the Town of East Montpelier, it is recommended that the Town, with the support of the school board and school officials, proceed with further design of this retrofit. Further design will involve refinement of the retrofit design with respect to size, outlet design, and routing to ensure that the target volume can be completely managed and that larger storms bypass the system safely.

4.1.5 Permit Needs

A project readiness screening worksheet has been completed for this project and is included in Appendix B15 - Permit Review Sheets. In summary:

Stormwater Permit
U-32 High School has a current stormwater permit covering 0.02 acres of impervious surfaces. However, this site will likely need a stormwater permit under the proposed 3-acre impervious cover rule as the greater parcel contains 10.86 acres if impervious cover.

The site should qualify for an Erosion Prevention and Sediment Control permit (3-9020) under the Low Risk categorization if the following guidelines are followed:

- Less than 2 acres of disturbance at any one time.
- All soils must be stabilized (temporary or final) within 7 days.
- Runoff from the site must pass through a 50’ vegetated buffer prior to entering any Water of the State.

Local Permitting
No local permits are anticipated.

Other Permits
An Act 250 permit for U-32 High School (500003) exists, and as such this project should be reviewed to determine if an amendment to this permit would be required. This project should be reviewed by a wetland ecologist prior to final design due to the assumed (unmapped) presence of wetlands adjacent to the location of the proposed BMP. No River Corridor permitting is anticipated for this project.

4.2 U-32 High School West

4.2.1 30% Concept Design Description

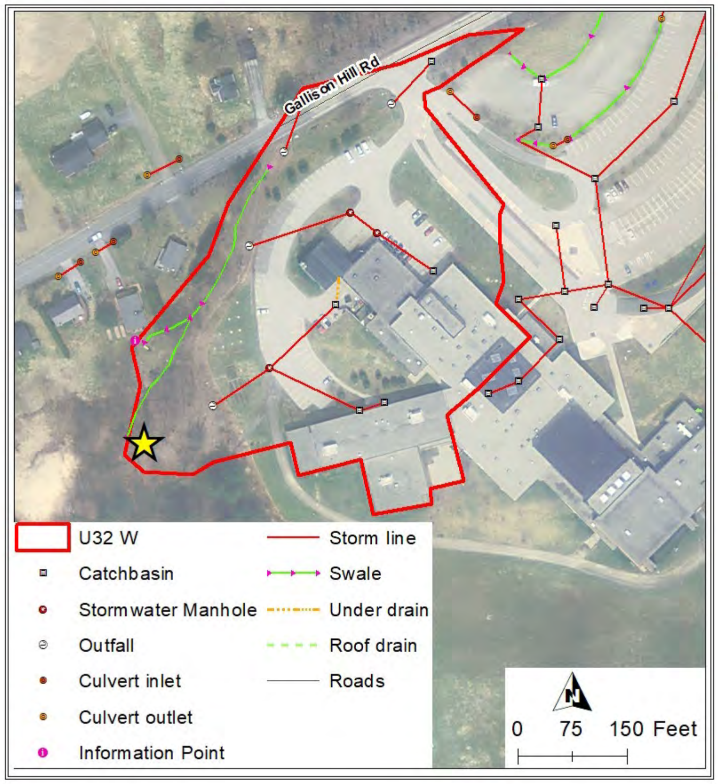

Figure B16. The proposed BMP drainage area is shown in red. The BMP location is shown with a star.

Union High School District No. 32 (aka U-32) is located at 930 Gallison Hill Rd in Montpelier, VT. The site includes roof drains from associated buildings and the two lower parking lots. This area currently drains via a swale and a closed catchbasin and pipe system to a vegetated low point beyond the tree line, west of the school building. Drainage from this area travels via overland flow and eventually discharges to the Winooski River by VT-2 without treatment. This area was noted by the Town as being a good potential candidate for inclusion as a high-priority site within this plan.

The retrofit for this site includes construction of a two-cell gravel wetland along the school's property line, below bank where drainage ditch currently drains, west of the raised garden beds (see starred location in Figure B16). The system will outlet to the woods southeast of the wetland. It is recommended that an educational sign is installed in conjunction with this gravel wetland for students and the general public. The retrofit would also involve creating a grass swale for pre-treatment in the existing drainage ditch west of the lower parking lot. This swale will be directed to the gravel wetland. A small access road should be constructed along the edge of the parking lot for construction and maintenance needs. A subsurface hydrodynamic separator will be installed for pre-treatment in stormline between stormwater manhole and raised garden beds. See the photos and associated descriptions in Figure B17. School officials have expressed their willingness to proceed with further design.

Stormwater from Gallison Hill Rd is directed to a drainage ditch west of the school.

A grass pretreatment swale is proposed in the location of the existing drainage ditch.

Proposed location of a two-cell gravel wetland. A small maintenance access road is proposed alongside the pretreatment swale and wetland feature.

Stormwater from roof drains and the western parking lots are collected in a catchbasin and pipe system.

Figure B17. The proposed retrofits are described in the above photos.

Soils are mapped as being very poor at this site (Hydrologic Group D), so an analysis was not conducted to evaluate the potential for an infiltration practice.

A rendering of the proposed stormwater improvements was created to bring a concept to life in ways that engineering plans cannot. This rendering is one possible configuration for this site. This graphically engaging rendering visually communicates the plans and can be used by the Town and the CVRPC to help advance designs toward implementation. This rendering can be found in Appendix B16 - Site Renderings.

The design standard used for this retrofit was detention and slow release of the Channel Protection volume (CPv, or 2.02 inches of rain in a 24-hour period) for the gravel wetland feature, equal to 12,957 ft^3 of runoff.

An updated BMP summary sheet is included in Appendix B11 - Top 5 Sites. A 30% design plan is provided in Appendix B13- 30% Designs.

4.2.2 Pollutant Removal and Other Water Quality Benefits

A retrofit of this site has the potential to prevent more than 2,000 lbs of total suspended solids (TSS) and more than 1.5 lbs of total phosphorus (TP) from entering receiving waters (Table B9).

Table B9. U-32 High School West benefit summary table.

TSS Removed	2,172 lbs
TP Removed	1.6 lbs
Impervious Treated	2.6 acres
Total Drainage Area	5 acres

4.2.3 Cost Estimates

The total estimated cost for this retrofit is $60,000. Note that these costs are very preliminary. Cost projections can be found in Table B10. It is recommended that an educational sign be installed at this site. This cost is not reflected in the estimated project cost itemized below. It is recommended that approximately $500 should be budgeted for this sign.

- The cost per pound of phosphorus treated is $37,500.
- The cost per impervious acre treated is $23,077.
- The cost per cubic foot of runoff treated is $4.63.

Table B10. U-32 High School West project initial construction cost projection.

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
Site Preparation					
N/A	MOBILIZATION	LS	1	$ 500.00	$ 500.00
653.55	PROJECT DEMARCATION FENCE	LF	250	$ 1.17	$ 292.50
649.51	GEOTEXTILE FOR SILT FENCE	SY	155	$ 4.13	$ 640.15
N/A	CONSTRUCTION STAKING	HR	6	$ 125.00	$ 750.00
				Subtotal:	$ 2,182.65
Gravel Wetland - Excavation and Materials					
		EXCAVATION			
203.15	COMMON EXCAVATION	CY	485	$ 9.86	$ 4,782.10
		MATERIALS			
		GRAVEL LAYERING			
651.35	TOPSOIL (MUCK SOIL)	CY	38	$ 30.96	$ 1,176.48
629.54	CRUSHED STONE BEDDING (3/4" - 1 1/2" STONE)	TON	17	$ 34.04	$ 578.68
301.26	SUBBASE OF CRUSHED GRAVEL, FINE GRADED	CY	100	$ 40.03	$ 4,003.00
		PIPING			
605.13	12 INCH UNDERDRAIN PIPE	LF	55	$ 47.00	$ 2,585.00
649.41	GEOTEXTILE FOR UNDERDRAIN TRENCH LINING	SY	8	$ 4.04	$ 32.32
601.0905	12" CPEP	LF	20	$ 39.24	$ 784.80
601.0915	18" CPEP (Outlet)	LF	30	$ 64.04	$ 1,921.20
601.0920	24" CPEP (stand pipe)	LF	36	$ 61.37	$ 2,209.32
		STRUCTURES AND APPURTENANCES			
604.18	PRECAST REINFORCED CONCRETE DROP INLET WITH CAST IRON GRATE	EACH	2	$ 4,009.29	$ 8,018.58
N/A	18' ANTI-SEEP COLLAR	EACH	3	$ 250.00	$ 750.00
N/A	18" BEEHIVE GRATE	EACH	8	$ 615.00	$ 4,920.00
N/A	30 MM PVC LINER	SY	486	$ 5.40	$ 2,624.40

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
	OVERFLOWS AND TRANSFER WEIRS				
613.11	*STONE FILL, TYPE II*	*CY*	*30*	*$ 42.49*	*$ 1,274.70*
613.10	STONE FILL, TYPE I	CY	7	$ 43.91	$ 307.37
	PLANTING				
N/A	WETLAND PLANT SEEDS	LBS	10	$ 125.00	$ 1,250.00
	PRETREATMENT GRASS CHANNEL				
203.27	*UNCLASSIFIED CHANNEL EXCAVATION*	*CY*	*65*	*$ 13.65*	$ 887.25
	GRASS REPLACEMENT				
653.20	TEMPORARY EROSION MATTING	SY	125	$ 2.20	$ 275.00
651.29	STRAW MULCH	TON	1	$ 455.33	$ 455.33
651.15	SEED	LB	10	$ 7.66	$ 76.60
				Subtotal:	$ 38,912.13
Subtotal:					$ 41,094.78
	Construction Oversight**	HR	16	$ 125.00	$ 2,000.00
	Construction Contingency - 10%**				$ 4,109.48
	Incidentals to Construction - 5%**				$ 2,054.74
	Minor Additional Design Items - 5%**				$ 2,054.74
	Final Design	HR	55	$ 125.00	$ 6,875.00
	Permit Review and Applications (exclusive of permit fees)	HR	16	$ 125.00	$ 2,000.00
				Total (Rounded to nearest $1,000)	**$ 60,000.00**

4.2.4 Next Steps

As this site is owned and operated by the Town of East Montpelier, it is recommended that the Town, with the support of the school board and school officials, proceed with further design of this retrofit. Further design will involve refinement of the retrofit design with respect to size, outlet design, and routing to ensure that the target volume can be completely managed and that larger storms bypass the system safely.

4.2.5 Permit Needs

A project readiness screening worksheet has been completed for this project and is included in Appendix B15 - Permit Review Sheets. In summary:

Stormwater Permit
U-32 High School has a current stormwater permit covering 0.02 acres of impervious surfaces. However, this site will likely need a stormwater permit under the proposed 3-acre impervious cover rule as the greater parcel contains 10.86 acres if impervious cover.

The site should qualify for an Erosion Prevention and Sediment Control permit (3-9020) under the Low Risk categorization if the following guidelines are followed:

- Less than 2 acres of disturbance at any one time.
- All soils must be stabilized (temporary or final) within 7 days.
- Runoff from the site must pass through a 50’ vegetated buffer prior to entering any Water of the State.

Local Permitting

No local permits are anticipated.

Other Permits

An Act 250 permit for U-32 High School (500003) exists, and as such this project should be reviewed to determine if an amendment to this permit would be required. This project should be reviewed by a wetland ecologist prior to final design due to the presence of hydric soils. No River Corridor permitting is anticipated for this project.

4.3 Morse Farm Maple Sugarworks

4.3.1 30% Concept Design Description

Morse Farms Maple Sugarworks is located at 1168 County Rd in Montpelier, VT. The site includes several buildings and associated driveways and parking lots. This area currently drains via overland flow to a small tributary in the cow pasture located southwest of the lower driveway. This area was noted by the Town as being a good potential candidate for inclusion as a high-priority site within this plan.

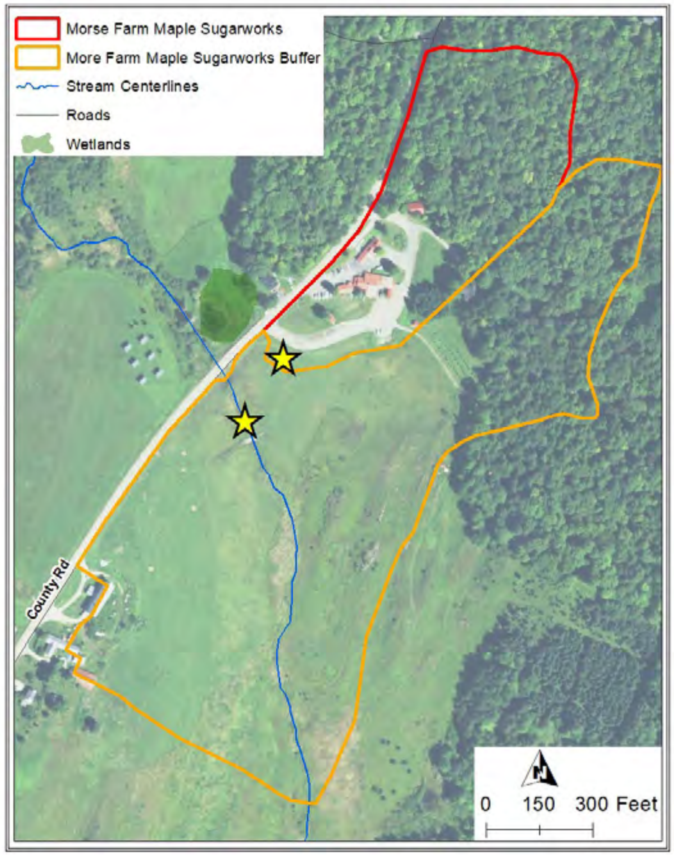

Figure B18. The drainage area for the proposed gravel wetland is outlined in red. The drainage area for the buffer restoration is shown in orange.

The concept for this site includes adding a stone lined swale along County Rd to collect site and road drainage and adding a driveway culvert under lower driveway. The upper parking lot will be regraded to better direct runoff to the stone lined swale. The lower parking lot will also be regraded and a perimeter grass swale will be added along the northern edge of lower parking lot. This swale will direct drainage to the stone lined swale along the road. A gravel wetland is proposed below the driveway culvert outlet, just west of the lower driveway (see starred location in Figure B18). The fence will need to be relocated to the south to keep cows out of this area. It is recommended that an educational sign be installed at this site to educate visitors. This cost is not reflected in the estimated project cost itemized below. Approximately $500 should be budgeted for this sign. The proposed retrofits also include an improved stream buffer between the road and the property line on either side of the stream. See the photos and associated descriptions in Figure B19. The Morse Farm owner has expressed willingness to proceed with further design.

Puddles and potholes in the upper parking lot.

Drainage from the upper parking lot and County Rd flows along the grass and over the lower driveway.

A gravel wetland is proposed in the greenspace across from the sign (pictured above). A driveway culvert will be added to the right of the sign to direct drainage to the practice.

Figure B19. The proposed retrofits are described in the above photos.

Soils are mapped as being poor at this site (Hydrologic Group C), so an analysis was not conducted to evaluate the potential for an infiltration practice.

A rendering of the proposed stormwater improvements was created to bring a concept to life in ways that engineering plans cannot. This rendering is one possible configuration for this site. This graphically engaging rendering visually communicates the plans and can be used by the Town and the CVRPC to help advance designs toward implementation. This rendering can be found in Appendix B16 - Site Renderings.

The drainage area for this proposed BMP is 36 acres, approximately 6% of which is classified as impervious. This practice will provide a significant water quality benefit (see Table B11). The design standard used for this retrofit was filtration and slow release of the Water Quality volume (WQv, or 1 inch of rain in a 24-hour period), equal to 3,833 ft^3 of runoff.

An updated BMP summary sheet is included in Appendix B11 - Top 5 Sites. A 30% design plan is provided in Appendix B13 - 30% Designs.

4.3.2 Pollutant Removal and Other Water Quality Benefits

A retrofit of this site has the potential to prevent nearly 12,000 lbs of total suspended solids (TSS) and 6.7 lbs of total phosphorus (TP) from entering receiving waters annually (Table B11).

Table B11. More Farm Maple Sugarworks benefit summary table.

TSS Removed	11,988 lbs
TP Removed	6.7 lbs
Impervious Treated	2 acres
Total Drainage Area	36 acres

4.3.3 Cost Estimates

The total estimated cost for this project is $60,000. Note that these costs are very preliminary. Cost projections can be found in Table B12. This amount differs from the amount initially projected for this site as design-specific amounts and costs were used.

- The cost per pound of phosphorus treated is $8,955.
- The cost per impervious acre treated is $30,000.
- The cost per cubic foot of runoff treated is $15.65.

Table B12. More Farm Maple Sugarworks project initial construction cost projection.

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
Site Preparation					
N/A	MOBILIZATION	LS	1	$ 500.00	$ 500.00
653.55	PROJECT DEMARCATION FENCE	LF	225	$ 1.17	$ 263.25
649.51	GEOTEXTILE FOR SILT FENCE	SY	151	$ 4.13	$ 623.63
N/A	CONSTRUCTION STAKING	HR	6	$ 125.00	$ 750.00
				Subtotal:	$ 2,136.88
Gravel Wetland - Excavation and Materials					
	EXCAVATION				
203.15	COMMON EXCAVATION	CY	391	$ 9.86	$ 3,855.26
	MATERIALS				
	GRAVEL LAYERING				
651.35	TOPSOIL (MUCK SOIL)	CY	33	$ 30.96	$ 1,021.68
629.54	CRUSHED STONE BEDDING (3/4" - 1 1/2" STONE)	TON	15	$ 34.04	$ 510.60
301.26	SUBBASE OF CRUSHED GRAVEL, FINE GRADED	CY	87	$ 40.03	$ 3,482.61
	PIPING				
605.13	12 INCH UNDERDRAIN PIPE	LF	36	$ 47.00	$ 1,692.00
649.41	GEOTEXTILE FOR UNDERDRAIN TRENCH LINING	SY	15	$ 4.04	$ 60.60
601.0905	12" CPEP	LF	15	$ 39.24	$ 588.60
601.0915	18" CPEP (Outlet)	LF	60	$ 64.04	$ 3,842.40
601.0920	24" CPEP (stand pipe)	LF	24	$ 61.37	$ 1,472.88
	STRUCTURES AND APPURTENANCES				
604.18	PRECAST REINFORCED CONCRETE DROP INLET WITH CAST IRON GRATE	EACH	1	$ 4,009.29	$ 4,009.29
N/A	18' ANTI-SEEP COLLAR	EACH	1	$ 250.00	$ 250.00
N/A	18" BEEHIVE GRATE	EACH	4	$ 615.00	$ 2,460.00
N/A	30 MM PVC LINER	SY	385	$ 5.40	$ 2,079.00
	OVERFLOWS AND TRANSFER WEIRS				
613.11	STONE FILL, TYPE II	*CY*	*15*	*$ 42.49*	*$ 637.35*
	PLANTING				
N/A	WETLAND PLANT SEEDS	LBS	10	$ 125.00	$ 1,250.00
	CONVEYANCE SWALES AND STRUCTURES				
613.10	STONE FILL, TYPE I	CY	122	$ 43.91	$ 5,357.02
601.0915	18" CPEP (CULVERT)	LF	75	$ 64.04	$ 4,803.00
203.27	UNCLASSIFIED CHANNEL EXCAVATION	CY	92	$ 13.65	$ 1,255.80

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
	GRASS REPLACEMENT				
653.20	TEMPORARY EROSION MATTING	SY	185	$ 2.20	$ 407.00
651.29	STRAW MULCH	TON	1	$ 455.33	$ 455.33
651.15	SEED	LB	5	$ 7.66	$ 38.30
				Subtotal:	$ 39,528.72
Subtotal:					$ 41,665.60
	Construction Oversight**	HR	16	$ 125.00	$ 2,000.00
	Construction Contingency - 10%**				$ 4,166.56
	Incidentals to Construction - 5%**				$ 2,083.28
	Minor Additional Design Items - 5%**				$ 2,083.28
	Final Design	HR	45	$ 125.00	$ 5,625.00
	Permit Review and Applications (exclusive of permit fees)	HR	16	$ 125.00	$ 2,000.00
				Total (Rounded to nearest $1,000)	**$ 60,000.00**

4.3.4 Next Steps

As this site is owned by the Burr Morse, it is recommended that the Town proceed with further design of this retrofit after obtaining a formal memorandum of understanding with the landowner. Further design will involve refinement of the retrofit design with respect to size, outlet design, and routing to ensure that the target volume can be completely managed and that larger storms bypass the system safely.

4.3.5 Permit Needs

A project readiness screening worksheet has been completed for this project and is included in Appendix B15 - Permit Review Sheets. In summary:

Stormwater Permit
It is not expected that a stormwater permit will be required at this time.

The site should qualify for an Erosion Prevention and Sediment Control permit (3-9020) under the Low Risk categorization if the following guidelines are followed:

- Less than 2 acres of disturbance at any one time.
- All soils must be stabilized (temporary or final) within 7 days.
- Runoff from the site must pass through a 50’ vegetated buffer prior to entering any Water of the State.

Local Permitting
No local permits are anticipated.

Other Permits
This site should be reviewed by a River Scientist prior to final design due to the project’s close proximity to surface waters. This project should be reviewed by a wetland ecologist prior to final design due to the project’s close proximity to hydric soils. No Act 250 permitting concerns are anticipated for this project.

4.4 Town Garage and Fire Station

4.4.1 30% Concept Design Description

This site includes the garage building, salt shed, equipment and materials storage, and a large sand pile. Drainage from this site currently travels via overland flow to Chapels Pond located just east of the site. Chapels Pond drains to a tributary of Sodom Pond Brook. Significant erosion was observed in several locations around the site and salt residue was also observed around the front of the salt shed. The Town Garage was noted by the Town as a stormwater problem area.

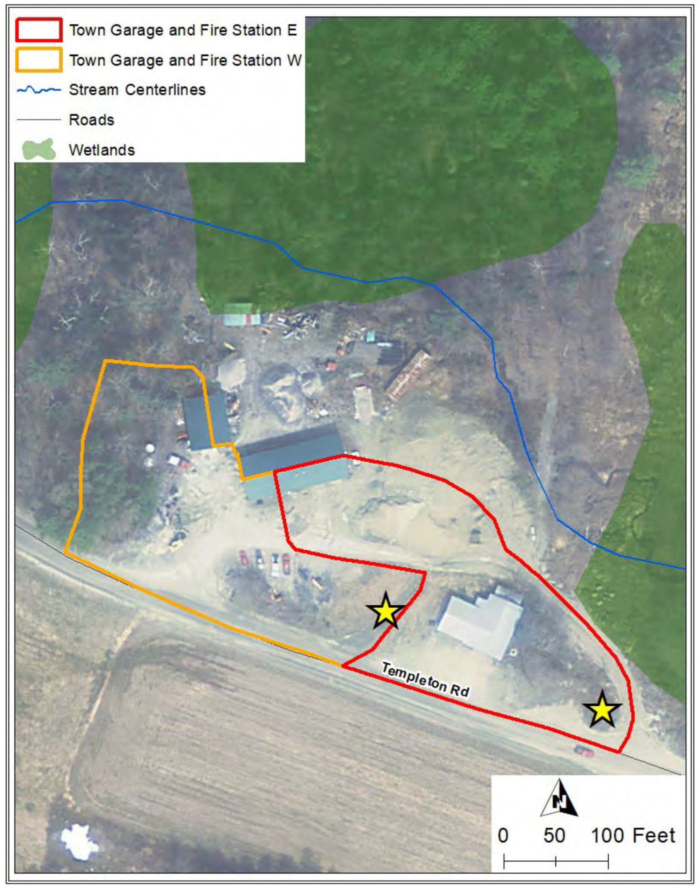

Figure B20. The two proposed sediment traps are shown with yellow stars. The drainage areas for these two practices are shown in orange (west) and red (east).

The proposed retrofit for this area includes creating a paved apron at the entrance of the salt shed to improve chloride management by reducing material transport outside of shed. It is recommended that the Town ensure that any spills are cleaned up immediately. The retrofit also includes regrading and resurfacing the driveway and parking lot with Staymat to reduce erosion and sediment transport through this area. The ditch located on the south side of the driveway behind fire station building should be stabilized with stone. The existing sediment trap, west of the fire station, will be expanded to allow for more sediment retention. An additional sediment trap is proposed east of the fire station in the existing vegetated low point (see starred locations in Figure B20). The drainage from the ditch behind fire station and road will be directed to the new sediment trap. It is further suggested that management of the sand pile could be improved with a covered structure or retaining wall. See the photos and associated descriptions in Figure B21.

Salt residue at entrance of salt shed. Create a paved apron here to improve salt management.

Expand the existing sediment trap west of the fire station.

Erosion along driveway between sand piles and fire station building.

A second sediment trap is proposed east of the fire station building.

Figure B21. The proposed retrofits are described in the above photos.

Soils are mapped as being poor and very poor (Hydrologic Group C/D), so an analysis was not conducted to evaluate the potential for an infiltration practice.

A rendering of the proposed stormwater improvements was created to bring a concept to life in ways that engineering plans cannot. This rendering is one possible configuration for this site. This graphically engaging rendering visually communicates the plans and can be used by the Town and the CVRPC to help advance designs toward implementation. This rendering can be found in Appendix B16 - Site Renderings.

The drainage area for this proposed BMP is 2.1 acres, approximately 60% of which is classified as impervious. This practice will provide a significant water quality benefit (Table B13). The design standard used for this retrofit was filtration and slow release of the Water Quality volume (WQv, or 1 inch of rain in a 24-hour period), equal to 3,703 ft^3 of runoff.

An updated BMP summary sheet is included in Appendix B11 - Top 5 Sites. A 30% design plan is provided in Appendix B13 - 30% Designs.

4.4.2 Pollutant Removal and Other Water Quality Benefits

A retrofit of this site has the potential to prevent nearly 5,000 lbs of total suspended solids (TSS) and 5 lbs of total phosphorus (TP) from entering receiving waters annually (Table B13).

Table B13. Town Garage and Fire Station benefit summary table.

TSS Removed	4,829 lbs
TP Removed	5 lbs
Impervious Treated	1.3 acres
Total Drainage Area	2.1 acres

4.4.3 Cost Estimates

The total estimated cost for this project is $34,000. Note that these costs are very preliminary. Cost projections can be found in Table B14. This amount differs from the amount initially projected for this site as design-specific amounts and costs were used.

- The cost per pound of phosphorus treated is $6,800.
- The cost per impervious acre treated is $26,154.
- The cost per cubic foot of runoff treated is $9.18.

Table B14. Town Garage and Fire Station project initial construction cost projection.

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
Site Preparation					
N/A	MOBILIZATION	LS	1	$ 500.00	$ 500.00
201.11	CLEARING AND GRUBBING, INCLUDING INDIVIDUAL TREES AND STUMPS	ACRE	0.005	$ 33,805.52	$ 169.03
653.55	PROJECT DEMARCATION FENCE	LF	200	$ 1.17	$ 234.00
649.51	GEOTEXTILE FOR SILT FENCE	SY	200	$ 4.13	$ 826.00
N/A	CONSTRUCTION STAKING	HR	4	$ 125.00	$ 500.00
				Subtotal:	$ 2,229.03
Sediment Trap					
	EXCAVATION				
203.15	COMMON EXCAVATION	CY	260	$ 9.86	$ 2,563.60
	INLET / OUTLET PROTECTION				
613.10	STONE FILL, TYPE I (Basin Liner)	CY	32	$ 43.91	$ 1,405.12
	SIDE SLOPE EROSION CONTROL				
651.15	SEED	LB	10	$ 7.66	$ 76.60
651.25	HAY MULCH	TON	1	$ 597.15	$ 597.15
				Subtotal:	$ 4,642.47
New Infrastructure For Conveyance of Runoff to Practice					
	EXCAVATION				
203.27	UNCLASSIFIED CHANNEL EXCAVATION	CY	67	$ 13.65	$ 914.55
613.10	STONE FILL, TYPE I (Basin Liner)	CY	50	$ 43.91	$ 2,195.50
				Subtotal:	$ 3,110.05
Pavement Replacement					
401.10	AGGREGATE SURFACE COURSE	CY	150	$ 43.60	$ 6,540.00
406.25	BITUMINOUS CONCRETE PAVEMENT	TON	55	$ 127.86	$ 7,032.30
				Subtotal:	$ 13,572.30
Subtotal:					$ 23,553.85
	Construction Oversight**	HR	16	$ 125.00	$ 2,000.00
	Construction Contingency - 10%**				$ 2,355.38
	Final Design	HR	45	$ 125.00	$ 5,625.00
				Total (Rounded to nearest $1,000)	**$ 34,000.00**

4.4.4 Next Steps

As this site is owned and operated by the Town of East Montpelier, it is recommended that the Town proceed with further design of this retrofit. Further design will involve refinement of the retrofit design with respect to size, outlet design, and routing to ensure that the target volume can be completely managed and that larger storms bypass the system safely.

4.4.5 Permit Needs

A project readiness screening worksheet has been completed for this project and is included in Appendix B15 - Permit Review Sheets. In summary:

Stormwater Permit
It is not expected that a stormwater permit will be required at this time.

The site should qualify for an Erosion Prevention and Sediment Control permit (3-9020) under the Low Risk categorization if the following guidelines are followed:

- Less than 2 acres of disturbance at any one time.
- All soils must be stabilized (temporary or final) within 7 days.
- Runoff from the site must pass through a 50’ vegetated buffer prior to entering any Water of the State.

Local Permitting
No local permits are anticipated.

Other Permits
This project should be reviewed by a wetland ecologist prior to final design due to project’s close proximity to hydric soils and mapped wetlands. No Act 250 permitting or River Corridor concerns are anticipated for this project.

4.5 East Montpelier Elementary School

4.5.1 30% Concept Design Description

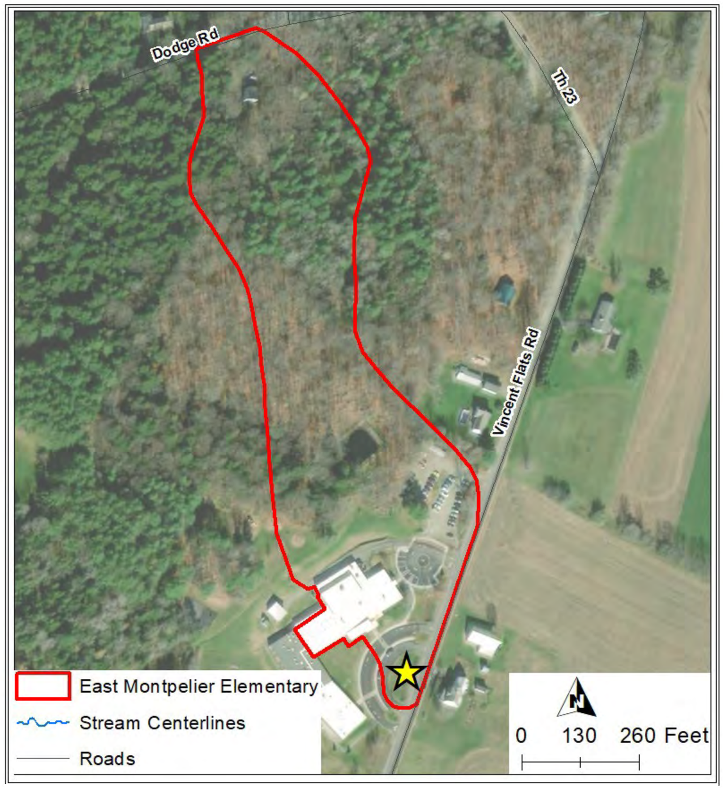

Figure B22. The proposed BMP drainage area is shown in red. The BMP location is shown with a star.

The East Montpelier Elementary School is located at 665 Vincent Flats Rd in East Montpelier, VT. The site is bordered by undeveloped woods to the northwest, and the Town's recreation fields and adjacent wetland to the southwest. This area includes the school building and associated driveways and parking lots. Stormwater currently sheet flows through this area, is collected by catchbasins, and conveyed through a number of grass swales along the road. A catchbasin located in the southeastern corner of the school's property drains to a pipe under the Town's rec fields and discharges to the adjacent wetland via a level spreader. The wetland drains to a tributary of the Winooski. Although the school has an active stormwater permit, the permit only covers impervious added during recent school improvements and not the entire site. The school was noted by the Town as being a good potential candidate to be included in the plan as a high priority site.

The concept for this site includes guttering the roof of the building in upper parking lot and directing drainage to a series of rain barrels for water reuse. The western half of upper parking lot will be regraded to better direct drainage to the central greenspace. The eastern half of upper parking will be regraded lot towards eastern edge. A vegetated swale along the eastern edge of the parking lot will be created. A culvert will be added to drain the central greenspace to the new swale. Also included in the retrofit is to construct a stone lined swale between the swale and existing driveway culvert by road. A bioretention feature is proposed in the greenspace along the road by the turn around in front of the school building (see starred location in Figure B22). This feature will outlet to the existing culvert. It is recommended that an educational sign be installed at this site to educate students and the general public. This cost is not reflected in the estimated project cost itemized below. Approximately $500 should be budgeted for this sign. See the photos and associated descriptions in Figure B23. School officials have expressed their willingness to proceed with further design.

A bioretention is proposed in the roadside ditch by the turnaround in front of the school.

A vegetated swale is proposed along the eastern edge of the upper parking lot.

A new culvert will drain the central greenspace of the upper parking lot to the new swale.

Gutter the roof and direct to a series of rain barrels for water reuse (garden adjacent).

Figure B23. The proposed retrofits are described in the above photos.

Figure B24. Soils were generally loamy.

Soils are mapped as being good at this site (Hydrologic Group B), so an analysis was conducted to evaluate the potential for an infiltration practice. Soils were assessed and were found to be generally loamy with a higher percentage of silt and clay (Figure B24). Soils conditions observed during analysis did prompt a need to alter the initially proposed infiltration-based retrofit design to include an underdrain. See Appendix B14 for this site's complete soil log.

A rendering of the proposed stormwater improvements was created to bring a concept to life in ways that engineering plans cannot. This rendering is one possible configuration for this site. This graphically engaging rendering visually communicates the plans and can be used by the Town and the CVRPC to help advance designs toward implementation. This rendering can be found in Appendix B16 - Site Renderings.

The drainage area for these proposed BMPs is 10.4 acres, approximately 19% of which is classified as impervious. The design standard used for this retrofit was detention and slow release of the Water Quality volume (WQv, or 1 inch of rain in a 24-hour period), equal to 5,328 ft^3 of runoff.

An updated BMP summary sheet is included in Appendix B11 - Top 5 Sites. A 30% design plan is provided in Appendix B13 - 30% Designs.

4.5.2 Pollutant Removal and Other Water Quality Benefits

A retrofit of this site has the potential to prevent more than 1,000 lbs of total suspended solids (TSS) and 4.4 lbs of total phosphorus (TP) from entering receiving waters annually (Table B15).

Table B15. East Montpelier Elementary School benefit summary table.

TSS Removed	1,036 lbs
TP Removed	4.4 lbs
Impervious Treated	2 acres
Total Drainage Area	10.4 acres

4.5.3 Cost Estimates

The total estimated cost for this project is $41,000. Note that these costs are very preliminary. Cost projections can be found in Table B16. This amount differs from the amount initially projected for this site as design-specific amounts and costs were used.

- The cost per pound of phosphorus treated is $9,318.
- The cost per impervious acre treated is $20,500.
- The cost per cubic foot of runoff treated is $7.69.

Table B16. East Montpelier Elementary School project initial construction cost projection.

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
Site Preparation					
N/A	MOBILIZATION	LS	1	$ 500.00	$ 500.00
201.15	REMOVING MEDIUM TREES	EACH	3	$ 1,335.18	$ 4,005.54
653.55	PROJECT DEMARCATION FENCE	LF	360	$ 1.17	$ 421.20
N/A	CONSTRUCTION STAKING	HR	6	$ 125.00	$ 750.00
				Subtotal:	$ 5,676.74
Bioretention - Excavation and Materials					
		EXCAVATION			
203.15	COMMON EXCAVATION	CY	360	$ 9.86	$ 3,549.60
		MATERIALS			
		BIORETENTION MEDIA			
651.35	TOPSOIL (BIORETENTION MEDIA)	CY	112	$ 30.96	$ 3,467.52
		PLANTING			
N/A	WILDFLOWER PLANT SEEDS	LBS	2	$ 125.00	$ 250.00
651.15	SEED	LB	2	$ 7.66	$ 15.32
653.20	TEMPORARY EROSION MATTING	SY	360	$ 2.20	$ 792.00
651.25	HAY MULCH	TON	0.5	$ 597.15	$ 298.58
				Subtotal:	$ 8,373.02
New Infrastructure For Conveyance of Runoff to Practice					
		GRASS CHANNEL			
203.27	UNCLASSIFIED CHANNEL EXCAVATION	CY	72	$ 13.65	$ 982.80
613.10	STONE FILL, TYPE I (Basin Liner)	CY	50	$ 43.91	$ 2,195.50
		STRUCTURES AND PIPES			
601.0915	18" CPEP	LF	72	$ 64.04	$ 4,610.88
		RE-GRADING OF PARKING LOT			
401.10	AGGREGATE SURFACE COURSE	CY	160	$ 43.60	$ 6,976.00
		GRASS REPLACEMENT			
651.25	HAY MULCH	TON	0.5	$ 597.15	$ 298.58
651.15	SEED	LB	10	$ 7.66	$ 76.60
				Subtotal:	$ 15,140.36
Rain Barrells					
NA	Rain Barrel	LS	2	$ 250.00	$ 500.00
NA	Guttering	LF	55	$ 7.50	$ 412.50
				Subtotal:	$ 912.50
Subtotal:					$ 30,102.61
	Construction Oversight**	HR	16	$ 125.00	$ 2,000.00
	Construction Contingency - 10%**				$ 3,010.26
	Final Design	HR	45	$ 125.00	$ 5,625.00
				Total (Rounded to nearest $1,000)	**$ 41,000.00**

4.5.4 Next Steps

As this site is owned and operated by the Town of East Montpelier, it is recommended that the Town, with the support of the school board and school officials, proceed with further design of this retrofit. Further design will involve refinement of the retrofit design with respect to size, outlet design, and routing to ensure that the target volume can be completely managed and that larger storms bypass the system safely.

4.5.5 Permit Needs

A project readiness screening worksheet has been completed for this project and is included in Appendix B15 - Permit Review Sheets. In summary:

Stormwater Permit
It is not anticipated that this site will need a stormwater permit at this time.

The site should qualify for an Erosion Prevention and Sediment Control permit (3-9020) under the Low Risk categorization if the following guidelines are followed:

- Less than 2 acres of disturbance at any one time.
- All soils must be stabilized (temporary or final) within 7 days.
- Runoff from the site must pass through a 50’ vegetated buffer prior to entering any Water of the State.

Local Permitting
No local permits are anticipated.

Other Permits
No Act 250 permitting, wetlands, or river corridor concerns are anticipated for this project.

C. Chapter 3: Woodbury

1 Background

1.1 Problem Definition

The Town of Woodbury is located in Washington County primarily within the Kingsbury Branch watershed, though small portions fall within four other watersheds including the Headwaters Winooski River and the Nasmith Brook-Winooski River watersheds (Figure C1). Each of these watersheds is within the larger Winooski River watershed, which drains to Lake Champlain. The Winooski River has numerous reaches that are adversely impacted by stormwater runoff and development.

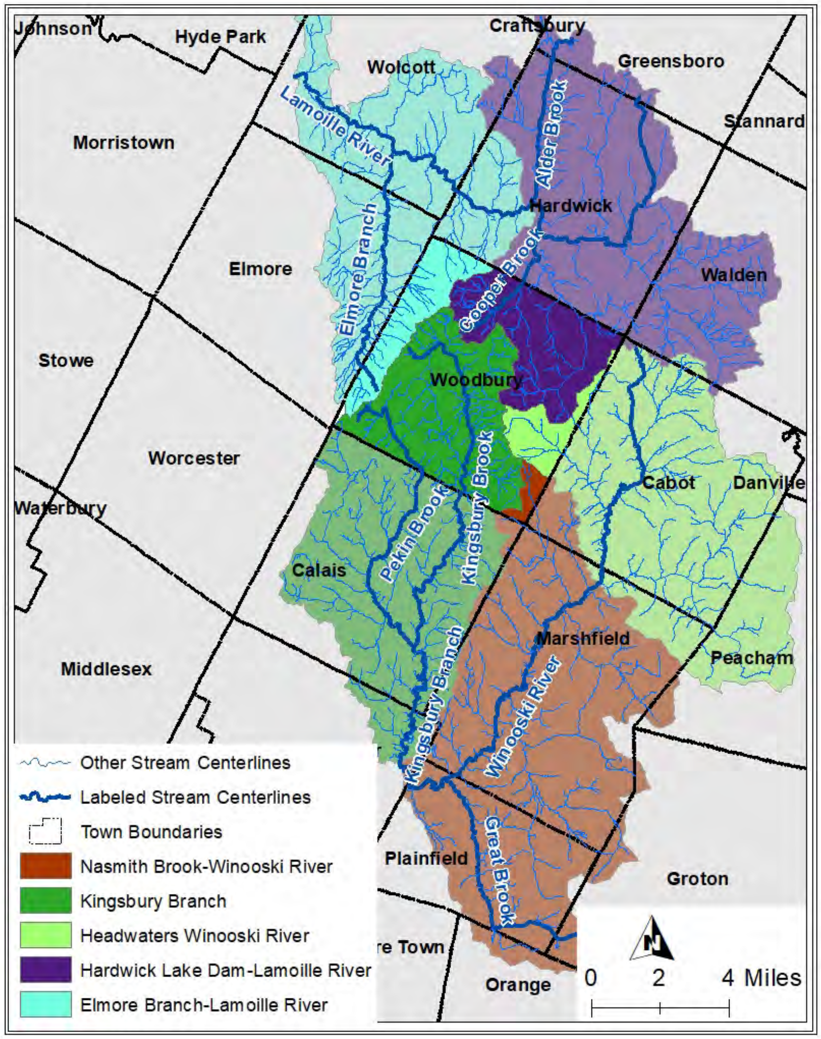

Figure C1. The Town of Woodbury is located primarily within the Kingsbury Branch watershed, a tributary of the Winooski River.

Woodbury has experienced increased development along Route 14, with expanding areas of impervious surfaces. Route 14 parallels the Kingsbury Branch as far north as Greenwood Lake, with moderately developed areas falling within or close to the river corridor. This development has constrained the Kingsbury Branch along both banks in some locations such as downtown Woodbury. In addition to development along this corridor, Woodbury experiences erosion as a result of steep slopes and unstable soils, further contributing to sediment and nutrient loading in surface waters.

The human-influenced stressors in the watersheds include construction of roads, residential development, and clearing of previously forested areas. Additionally, in part due to likely historic straightening of rivers in the area, associated incision of stream channels, and limited floodplain access, both nuisance flooding and potentially more extreme flood events can occur. Unmanaged stormwater runoff, particularly from impervious surfaces and landscaped pervious areas, exacerbate this flooding. The Winooski River watershed and its tributaries have experienced extreme flooding in the past, and these flood events are only expected to occur more frequently due to the predicted increased frequency and intensity of extreme weather events associated with climate change. These heavy rains and easily erodible soils have contributed to erosion issues throughout the area. The stormwater management practices investigated seek to protect local river resources as well as the larger Lake Champlain Basin, which currently has a Total Maximum Daily Load (TMDL) in place. This TMDL requires reductions in phosphorus loading to Lake Champlain via its tributaries through reductions in stormwater and agricultural runoff pollution.

1.2 Existing Conditions

The Town of Woodbury spans approximately 25,139 acres in Washington County, VT and is primarily forested (86%) with small areas of agricultural (2%) and urban land cover (3%). Of that area, there are 254 acres (1%) of impervious cover. Woodbury lies north of Calais and south of Hardwick (Figure C2). This area of the state is generally primarily rural with small commercial developments and rural residential areas. Development in the Town is concentrated along the Route 14 corridor, which parallels Kingsbury Brook. The remainder of the Town is primarily rural-residential or undeveloped. There are also several large lakes and ponds in Woodbury, and development has occurred along several of these lakeshores.

Many of the developments within the Town were constructed before current stormwater standards were developed, and they were constructed without any or with only minimal stormwater management. This has resulted in untreated stormwater draining from developed lands discharging directly to surface waters.

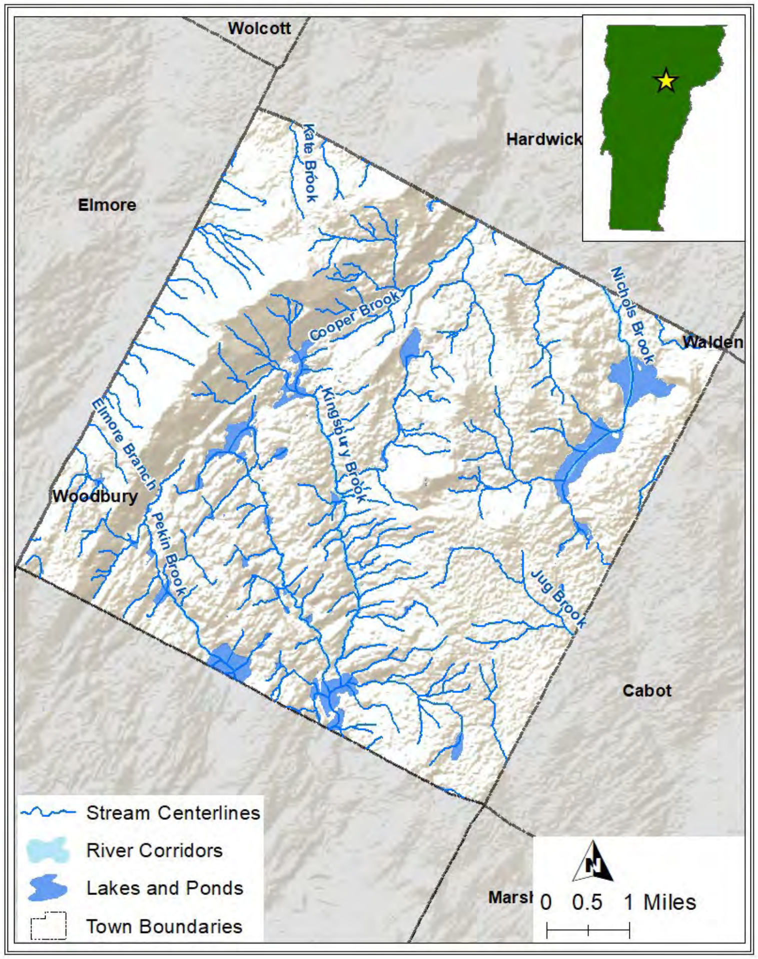

Figure C2. The Town of Woodbury is located in Washington County, VT.

Surrounding the developed lands, rural roads are generally unpaved, with open roadside ditches, and cross culverts. Many of these roads have steep slopes, and traverse large areas. Furthermore, the rural roads access residential driveways which often convey drainage into, and through the Town road drainage system. This is a problem because runoff from private lands is negatively impacting the Town's overall drainage system.

Soils analyses indicate that of the 25,139 total acres in the Town, 91% are classified as either potentially highly-erodible, or highly-erodible by the latest Natural Resources Conservation Service (NRCS) soil mapping data. Additionally, the majority of the soils in the watershed have very low infiltration potential as indicated by NRCS Hydrologic Soil Group classifications where soils are classified from group A (highest infiltration potential) to group D (lowest infiltration potential). In the Town, the majority of areas belong to either Hydrologic Soil Group C (49%) or D (28%), while only 4% are in group A, and 16% are in group B. The remainder is not classified or comprised of water. This combination of limited infiltration capacity and a highly-erodible surface make the area particularly susceptible to erosion. Maps depicting existing watershed conditions can be found in Appendix C1 – Map Atlas. Maps include:

- river corridors, wetlands, and hydric soils,
- impervious cover,
- soil infiltration potential,
- soil erodibility,
- land cover,
- slope,
- stormwater infrastructure and stormwater permits,
- and parcels with ≥3 acres of impervious cover.

2 Methodology

2.1 Identification of All Opportunities

2.1.1 Initial Data Collection and Review:

All relevant prior watershed studies and any studies that could inform planning in the project area were assembled and reviewed in the context of this stormwater master plan (SWMP) study. These reports include the Water Quality Management Plan, geomorphic studies including the River Corridor Management Plan, aquatic life studies, and stormwater infrastructure mapping and prioritization.

Relevant Geographic Information System (GIS) data was drawn from a variety of public resources including the Agency of Natural Resource’s Atlas, Vermont Center for Geographic Information Open Geodata Portal, and data created by the University of Vermont’s Spatial Analysis Lab. A file geodatabase was created to ensure organization and for ease of use. These data represent the “best available” data at the time of data collection (2017). The information collected and reviewed for the creation of this SWMP as well as a summary memo are included as Appendix C2 – Data Review.

The project team met with Town of Woodbury stakeholders and the Central Vermont Regional Planning Commission (CVRPC) on November 16, 2017 to discuss the SWMP and solicit information on problem areas from the Town. Meeting minutes from this meeting are included in Appendix C3. A second meeting was held on January 26, 2018 to identify a list of problem areas including particular parcels and general areas of importance. These areas were noted and added to the list of sites identified during the desktop assessment (see section 2.1.2).

2.1.2 Desktop Assessment and Digital Map Preparation

2.1.2.1 *Desktop Assessment*

A desktop assessment was completed to identify additional potential sites for stormwater best management practice (BMP) implementation. This process involved a thorough review of existing GIS resources and associated attribute data. Data included, but was not limited to, storm sewer infrastructure, soils classifications, parcel data, wetlands, and river corridors. This data was used to identify and map stormwater subwatersheds with particularly high impervious cover, stormwater subwatersheds that are more directly connected to water bodies (direct pipes to streams or via overland flow), areas where infill development may occur, areas that may have worsening stormwater impacts in the future, and the parcel with ≥3 acres of impervious cover without a current stormwater permit as this area will be subject to a permit in the future. A point location was created for each identified site or area for assessment in the field.

A ‘green streets’ assessment was also conducted to identify any road segments in the Town potentially appropriate for green stormwater infrastructure (GSI) retrofit opportunities. Streets were evaluated and scored according to width, slope, and soil permeability utilizing a methodology adapted from the "Promoting Green Streets" report published by the River Network (July 2016; included as Appendix B4).

The methodology was modified to better fit specific conditions found in the study area. The analysis utilized two prerequisites and one secondary consideration.

Prerequisites:

1. Road Slope
   - 1-5% Slope = Ideal (Score: 2 points)
   - 5-7.5% Slope = Potential (Score: 1 point)
   - > 7.5% Slope = Unsuitable (Score: 0 points; discarded from further analysis)
2. Road Right-of-Way Width
   - ≥ 50 ft = Ideal (Score: 2 points)
   - 46-50 ft = Potential (Score: 1 point)
   - < 46 ft = Unsuitable (Score: 0 points; discarded from further analysis)

Secondary Consideration:

3. Hydrologic Soil Group (indication of infiltration potential)
   - A/B (highest infiltration potential) = Ideal (Score: 2 points)
   - B/C (moderate infiltration potential) = Potential (Score: 1 point)
   - C/D (lowest infiltration potential) = Unsuitable (Score: 0 points; **not** discarded from further analysis)

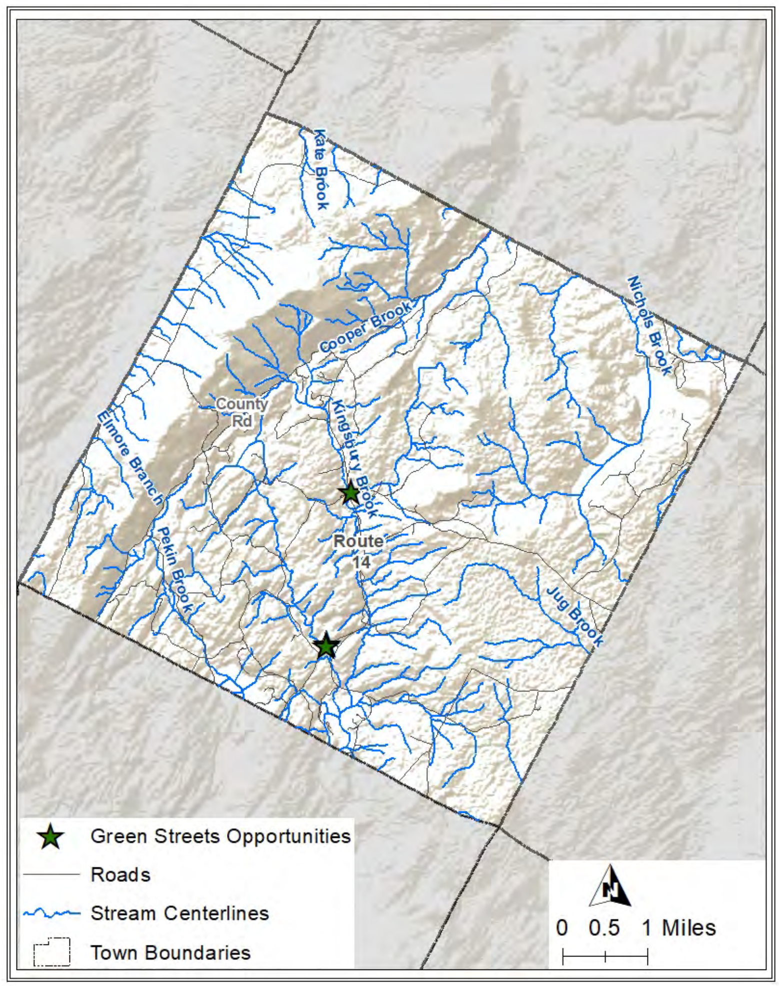

Figure C3. The 3 locations identified as potential green streets opportunities are shown with green stars.

The scores from each of the three criteria were added, and a score was assigned for each road segment where higher scores indicated a greater potential for GSI suitability. In total, 3 sites with potential were noted for assessment in the field (Figure C3).

A total of 54 locations, including the Green Streets sites, were identified for stormwater retrofit potential

2.1.2.2 Basemap and Mobile App Creation

In order to maximize efficiency in the field and better understand site-specific conditions, digital base maps were created for the Town. The maps show parcel boundaries, public parcels, stormwater infrastructure, hydrologic soils groups, river corridors, hydric soils, and wetlands. This information was used in the field to assess potential feasibility issues for proposed practices and to better identify preliminary BMP locations.

The base layers were pre-loaded into a project-specific mobile app that was customized for this project using the Fulcrum platform. The app was also pre-loaded with the 54 point locations for the potential BMP sites. These points allowed for easy site location and data collection in the field (Figure C4).

The app was used to collect information including site suitability, photographic documentation, follow-up notes, and other pertinent data (Figure C4). All collected data was securely uploaded to the Cloud for later use.

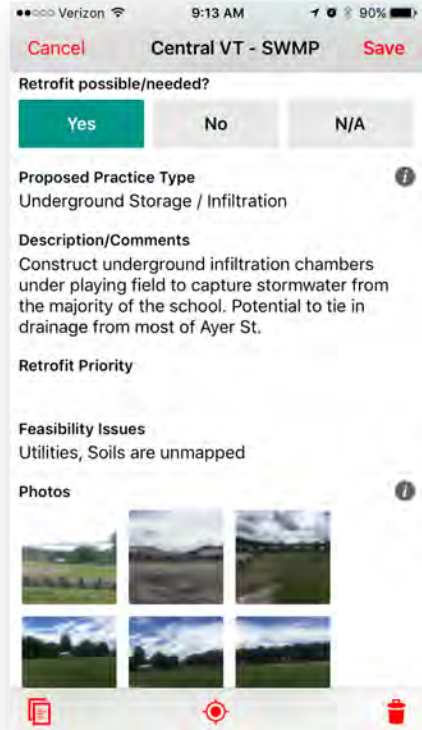

Figure C4. Example screen from data collection app.

2.1.3 Field Data Collection:

Each of the 54 previously identified potential BMP locations were evaluated in the field during the Summer of 2018 (Figure C5). Data was collected about each site in the mobile app. A large map of these sites with associated site names and a list of these sites including potential BMP options and site notes can be found in Appendix C5 - Initial Site Identification.

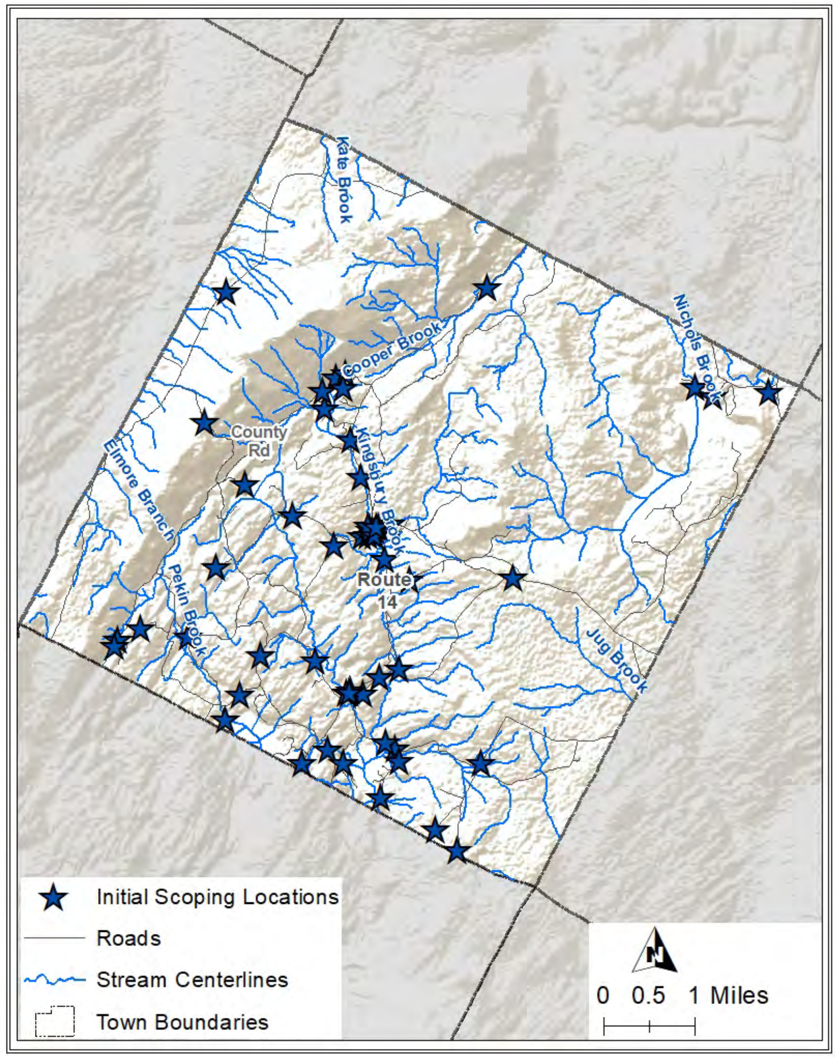

Figure C5. 54 potential sites for BMP implementation were identified for field investigation.

Through the course of these field visits, additional stormwater retrofit sites were identified that had not been included in the initial assessment. A total of 54 sites in Woodbury were assessed as part of this plan. Some site locations that seemed like potential opportunities for BMP implementation were excluded from further analysis due to specific, prohibitive site conditions. Following this process, a total of 51 sites in Woodbury sites remained as potential BMP opportunities.

2.2 Preliminary BMP Ranking

After the initial field visits were completed and the project list was updated, a preliminary ranking system was utilized to prioritize these 51 projects (Figure C6). The goal of this ranking was to identify the 20 sites that would provide the greatest water quality benefit and have a high likelihood of implementation. This prioritization was accomplished by completing an assessment of project feasibility and benefits including drainage area size, pollutant load reduction potential, proximity to water, land ownership, and feasibility issues. See Appendix C6 - Preliminary Site Ranking for the complete list of factors utilized in the preliminary ranking. Also included in Appendix C6 is the completed ranking for each potential site, one-page field data summary sheets with initial ranking information, and a memo detailing this ranking process.

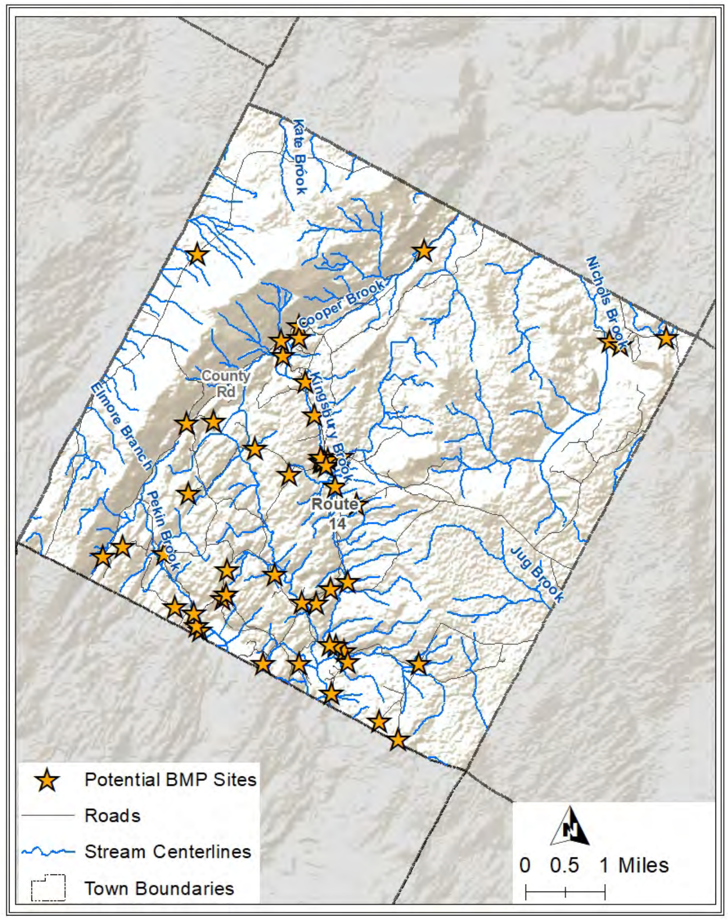

Figure C6. Following field investigations and stakeholder feedback, the list of potential BMP sites was refined to 50. Point locations are shown for each site.

The draft Top 20 list was distributed to Woodbury stakeholders and the CVRPC. As part of this process, the project team met with the stakeholders on September 11, 2018 to discuss the proposed Top 20 project sites. Following feedback from the Town, the list was refined to reflect the Town's knowledge of potentially unwilling landowners and the Town's priorities. The list was reduced from 51 to 50 sites. These Top 20 sites are listed in Table C1. Point locations are shown in Figure C7.

Table C1. Top 20 BMPs selected for the Woodbury SWMP.

Site ID	Proposed Practice Type
Woodbury School	Gravel Wetland
Church St	Underground Storage
Woodbury Garage	Sediment Trap
Fire Dept Annex & Food Shelf	Underground Storage
Fire Station and Post Office	Underground Storage
Woodbury Church and Town Clerk	Infiltration Trench
Scribner Rd	Ditch / Swale Improvements
Tebbets Rd	Ditch / Swale Improvements
W Woodbury Rd	Ditch / Swale Improvements
Blueberry Hill Rd	Ditch / Swale Improvements
Sabin Pond Fish & Wildlife Access	Infiltration Basin
East Hill Rd	Dry Well
Chartier Hill Rd Lower to Farm	Ditch / Swale Improvements
Cabot Rd Box Culvert	Buffer
Nelson Pond Access Point	Bioretention
County Rd Residential	Buffer
Route 14 Driveway	Infiltration Basin
Shatney's Garage	Ditch / Swale Improvements
Fishing Access on Route 14	Buffer
County Road Buffer	Buffer

2.3 Modeling and Concept Refinement for Top 20 BMPs

Modeling was completed for each of the Top 20 sites. This modeling allowed for accurate sizing of the proposed practices, as well as an understanding of the water quality and quantity benefits. The contributing drainage area of each of the BMPs was defined and landuse/landcover was digitized using the best available topographic data and aerial imagery. Drainage areas were refined based on field observations. Each of the sites was modeled in HydroCAD to determine the appropriate BMP size and resultant stormwater volume reductions (see Appendix C8 - Top 20 Sites Modeling for modeling reports).

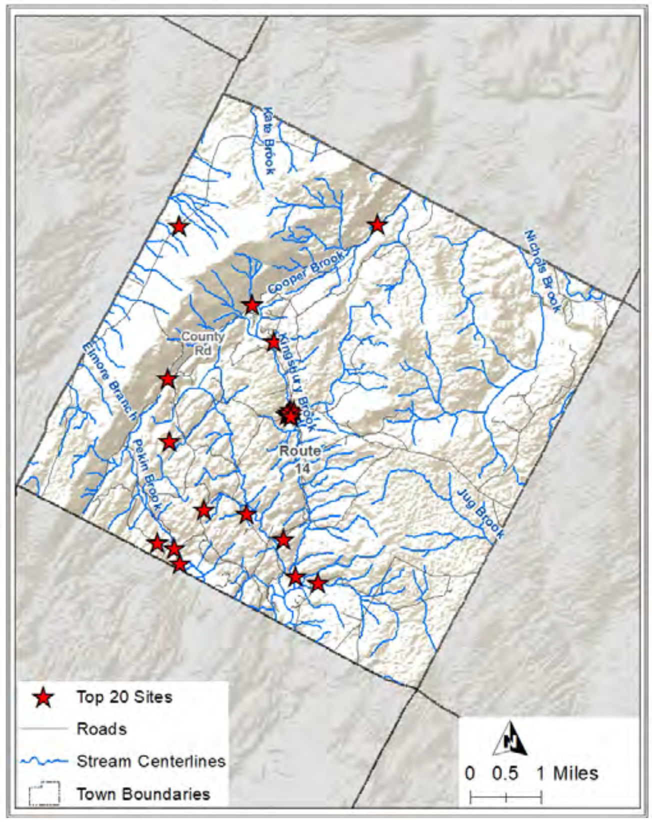

Figure C7. The Top 20 project locations are shown.

Each of these sites was also modeled using the Source Loading and Management Model for Windows (WinSLAMM) to determine the annual total suspended solids (TSS) and total phosphorus (TP) loading from the drainage area of each site. Pollutant load reductions from each of the BMPs were then calculated using one of two sources, depending on the practice type. WinSLAMM was used when possible, and, for those practices that WinSLAMM does not model well (generally non-infiltration-based practices; based on experience and literature), pollutant removal rates published by the University of New Hampshire Stormwater Center were applied to the initial pollutant loading modeled with WinSLAMM for the site's current conditions. This yielded expected pollutant removal loads (lbs) and rates (%). Complete modeling results are provided in Appendix C8 - Top 20 Sites Modeling.

Table C2. Modeled volume and pollutant load reductions for the Top 20 BMPs.

Site ID	Volume Managed (ac-ft)	Volume Infiltrated (ac-ft)	Total Suspended Solids Removal (lbs)	Total Suspended Solids Removal (%)	Total Phosphorus Removal (lbs)	Total Phosphorus Removal (%)
Woodbury School	0.120	0.120	1202	100%	1.23	95.78%
Church St	0.138	0.138	3947	62.61% (Sediment Trap); 99.03% (Subsurface Infiltration)	2.85	63.33% (Sediment Trap); 98.92% (Subsurface Infiltration)
Woodbury Garage	0.053	0.053	1064	100% (sediment trap); 73% (sand management)	1.83	100% (sediment trap); 45% (sand management)
Fire Dept Annex & Food Shelf	0.043	0.043	1638	100% (Subsurface Infiltration); 75.51% (Buffer)	0.59	100% (Subsurface Infiltration); 75% (Buffer)
Fire Station and Post Office	0.041	0.041	1177	100% (Buffer); 99.79% (Subsurface Infiltration)	0.35	100% (Buffer); 99.73% (Subsurface Infiltration)
Woodbury Church and Town Clerk	0.153	0.153	1638	89.77%	1.68	85.42%
Scribner Rd	0.233	N/A	7610	60.00%	1.73	20.00%
Tebbets Rd	0.190	N/A	6084	60.00%	2.04	20.00%
W Woodbury Rd	0.355	N/A	15510	60.00%	3.11	20.00%
Blueberry Hill Rd	0.158	0.000	5389	60.00%	1.25	20.00%
Sabin Pond Fish & Wildlife Access	0.108	0.089	1154	77.61%	0.63	78.63%
East Hill Rd	0.316	0.056	1986	62.65%	1.28	65.50%
Chartier Hill Rd Lower to Farm	0.037	N/A	906	60.00%	0.31	20.00%
Cabot Rd Box Culvert	0.002	0.000	82	65.00%	0.03	20.00%
Nelson Pond Access Point	0.017	0.000	411	95.83%	0.31	90.44%
County Rd Residential	0.001	N/A	263	65% (GSI); 100% (Filter)	0.09	20% (GSI); 100% (Filter)
Route 14 Driveway	0.020	0.02	143	98.41%	0.16	98.89%
Shatney's Garage	0.054	0.000	334	60.00%	0.10	20.00%
Fishing Access on Route 14	0.009	0.000	234	65.00%	0.05	20.00%
County Road Buffer	0.036	0.000	362	65.00%	0.10	20.00%

2.4 Final Ranking Methodology

A prioritization matrix was utilized to quantitatively rank each of the Top 20 projects. Considerations that factored into the ranking of BMP projects included:

- Impervious area managed
- Ease of operation and maintenance
- Volume managed
- Volume infiltrated
- Permitting restrictions
- Land availability
- Flood mitigation
- TSS removed
- TP removed
- Other project benefits
- Project cost

Each of these criteria are listed and explained in Appendix C9 - Top 20 Site Final Ranking. The scores associated with each of the categories are also provided in this table.

2.4.1 Project Cost Estimation

Project cost, listed as one of the criteria considered, was calculated for each project using a spreadsheet-based method. The methodology for determining these planning level costs was first developed for the City of South Burlington by the Horsley Witten (HW) Group as part of the Centennial Brook Flow Restoration Plan development. The HW Memorandum describing this methodology is provided in Appendix C10. Note that a variation of this method was used for this plan. The criteria used in this cost estimation can be found in Appendix C9 - Top 20 Site Final Ranking. This methodology provides consistent budgetary cost estimates across BMPs.

Cost estimates are based on average costs for conceptual level projects and deviation from these estimates are expected as projects move forward with engineering design. There are differences between project cost estimates presented in the plan and actual project bid costs. The BMP cost estimates presented in the plan are based on limited site investigation. This methodology, while providing consistency in budget cost estimating, may fail to accurately reflect project cost impacts associated with actual site conditions and constraints. Therefore, the BMP cost estimates presented are suitable for planning purposes only, and not detailed program budgeting. The BMP cost estimates were developed based on the following assumptions:

Design Control Volumes: Design control volumes were based on the estimated runoff volume associated with the Channel Protection volume (CPv) or Water Quality volume (WQv) storm events for off-line, underground, or green stormwater infrastructure (GSI)-type practices. Off-line stormwater management systems are designed to manage storm events by diverting a percentage of stormwater from a storm drainage system. Underground systems and GSI-type practices were conceptually designed as offline practices that only accept runoff from the target storm event. Runoff volumes for all storm events were determined based on HydroCAD model results that rely on the Soil Conservation Service (SCS) TR-55 and TR-20 hydrologic methods.

Unit Costs and Site Adjustment Factors: Unit cost for each BMP and site adjustment factors were derived from research by the Charles River Watershed Association and Center for Watershed Protection, as well as from experience with actual construction[3] and modified for this project to reflect the newest cost estimates available. Underground filtration chamber systems were typically designed using Stormtech MC-4500™ chamber systems. Cost adjustment factors were used to account for site-specific differences typically related to project size, location, and complexity. The values used to estimate BMP costs are summarized in Table C3 below.

Table C3. BMP unit costs and adjustment factors modified to reflect newer information.

BMP Type	Base Cost ($/ft^3)
Porous Asphalt	$5.32
Infiltration Basin	$6.24
Underground Chamber (infiltration or detention)	$6.25
Detention Basin / Dry Pond	$6.80
Gravel Wetland	$8.78
Infiltration Trench	$12.49
Bioretention	$15.46
Sand Filter	$17.94
Porous Concrete	$18.07
Site Type	**Cost Multiplier**
Existing BMP retrofit or simple BMP	0.25
Large aboveground basin projects	0.5
New BMP in undeveloped area	1
New BMP in partially developed area	1.5
New BMP in developed area	2
Difficult installation in highly urban settings	3

Site-Specific Costs: Cost of significant utility or other work related to the construction of the BMP itself. Site-specific costs are variable based on past experience.

Base Construction Cost: Calculated as the product of the design control volume, the unit cost, and the site adjustment factor.

[3] Horsley Witten Group, Inc. 2014. Centennial Brook Watershed: Flow Restoration VTBMPDSS Modeling Analysis and BMP Supporting Information. Memorandum dated January 9th, 2014.

Permits and Engineering Costs: Used either 20% for large aboveground projects or 35% for smaller or complex projects.

Total Project Cost: Calculated as the sum of the base construction cost, permitting and engineering costs, and land acquisition costs.

Cost per Impervious Acre: Calculated as the construction costs plus the permitting and engineering costs, divided by the impervious acres managed by the BMP.

Operation and Maintenance: The annual operation and maintenance (O&M) was calculated as 3% of the base construction costs, with a maximum of $10,000.

Minimum Cost Adjustment: After total project costs were determined for each proposed BMP based on the HW methodology, costs were reviewed and adjusted so that projects involving a simple BMP such as a small rain garden were assigned a minimum cost of $10,000 and more complex projects were assigned a minimum cost of $25,000.

2.4.2 Final Ranking Scoring

Each of the factors noted in Appendix C9 - Top 20 Site Final Ranking were scored, and scores were totaled for each of the criteria. Projects were assigned a rank from 1 to 20 with those projects receiving the highest scores assigned the highest rank. In the case of a tie between two projects, the TP removed (lbs) by the practice was used as a tiebreaker.

2.5 Final Modeling and Prioritization

A summary of the practices and ranks are shown below in Table C4. The comprehensive ranking matrix used to rank the proposed BMP projects is provided in Appendix C9 - Top 20 Site Final Ranking. If future funding becomes available for further implementation, this prioritization matrix can be utilized in selecting additional projects for implementation.

Table C4. Top 20 potential BMP sites for the Town of Woodbury.

Rank	Site ID	Address	Proposed Practice Type
1	Woodbury School	63 Valley Lake Rd, Woodbury, VT	Gravel Wetland
2	Church St	52 Church St, Woodbury, VT	Ditch / Swale Improvements, Filter Strip / Buffer Enhancement, Underground Storage / Infiltration, Infrastructure Addition
3	Woodbury Garage	524 Dog Pond Rd, Woodbury, VT	Salt Management, Sediment Trap
4	Fire Dept Annex & Food Shelf	21 Valley Lake Rd, Woodbury, VT	Underground Storage / Infiltration, Filter Strip / Buffer Enhancement
5	Fire Station and Post Office	3665 Route 14, Woodbury, VT	Filter Strip / Buffer Enhancement, Underground Storage / Infiltration
6	Woodbury Church and Town Clerk	Route 14 and Foster Hill Rd, Woodbury, VT	Infiltration Basin, Infiltration Trench, Stormwater Planter, Bioretention
7	Scribner Rd	Scribner Rd (west of Nelson Pond Rd), Woodbury, VT	Check Dams, Ditch / Swale Improvements, Turnouts, Filter Strip / Buffer Enhancement
8	Tebbets Rd	452–598 Tebbets Rd, Woodbury, VT	Ditch / Swale Improvements
9	W Woodbury Rd	W Woodbury Rd (northeast of Slayton Pond Rd), Woodbury, VT	Ditch / Swale Improvements, Check Dams, Turnouts
10	Blueberry Hill Rd	Blueberry Hill Rd, Woodbury, VT	Turnouts, Cross culvert, Sediment Trap, Ditch / Swale Improvements
11	Sabin Pond Fish & Wildlife Access	1007-969 Route 14, Woodbury, VT	Filter Strip / Buffer Enhancement, Infiltration Basin
12	East Hill Rd	E Hill Rd and Route 14, Woodbury, VT	Ditch / Swale Improvements, Check Dams, Turnouts, Dry Wells
13	Chartier Hill Rd Lower to Farm	Chartier Hill Rd (east of Nelson Pond Rd), Woodbury, VT	Check Dams, Ditch / Swale Improvements, Turnouts
14	Cabot Rd Box Culvert	Cabot Rd (east of Route 14), Woodbury, VT	Filter Strip / Buffer Enhancement
15	Nelson Pond Access Point	300-824 Nelson Pond Rd, Woodbury, VT	Bioretention
16	County Rd Residential	County Rd (east of Hovey Rd), Woodbury, VT	Filter Strip / Buffer Enhancement
17	Route 14 Driveway	6940–7026 Route 14, Woodbury, VT	Filter Strip / Buffer Enhancement, Infiltration Basin
18	Shatney's Garage	3613 Route 14, Woodbury, VT	Filter Strip / Buffer Enhancement, Cistern / Rain Barrel
19	Fishing Access on Route 14	4685 Route 14, Woodbury, VT	Filter Strip / Buffer Enhancement
20	County Road Buffer	County Rd (west of Dog Pond Rd), Woodbury, VT	Filter Strip / Buffer Enhancement

2.6 Selection of Top 5 Potential BMPs

Selection of the Town's Top 5 sites considered the results from initial site investigations and preliminary modeling and ranking, input from municipal officials concerning project priorities, and the willingness of select private landowners to voluntarily participate in this plan. The location of these sites within the Town of Woodbury is shown in Figure C8. In the final ranking, these 5 sites were awarded additional points in the site scoring to reflect the Town's priorities and high-probability for implementation. The Top 5 sites are listed in Table C5.

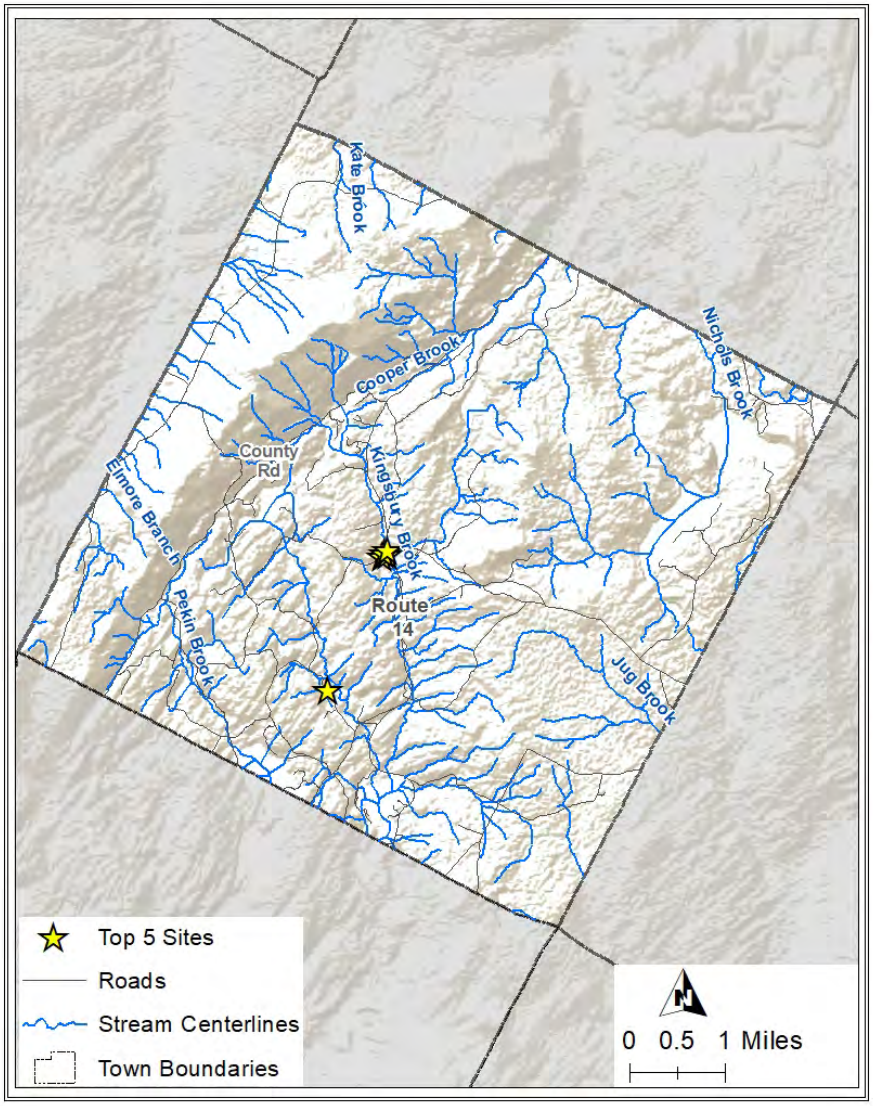

Figure C8. Top 5 sites for the Town of Woodbury SWMP.

Table C5. Top 5 BMP sites for the Town of Woodbury.

Rank	Site ID	Address	Proposed Practice Type
1	Woodbury School	63 Valley Lake Rd, Woodbury, VT	Gravel Wetland
2	Church St	52 Church St, Woodbury, VT	Ditch / Swale Improvements, Filter Strip / Buffer Enhancement, Underground Storage / Infiltration, Infrastructure Addition
3	Woodbury Garage	524 Dog Pond Rd, Woodbury, VT	Salt Management, Sediment Trap
4	Fire Dept Annex & Food Shelf	21 Valley Lake Rd, Woodbury, VT	Underground Storage / Infiltration, Filter Strip / Buffer Enhancement
5	Fire Station and Post Office	3665 Route 14, Woodbury, VT	Filter Strip / Buffer Enhancement, Underground Storage / Infiltration

3 Priority BMPs

The selected Top 5 BMP implementation sites are briefly described below. These opportunities are located on Town property and private property. Descriptions of each site are provided below. A memo describing these sites and updated field data sheets are provided in Appendix C11.

Site: 1

Project Name: Woodbury School

Figure C9. Stormwater runoff from the Woodbury School's parking lot will be treated in a gravel wetland.

Description: The site includes Valley Lake Rd, the School building, associated gravel driveway and parking lot, and small sheds behind the School. Stormwater drains east along the parking lot and driveway to the Kingsbury Branch. The concept for this site includes rain barrels for the sheds behind the School, general drainage improvements for the parking lot, and constructing a gravel wetland in the northwestern corner of the parking lot (see Figure C9). Note that some drainage from this site will be treated in a subsurface chamber infiltration system located by the Woodbury Volunteer Fire Department and Woodbury Food Shelf building. Soils are mapped as being good to poor at this site (Hydrologic Groups B and C), so an analysis was conducted to evaluate the potential for an infiltration practice. Soils were found to be generally loamy with a higher percentage of silt and clay.

Outreach: School officials expressed their willingness to further design.

Site: 2
Project Name: Church Street
Description: The site includes Church St, the Kingsbury Branch where it crosses under Church St, the garage and church located at the intersection of VT-14 and Church St, and a stormline draining VT-14 at the intersection with Cabot Rd. Stormwater from this area drains to the Kingsbury Branch via overland flow and a stormline. The concept for this site includes the implementation of a subsurface infiltration chamber system in the greenspace north of the church, a sediment trap along the south side of Church St, general road and ditch improvements, and a buffer restoration along either side of the Kingsbury Branch crossing (see Figure C10). Soils are mapped as being good at this site (Hydrologic Group B), so an analysis was conducted to evaluate the potential for an infiltration practice. Soils were found to be generally loamy with many coarse fragments.
Outreach: Owners of the properties along Church St have expressed their willingness, after discussion with the Town, to further design.

Figure C10. A subsurface chamber system and sediment trap will treat runoff from Church St.

Site: 3
Project Name: Woodbury Garage
Description: The site includes the garage building, gravel parking lot, salt shed, and sand and equipment storage areas. Stormwater from this site is unmanaged and drains offsite via overland flow. The concept for this site includes improved salt management, erosion stabilization around the perimeter of the site, and a sediment trap or sedimentation basin southwest of the garage building (see Figure C11). Soils are mapped as being very good at this site (Hydrologic Group A), but due to site specific conditions, the proposed practices are not infiltration-based. Thus, an analysis was not conducted to evaluate the site's potential for infiltration.
Outreach: This site is owned and operated by the Town of Woodbury and as such no additional outreach was conducted.

Figure C11. A sediment trap or sedimentation basin will treat runoff from the Woodbury Garage site.

Site: 4
Project Name: Fire Dept Annex & Food Shelf
Description: The site includes the building shared by the Woodbury Volunteer Fire Department and the Woodbury Food Shelf, associated parking areas, and drainage from Valley Lake Rd and the Woodbury School's driveway. Stormwater in this area travels via overland flow to the Kingsbury Branch. The concept for this site includes the implementation of a subsurface infiltration chamber system between the building and the School's driveway, and a buffer restoration along the Kingsbury Branch behind the building (see Figure C12). Soils are mapped as being good at this site (Hydrologic Group B), so an analysis was conducted to evaluate the potential for an infiltration practice. Soils were found to be generally loamy with a high percentage of silt and many coarse fragments.
Outreach: The Woodbury Volunteer Fire Department and the Woodbury Food Shelf expressed their willingness, after discussion with the Town, to further design.

Figure C12. A subsurface chamber system is proposed to treat runoff from the Fire Department & Food Shelf site.

Site: 5
Project Name: Fire Station and Post Office
Description: The site includes the Post Office and Fire Department buildings and the parking lot between the buildings. Stormwater sheet flows through this area and is conveyed via a paved swale to the Kingsbury Branch (see Figure C13). The concept for this site includes the installation of a subsurface infiltration chamber system in the parking lot and a buffer restoration along the Kingsbury Branch. Soils are mapped as being good at this site (Hydrologic Group B), so an analysis was conducted to evaluate the potential for an infiltration practice. Soils were found to be generally loamy with a high percentage of sand and many coarse fragments.
Outreach: The Fire Department and Post Office expressed their willingness to further design.

Figure C13. A subsurface chamber system is proposed to treat runoff from the Fire Station and Post Office site.

When implemented, these five BMPs would treat approximately 17.5 acres, 2.3 acres (13%) of which are impervious. Modeled pollutant reductions for each of the projects, shown below in Table C6, indicate that these BMPs will prevent more than 8,500 lbs of TSS and more than 6.7 lbs of TP from reaching receiving waters annually.

Table C6. Pollutant reductions and select ranking criteria for Top 5 projects.

Site ID	Volume Managed (ac-ft)	Volume Infiltrated (ac-ft)	Total Suspended Solids Removal (lbs)	Total Suspended Solids Removal (%)	Total Phosphorus Removal (lbs)	Total Phosphorus Removal (%)
Woodbury School	0.120	0.120	1202	100%	1.23	95.78%
Church St	0.138	0.138	3947	62.61% (Sediment Trap); 99.03% (Subsurface Infiltration)	2.85	63.33% (Sediment Trap); 98.92% (Subsurface Infiltration)
Woodbury Garage	0.053	0.053	1064	100% (sediment trap); 73% (sand storage management)	1.83	100% (sediment trap); 45% (sand storage management)
Fire Dept Annex & Food Shelf	0.043	0.043	1638	100% (Subsurface Infiltration); 75.51% (Buffer)	0.59	100% (Subsurface Infiltration); 75% (Buffer)
Fire Station and Post Office	0.041	0.041	1177	100% (Buffer); 99.79% (Subsurface Infiltration)	0.35	100% (Buffer); 99.73% (Subsurface Infiltration)

Site surveys were completed for each of the Top 5 sites, and existing conditions plans were developed. These plans were used as the basis for the 30% proposed condition plans that were developed for each site. See Appendix C12 - Existing Conditions Plans for these plans.

4 30% Designs

30% engineering designs were completed for each of the Top 5 sites. Site-specific concepts are discussed in the following sections. All 30% designs can be found in Appendix C13 - 30% Designs.

Soils conditions were assessed at 4 of the top 5 sites where infiltration-based practices are proposed. Pits were excavated manually using a shovel and hand auger. Analysis at these sites included documentation of the depth to water table (if applicable), horizon breaks, soil structure, type, moisture, color, presence or absence of redoximorphic features, and size and quantity of roots and coarse fragments. Any other notes considered to be important were recorded during this time. The soil profiles with photos can be found in Appendix C14.

4.1 Woodbury School

4.1.1 30% Concept Design Description

The Town of Woodbury's Elementary School is located on Valley Lake Rd west of VT-14. The site includes a gravel driveway and large parking lot, the School building, and small sheds behind the School. The majority of this site drains east along the parking lot and driveway before entering the Kingsbury Branch behind the Woodbury Volunteer Fire Department Annex and Woodbury Food Shelf building. Note that this drainage also includes runoff from a portion of Valley Lake Rd as a culvert directs road runoff to the greenspace between the road and parking lot. Erosion and sediment transport were observed along the School's driveway as well as at a culvert outlet located just west of the Fire Department Annex/Food Shelf building. The Town noted this site as a stormwater problem area.

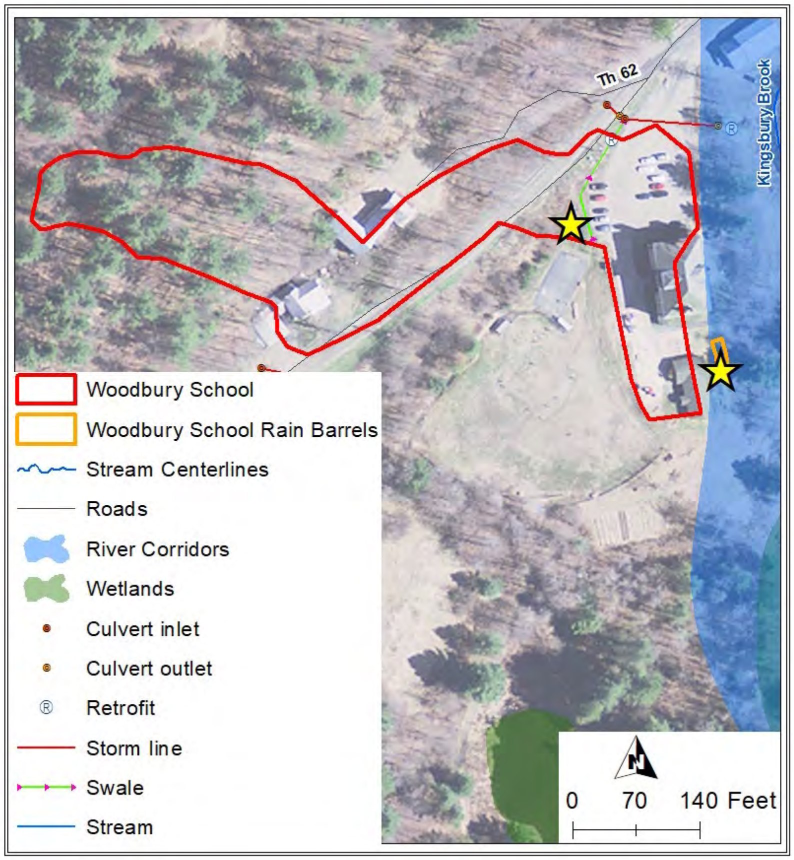

Figure C14. The drainage area for the proposed gravel wetland is shown in red and the practice location is shown with a star. Rain barrels are also proposed for the shed (outlined in orange).

The concept for this site includes the construction of a gravel wetland in the northwest corner of the School's parking lot (see starred location in Figure C14). This retrofit includes the creation of a grass filter strip between the basin and the parking lot. A new cross culvert is proposed under Valley Lake Rd to direct drainage from the road to the gravel wetland. There is a proposed reduction in parking lot impervious between the gravel wetland and the intersection with road to create a grass filter strip. The parking lot will be regraded to direct runoff to the gravel wetland. There is also potential to gutter the shed roofs behind the school to direct runoff to a series of rain barrels for water reuse (gardens adjacent). It is recommended that an educational sign be installed at this site to educate students and the general public. This cost is not reflected in the estimated project cost itemized below. Approximately $500 should be budgeted for this sign. See the photos and associated descriptions in Figure C15. School officials have expressed willingness to proceed with further design.

Eroded channel along the eastern edge of the School's driveway.

Stormwater flows over the School's gravel parking lot, transporting surface material to the ditch, and clogging the culvert.

A new culvert will direct runoff from Valley Lake Rd to the proposed gravel wetland.

A gravel wetland is proposed for the northwestern corner of the parking lot.

Figure C15. The proposed retrofits are described in the above photos.

Figure C17. A hand auger and shovel were used to assess soil conditions and infiltration potential.

Soils are mapped as being good to poor at this site (Hydrologic Group B/C), so an analysis was conducted to evaluate the potential for an infiltration practice. Soils were assessed using a hand auger and shovel (Figure C17) and were found to be generally loamy with a higher percentage of silt and clay (Figure C16). Soils conditions observed during analysis prompted a need to alter the proposed retrofit design and resulted in changing the proposed infiltration basin to a gravel wetland due to the presence of high groundwater. See Appendix C14 for this site's complete soil log.

Figure C16. Soils were generally loamy.

A rendering of the proposed stormwater improvements was created to bring a concept to life in ways that engineering plans cannot. This rendering is one possible configuration for this site. This graphically engaging rendering visually communicates the plans and can be used by the Town and the CVRPC to help advance designs toward implementation. This rendering can be found in Appendix C16 - Site Renderings.

The design standard used for this retrofit was management of the Channel Protection volume (CPv, or 2.02 inches of rain in a 24-hour period), equal to 5,227 ft^3 of runoff.

An updated BMP summary sheet is included in Appendix C11 - Top 5 Sites. A 30% design plan is provided in Appendix C13 - 30% Designs.

4.1.2 Pollutant Removal and Other Water Quality Benefits

This practice has the potential to prevent more than 1,200 lbs of total suspended solids (TSS) and 1.2 lbs of total phosphorus (TP) from entering receiving waters (Table C7).

Table C7. Woodbury School benefit summary table.

TSS Removed	1,202 lbs
TP Removed	1.23 lbs
Impervious Treated	0.8 acres
Total Drainage Area	2.2 acres

4.1.3 Cost Estimates

The estimated cost for this project is $54,000. Note that these costs are very preliminary. Costs are shown in Table C8. This amount differs from the amount initially projected for this site as design-specific amounts and costs were used.

- The cost per pound of phosphorus treated is $43,902.
- The cost per impervious acre treated is $67,500.
- The cost per cubic foot of runoff treated is $10.33.

Table C8. Woodbury School project initial construction cost projection.

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
Site Preparation					
N/A	MOBILIZATION	LS	1	$ 500.00	$ 500.00
653.55	PROJECT DEMARCATION FENCE	LF	300	$ 1.17	$ 351.00
653.20	TEMPORARY EROSION MATTING	SY	300	$ 2.20	$ 660.00
649.51	GEOTEXTILE FOR SILT FENCE	SY	80	$ 4.13	$ 330.40
N/A	CONSTRUCTION STAKING	HR	6	$ 125.00	$ 750.00
				Subtotal:	$ 2,591.40
Gravel Wetland - Excavation and Materials					
	EXCAVATION				
203.15	COMMON EXCAVATION	CY	200	$ 9.86	$ 1,972.00
	MATERIALS				
	GRAVEL LAYERING				
651.35	TOPSOIL (MUCK SOIL)	CY	25	$ 30.96	$ 774.00
629.54	CRUSHED STONE BEDDING (3/4" - 1 1/2" STONE)	TON	136	$ 34.04	$ 4,629.44
301.26	SUBBASE OF CRUSHED GRAVEL, FINE GRADED	CY	10	$ 40.03	$ 400.30
649.31	GEOTEXTILE UNDER STONE FILL	SY	150	$ 2.51	$ 376.50
	PIPING				
605.10	6 INCH UNDERDRAIN PIPE	LF	50	$ 21.86	$ 1,093.00
605.20	6 INCH UNDERDRAIN CARRIER PIPE	LF	25	$ 24.43	$ 610.75
649.41	GEOTEXTILE FOR UNDERDRAIN TRENCH LINING	SY	20	$ 4.04	$ 80.80
	STRUCTURES AND APPURTENANCES				
604.18	PRECAST REINFORCED CONCRETE DROP INLET WITH CAST IRON GRATE	EACH	1	$ 4,009.29	$ 4,009.29
604.55	CAST IRON COVER WITH FRAME (RISER COVERS)	EACH		$ 762.78	$ -
N/A	18' ANTI-SEEP COLLAR	EACH	1	$ 250.00	$ 250.00
N/A	18" BEEHIVE GRATE	EACH	1	$ 615.00	$ 615.00
N/A	30 MM PVC LINER	SY	175	$ 5.40	$ 945.00
	OVERFLOWS AND TRANSFER WEIRS				
613.10	STONE FILL, TYPE I	CY	5	$ 43.91	$ 219.55

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
	PLANTING				
N/A	WETLAND PLANT SEEDS	LBS	2	$ 125.00	$ 250.00
656.41	PERENNIALS	EACH	175	$ 8.77	$ 1,534.75
651.15	SEED	LB	15	$ 7.66	$ 114.90
653.65	LIVE FASCINE	LF	325	$ 19.00	$ 6,175.00
656.16	DECIDUOUS SEEDLINGS	EACH	6	$ 81.47	$ 488.82
651.25	HAY MULCH	TON	0.5	$ 597.15	$ 298.58
				Subtotal:	$ 24,837.68
New Infrastructure For Conveyance of Runoff to Practice					
	EXCAVATION				
203.27	UNCLASSIFIED CHANNEL EXCAVATION	CY	35	$ 13.65	$ 477.75
	STRUCTURES AND PIPES				
601.0915	18" CPEP	LF	30	$ 64.04	$ 1,921.20
	PAVEMENT REPLACEMENT				
401.10	AGGREGATE SURFACE COURSE	CY	175	$ 43.60	$ 7,630.00
	GRASS REPLACEMENT				
653.20	TEMPORARY EROSION MATTING	SY	275	$ 2.20	$ 605.00
				Subtotal:	$ 10,633.95
				Subtotal:	$ 38,063.03
	Construction Oversight**	HR	16	$ 125.00	$ 2,000.00
	Construction Contingency - 10%**				$ 3,806.30
	Incidentals to Construction - 5%**				$ 1,903.15
	Minor Additional Design Items - 5%**				$ 1,903.15
	Final Design	HR	45	$ 125.00	$ 5,625.00
	Permit Review and Applications (exclusive of permit fees)	HR	4	$ 125.00	$ 500.00
				Total (Rounded to nearest $1,000)	**$ 54,000.00**

4.1.4 Next Steps

As this site is owned and operated by the Town of Woodbury, it is recommended that the Town, with support of the school, proceed with further design of this retrofit. Further design will involve refinement of the retrofit design with respect to size, outlet design, and routing to ensure that the target volume can be completely managed and that larger storms bypass the system safely.

4.1.5 Permit Needs

A project readiness screening worksheet has been completed for this project and is included in Appendix C15 - Permit Review Sheets. In summary:

Stormwater Permit
It is not anticipated that this site will need a stormwater permit at this time.

The site should qualify for an Erosion Prevention and Sediment Control permit (3-9020) under the Low Risk categorization if the following guidelines are followed:

- Less than 2 acres of disturbance at any one time.
- All soils must be stabilized (temporary or final) within 7 days.
- Runoff from the site must pass through a 50’ vegetated buffer prior to entering any Water of the State.

Local Permitting

No local permits are anticipated.

Other Permits

This project should be reviewed by the River Scientist prior to final design due to the close proximity to the river corridor. This project should be reviewed by a wetland ecologist prior to final design due to the assumed (unmapped) presence of wetlands. No Act 250 permitting concerns are anticipated for this project.

4.2 Church Street

4.2.1 30% Concept Design Description

Church St is located off of VT-14 across from Cabot Rd in Woodbury, VT. This site includes runoff from Church St, a garage and church located on either side of the intersection of Church St and VT-14, and a stormline draining VT-14 at the intersection with Cabot Rd. The Kingsbury Branch crosses Church St behind the garage and church. Stormwater on both sides of the crossing travels via overland flow and drains into the Kingsbury Branch without treatment. The stormline on VT-14 collects runoff in a series of pipes and catchbasins before discharging directly to the Kingsbury Branch behind the garage. This area was noted by the Town as being a stormwater problem area, especially during larger storm events.

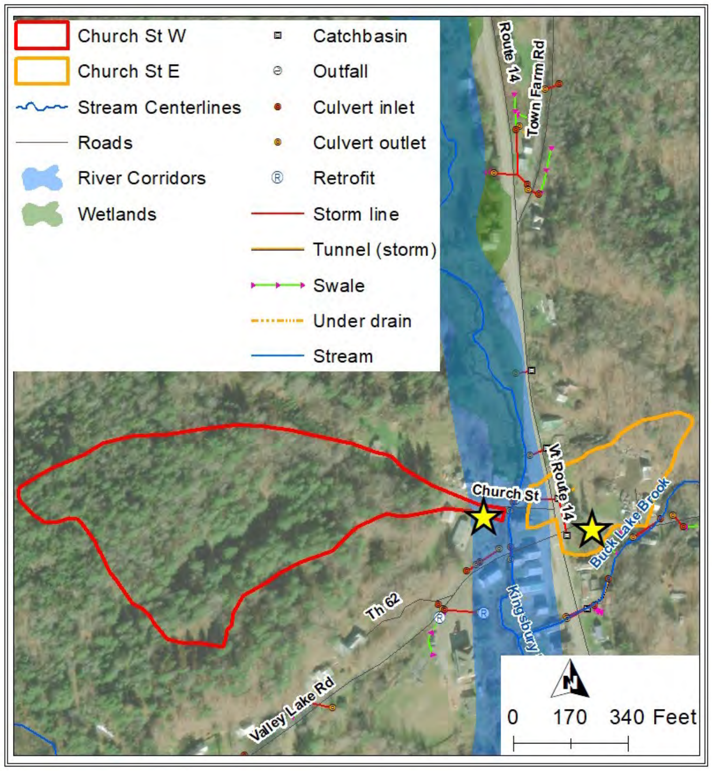

Figure C18. A subsurface chamber system and sediment basin are proposed to manage drainage from Church St and the surrounding area. The recommended location for each BMP locations is shown with a star.

The proposed stormwater improvements for this site includes implementing a subsurface infiltration chamber system in the greenspace west of the intersection of Church St and W Route 14 (see starred location within orange drainage area in Figure C18). This would involve adding a new catchbasin and pipe connection to the stormline south of the garage and directing the drainage to the chamber system by the church. It is recommended that an educational sign be installed at this site to educate the general public and church attendees. This cost is not reflected in the estimated project cost itemized below. Approximately $500 should be budgeted for this sign. The proposed design also includes the construction of a sediment trap just east of the first driveway after the Kingsbury Branch crossing along the south side of Church St (see starred location within red drainage area in Figure C18). It is also recommended that the riparian buffer behind the church and along the western bank across from the garage be enhanced. There is the potential for general road and ditch improvements along Church St including check dams, regrading, and recrowning the road. See the photos and associated descriptions in Figure C19. The owners of the properties along Church St, except the property owner at the top of road, have expressed their willingness, after discussion with the Town, to proceed with further design.

Church St drains to the Kingsbury Branch. A sediment trap is proposed after the driveway by the tree on the right.

Location where Kingsbury Branch crosses under Church St.

A subsurface infiltration chamber system is proposed along the road in the lawn north of the church .

A new catchbasin and pipe connection at the garage will direct stormwater to the new subsurface system.

Figure C19. The proposed retrofits are described in the above photos.

Figure C20. A hand auger and shovel were used to assess soil conditions and infiltration potential.

Figure C21. Soils were generally loamy with many coarse fragments.

Soils are mapped as being good at this site (Hydrologic Group B), so an analysis was conducted to evaluate the potential for an infiltration practice. Soils were assessed using a hand auger and shovel (Figure C20) and were found to be generally loamy with many coarse fragments (Figure C21). Soils conditions observed during analysis did not prompt a need to alter the proposed retrofit design. See Appendix C14 for this site's complete soil log.

A rendering of the proposed stormwater improvements was created to bring a concept to life in ways that engineering plans cannot. This rendering is one possible configuration for this site. This graphically engaging rendering visually communicates the plans and can be used by the Town and the CVRPC to help advance designs toward implementation. This rendering can be found in Appendix C16 - Site Renderings.

The design standard used for this retrofit was infiltration of the Channel Protection volume (CPv, or 2.02 inches of rain in a 24-hour period) for the subsurface infiltration chambers and filtration of the CPv for the sediment trap. In total, this would equal management of 6,011 ft^3 of runoff.

An updated BMP summary sheet is included in Appendix C11 - Top 5 Sites. A 30% design plan is provided in Appendix C13 - 30% Designs.

4.2.2 Pollutant Removal and Other Water Quality Benefits

A retrofit of this site has the potential to prevent nearly 4,000 lbs of total suspended solids (TSS) and 2.9 lbs of total phosphorus (TP) from entering receiving waters (Table C9). The retrofits in this location also have the potential to raise awareness of stormwater issues in the Town, as the proposed location for the practice has high visibility. It is recommended that an educational sign be installed in conjunction with the retrofits.

Table C9. Church St benefit summary table.

TSS Removed	3,947 lbs
TP Removed	2.9 lbs
Impervious Treated	0.6 acres
Total Drainage Area	12.7 acres

4.2.3 Cost Estimates

The estimated cost for this project is $40,000. Note that these costs are very preliminary. Costs are shown in Table C10. This amount differs from the amount initially projected for this site as design-specific amounts and costs were used.

- The cost per pound of phosphorus treated is $13,793.
- The cost per impervious acre treated is $66,667.
- The cost per cubic foot of runoff treated is $6.65.

Table C10. Church St project initial construction cost projection.

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
Site Preparation					
N/A	MOBILIZATION	LS	1	$ 500.00	$ 500.00
653.55	PROJECT DEMARCATION FENCE	LF	250	$ 1.17	$ 292.50
653.20	TEMPORARY EROSION MATTING	SY	70	$ 2.20	$ 154.00
649.51	GEOTEXTILE FOR SILT FENCE	SY	60	$ 4.13	$ 247.80
N/A	CONSTRUCTION STAKING	HR	8	$ 125.00	$ 1,000.00
				Subtotal:	$ 2,194.30
Chambers - EXCAVATION AND					
EXCAVATION					
203.15	COMMON EXCAVATION	CY	30	$ 9.86	$ 295.80
MATERIALS					
BASE / COVER / SURROUNDING STONE					
629.54	CRUSHED STONE BEDDING (3/4" - 1 1/2" STONE)	TON	15	$ 34.04	$ 510.60
STRUCTURES AND APPURTENANCES					
601.09	18" CPEP	LF	80	$ 64.04	$ 5,123.20
604.18	PRECAST REINFORCED CONCRETE DROP INLET WITH CAST IRON GRATE	EACH	1	$ 4,009.29	$ 4,009.29
GRASS REPLACEMENT					
653.20	TEMPORARY EROSION MATTING	SY	10	$ 2.20	$ 22.00
651.25	HAY MULCH	TON	0.1	$ 597.15	$ 59.72
651.15	SEED	LB	2	$ 7.66	$ 15.32
CHAMBERS					
	MC3500	EACH	16	$ 400.20	$ 6,403.20
	MC3500 PLAIN END CAP	EACH	3	$ 300.15	$ 900.45
	MC3500 24B END CAP	EACH	1	$ 404.23	$ 404.23
	12" 90 BEND	EACH	1	$ 57.10	$ 57.10
	12" COUPLER	EACH	2	$ 8.29	$ 16.58
	12" N12 AASHTO FOR MANIFOLD	LF	20	$ 7.75	$ 155.02
	24" N12 AASHTO FOR ISOLATOR ROW	LF	20	$ 22.54	$ 450.80
	315WTM FOR SCOUR PROTECTION	SY	500	$ 0.74	$ 370.00
	601TG TO WRAP SYSTEM	SY	2000	$ 0.82	$ 1,633.00
	12X6 INSPECTION PORT KIT	EACH	1	$ 430.10	$ 430.10
	6" RED HOLE SAW	EACH	1	$ 172.17	$ 172.17
				Subtotal:	$ 21,028.58

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
Sedimentation Basin					
EXCAVATION & MATERIALS					
203.15	COMMON EXCAVATION	CY	15	$ 9.86	$ 147.90
613.10	STONE FILL, TYPE I	CY	10	$ 43.91	$ 439.10
629.54	CRUSHED STONE BEDDING (3/4" - 1 1/2" STONE)	TON	5	$ 34.04	$ 170.20
INLET / OUTLET PROTECTION					
613.10	STONE FILL, TYPE I	CY	10	$ 43.91	$ 439.10
SIDE SLOPE EROSION CONTROL					
653.20	TEMPORARY EROSION MATTING	SY	20	$ 2.20	$ 44.00
651.15	SEED	LB	5	$ 7.66	$ 38.30
				Subtotal:	$ 1,240.30
Buffer Enhancement					
PLANTING					
N/A	WILDFLOWER PLANT SEEDS	LBS	3	$ 125.00	$ 375.00
651.15	SEED	LB	5	$ 7.66	$ 38.30
656.25	EVERGREEN SHRUBS	EACH	3	$ 73.38	$ 220.14
656.30	DECIDUOUS TREES	EACH	2	$ 289.14	$ 578.28
656.35	DECIDUOUS SHRUBS	EACH	3	$ 49.95	$ 149.85
651.25	HAY MULCH	TON	0.5	$ 597.15	$ 298.58
				Subtotal:	$ 1,660.15
				Subtotal:	$ 26,123.32
	Construction Oversight**	HR	16	$ 125.00	$ 2,000.00
	Construction Contingency - 10%**				$ 2,612.33
	Incidentals to Construction - 5%**				$ 1,306.17
	Minor Additional Design Items - 5%**				$ 1,306.17
	Final Design	HR	55	$ 125.00	$ 6,875.00
	Permit Review and Applications (exclusive of permit fees)	HR	16	$ 125.00	$ 2,000.00
Total (Rounded to nearest $1,000)					**$ 40,000.00**

4.2.4 Next Steps

The Town made contact with property owners along Church St and the majority expressed their willingness to allow further design. Confirmation is needed from VTrans due to the involvement of VT-14 stormline. Further design will involve refinement of the retrofit design with respect to size, outlet design, and routing to ensure that CPv can be completely managed and larger storms passed through the system safely. A formal agreement will need to be reached with the landowners prior to final design.

4.2.5 Permit Needs

A project readiness screening worksheet has been completed for this project and is included in Appendix C15 - Permit Review Sheets. In summary:

Stormwater Permit

This site is not anticipated to need a stormwater permit at this time.

The site should qualify for an Erosion Prevention and Sediment Control permit (3-9020) under the Low Risk categorization if the following guidelines are followed:

- Less than 2 acres of disturbance at any one time.
- All soils must be stabilized (temporary or final) within 7 days.
- Runoff from the site must pass through a 50’ vegetated buffer prior to entering any Water of the State.

Local Permitting

No local permits are anticipated.

Other Permits

This project should be reviewed by a River Scientist prior to final design due to the project’s location in the river corridor. However, it should be noted that this project will not result in any net fill within the river corridor. No Act 250 permitting or wetlands concerns are anticipated for this project.

4.3 Woodbury Garage

4.3.1 30% Concept Design Description

The Town of Woodbury's Town Garage is located at 526 Dog Pond Rd. This site is built up out of surrounding wetlands and includes the garage building, a large gravel parking lot, a salt shed, and sand storage and equipment storage. Salt residue was present around the front of the salt shed building. Stormwater from this site is currently unmanaged and drains offsite by way of overland flow. Erosion was observed around the perimeter of the site where runoff drains over the steep bank.

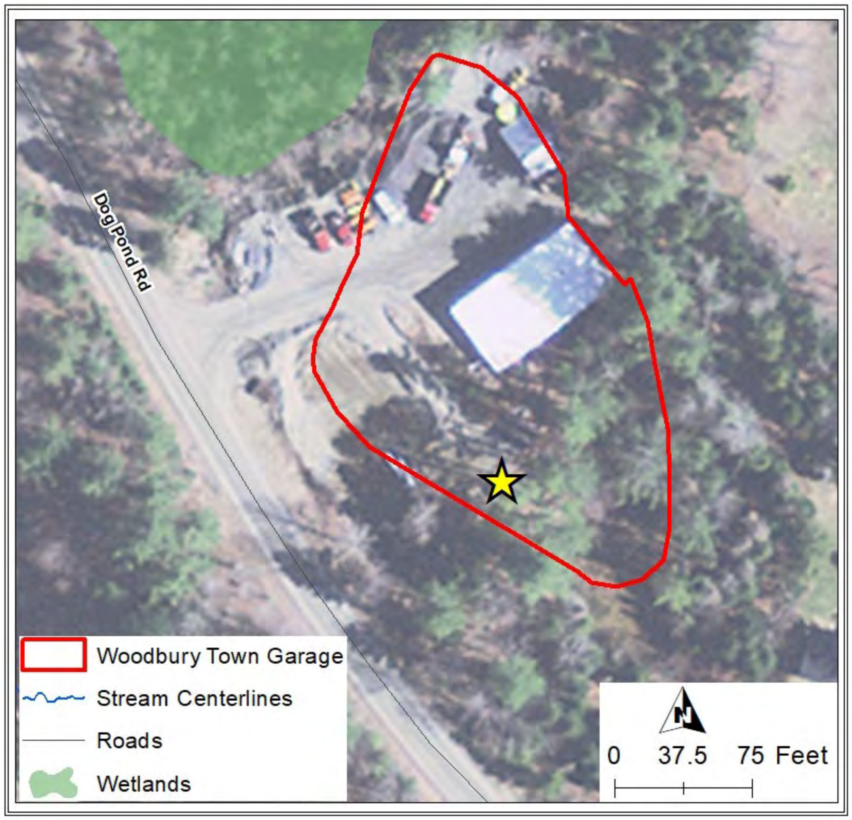

Figure C22. The drainage area for the proposed BMP is shown in red and the location of the BMP is shown with a star.

The proposed solution for this site includes improved salt management by adding a paved apron in front of the salt shed. It is recommended that the Town ensures that any spills are cleaned up immediately. It is also recommended that erosion along the perimeter of the site be stabilized. Drainage will be directed from site to a sedimentation basin below the driveway accessing the sand pile southwest of the garage building. (see starred location in Figure C22). See the photos and associated descriptions in Figure C23.

Town Garage building. This site was built up out of a wetland.

Salt residue around the front of the salt shed. Any spills should be cleaned immediately.

Eroded channels are forming due to drainage flowing over the steep bank.

Proposed location of a sedimentation basin to decrease sediment transport from the site.

Figure C23. The proposed retrofits are described in the above photos.

Soils are mapped as being very good at this site (Hydrologic Group A), but due to site specific conditions, the proposed practices are not infiltration-based. Thus, an analysis was not conducted to evaluate the site's potential for infiltration.

A rendering of the proposed stormwater improvements was created to bring a concept to life in ways that engineering plans cannot. This rendering is one possible configuration for this site. This graphically engaging rendering visually communicates the plans and can be used by the Town and the CVRPC to help advance designs toward implementation. This rendering can be found in Appendix C16 - Site Renderings.

The drainage area for this proposed BMP is 0.8 acres, about 46% of which is classified as impervious. The design standard used for this retrofit was detention and slow release of the Channel Protection volume (CPv, or 2.02 inches of rain in a 24-hour period), equal to 2,309 ft^3 of runoff.

An updated BMP summary sheet is included in Appendix C11 - Top 5 Sites. A 30% design plan is provided in Appendix C13 - 30% Designs.

4.3.2 Pollutant Removal and Other Water Quality Benefits

A retrofit of this site has the potential to prevent more than 1,000 lbs of total suspended solids (TSS) and 1.8 lbs of total phosphorus (TP) from entering receiving waters annually (Table C11).

Table C11. Woodbury Garage benefit summary table.

TSS Removed	1,064 lbs
TP Removed	1.83 lbs
Impervious Treated	0.4 acres
Total Drainage Area	0.8 acres

4.3.3 Cost Estimates

The estimated cost for this project is $18,000. Note that these costs are very preliminary. Costs are shown in Table C12. This amount differs from the amount initially projected for this site as design-specific amounts and costs were used.

- The cost per pound of phosphorus treated is $9,836.
- The cost per impervious acre treated is $45,000.
- The cost per cubic foot of runoff treated is $7.80.

Table C12. Woodbury Garage project initial construction cost projection.

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
Site Preparation					
N/A	MOBILIZATION	LS	1	$ 500.00	$ 500.00
653.55	PROJECT DEMARCATION FENCE	LF	300	$ 1.17	$ 351.00
653.20	TEMPORARY EROSION MATTING	SY	100	$ 2.20	$ 220.00
649.51	GEOTEXTILE FOR SILT FENCE	SY	70	$ 4.13	$ 289.10
N/A	CONSTRUCTION STAKING	HR	4	$ 125.00	$ 500.00
				Subtotal:	$ 1,860.10
Sediment Trap					
	EXCAVATION				
203.15	COMMON EXCAVATION	CY	75	$ 9.86	$ 739.50
	MATERIALS				
613.10	STONE FILL, TYPE I	CY	65	$ 43.91	$ 2,854.15
	INLET / OUTLET PROTECTION				
613.10	STONE FILL, TYPE I	CY	41	$ 43.91	$ 1,800.31
	SIDE SLOPE EROSION CONTROL				
653.20	TEMPORARY EROSION MATTING	SY	100	$ 2.20	$ 220.00
				Subtotal:	$ 5,613.96
Bank Stabilization					
203.15	COMMON EXCAVATION	CY	40	$ 9.86	$ 394.40
653.21	PERMANENT EROSION MATTING	SY	250	$ 5.40	$ 1,350.00
				Subtotal:	$ 1,744.40
Paved Apron					
406.25	BITUMINOUS CONCRETE PAVEMENT	TON	11	$ 127.86	$ 1,406.46
				Subtotal:	$ 1,406.46
				Subtotal:	$ 10,624.92
	Construction Oversight**	HR	12	$ 125.00	$ 1,500.00
	Minor Additional Design Items - 5%**				$ 531.25
	Incidentals to Construction - 5%**				$ 531.25
	Final Design	HR	40	$ 125.00	$ 5,000.00
	Total (Rounded to nearest $1,000)				**$ 18,000.00**

4.3.4 Next Steps

As this site is owned and operated by the Town of Woodbury, it is recommended that the Town proceed with further design of this retrofit. Further design will involve refinement of the retrofit design with respect to size, outlet design, and routing to ensure that the target volume can be completely managed and that larger storms bypass the system safely.

4.3.5 Permit Needs

A project readiness screening worksheet has been completed for this project and is included in Appendix C15 - Permit Review Sheets. In summary:

Stormwater Permit
This site will likely not need a stormwater permit at this time.

The site should qualify for an Erosion Prevention and Sediment Control permit (3-9020) under the Low Risk categorization if the following guidelines are followed:

- Less than 2 acres of disturbance at any one time.
- All soils must be stabilized (temporary or final) within 7 days.
- Runoff from the site must pass through a 50’ vegetated buffer prior to entering any Water of the State.

Local Permitting
No local permits are anticipated.

Other Permits
This project should be reviewed by a wetland ecologist prior to final design due to the project’s close proximity to wetlands. No Act 250 permitting or river corridor concerns are anticipated for this project.

4.4 Fire Dept Annex & Food Shelf

4.4.1 30% Concept Design Description

The Woodbury Volunteer Fire Department Annex and Woodbury Food Shelf share a building located on Valley Lake Rd just east of the Woodbury Elementary School. The building is constrained between the road and the Kingsbury Branch which flows east and south of the building. Stormwater from this site includes roof runoff and drainage from the school's driveway, which travels via overland flow to the Kingsbury Branch. The Town noted this site as a stormwater problem area due to drainage from the adjacent school property.

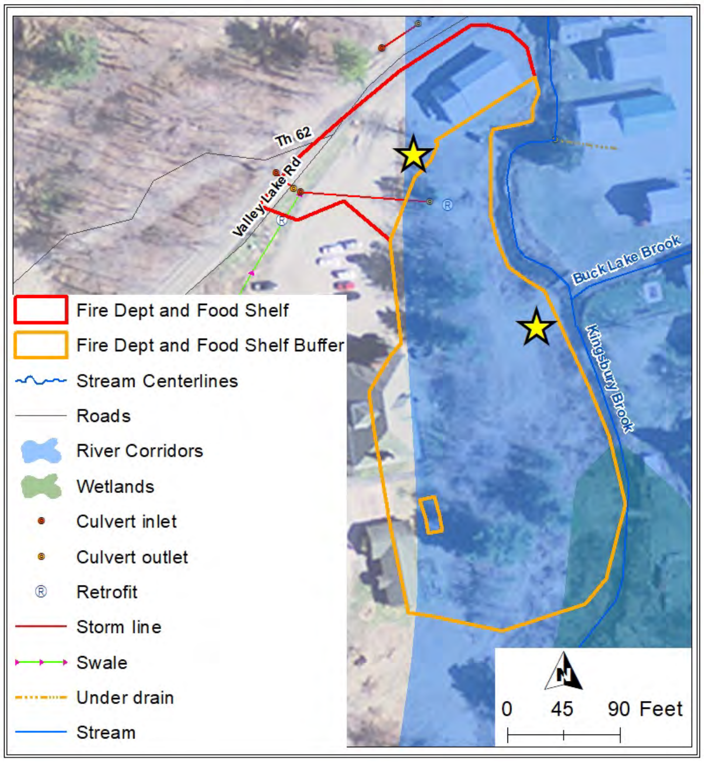

Figure C24. The proposed drainage areas for the subsurface infiltration chambers (red drainage area) and riparian buffer (orange drainage area) are shown.

The stormwater management practice recommended for this site includes implementation of a subsurface chamber infiltration system west of the building (see starred location within red drainage area in Figure C24). This retrofit includes directing the roof runoff from the Fire Department Annex / Food Shelf building to the system. Discharge from the culvert outlet draining the school's driveway will also be directed to the system. The system will overflow to the Kingsbury Branch. It is recommended that an educational sign be installed at this site to educate the general public. This cost is not reflected in the estimated project cost itemized below. Approximately $500 should be budgeted for this sign. The second component of this project was to restore the riparian buffer from Valley Lake Rd to the location of the Town's seasonal ice rink. See the photos and associated descriptions in Figure C25. The Woodbury Volunteer Fire Department and the Woodbury Food Shelf have expressed their willingness, after discussion with the Town, to proceed with further design.

The Women's Auxiliary Fire Department and Woodbury's Food Shelf share a building on Valley Lake Rd. Gutters from the roof will be directed to a proposed dry well located behind the building.

Drainage from Valley Lake Rd and the School's parking lot and driveway transports sediment to the site.

The Kingsbury Branch flows along the eastern side of the building.

A buffer enhancement is proposed along the Kingsbury Branch behind the building.

Figure C25. The proposed retrofits are described in the above photos.

Figure C26. A hand auger and shovel were used to assess soil conditions and infiltration potential.

Figure C27. Soils were generally loamy with many coarse fragments.

Soils are mapped as being good at this site (Hydrologic Group B), so an analysis was conducted to evaluate the potential for an infiltration practice. Soils were assessed using a hand auger and shovel (Figure C26) and were found to be generally loamy with a high percentage of silt and many coarse fragments (Figure C27). Soils conditions observed during analysis did not prompt a need to alter the proposed retrofit design. See Appendix C14 for this site's complete soil log.

A rendering of the proposed stormwater improvements was created to bring a concept to life in ways that engineering plans cannot. This rendering is one possible configuration for this site. This graphically engaging rendering visually communicates the plans and can be used by the Town and the CVRPC to help advance designs toward implementation. This rendering can be found in Appendix C16 - Site Renderings.

The drainage area for this proposed BMP is 1.4 acres, approximately 20% of which is classified as impervious. The design standard used for this retrofit was full infiltration of the Channel Protection volume (CPv, or 2.02 inches of rain in a 24-hour period), equal to 1,873 ft^3 of runoff.

An updated BMP summary sheet is included in Appendix C11 - Top 5 Sites. A 30% design plan is provided in Appendix C13 - 30% Designs.

4.4.2 Pollutant Removal and Other Water Quality Benefits

A retrofit of this site has the potential to prevent 1,638 lbs of total suspended solids (TSS) and 0.59 lbs of total phosphorus (TP) from entering receiving waters annually (Table C13).

Table C13. Fire Department Annex and Food Shelf benefit summary table.

TSS Removed	1,638 lbs
TP Removed	0.59 lbs
Impervious Treated	0.3 acres
Total Drainage Area	1.4 acres

4.4.3 Cost Estimates

The estimated cost for implementation of this project is $29,000. Note that these costs are very preliminary. Cost projections can be found in Table C14. This amount differs from the amount initially projected for this site as design-specific amounts and costs were used.

- The cost per pound of phosphorus treated is $49,153.
- The cost per impervious acre treated is $96,667.
- The cost per cubic foot of runoff treated is $15.48.

Table C14. Fire Dept Annex & Food Shelf project initial construction cost projection.

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
Site Preparation					
N/A	MOBILIZATION	LS	1	$ 500.00	$ 500.00
653.55	PROJECT DEMARCATION FENCE	LF	150	$ 1.17	$ 175.50
649.51	GEOTEXTILE FOR SILT FENCE	SY	30	$ 4.13	$ 123.90
N/A	CONSTRUCTION STAKING	HR	6	$ 125.00	$ 750.00
				Subtotal:	$ 1,549.40
Chambers - Excavation and Materials					
	EXCAVATION				
203.15	COMMON EXCAVATION	CY	150	$ 9.86	$ 1,479.00
	MATERIALS				
	BASE / COVER / SURROUNDING STONE				
629.54	CRUSHED STONE BEDDING (3/4" - 1 1/2"	TON	75	$ 34.04	$ 2,553.00
	STRUCTURES AND APPURTENANCES				
604.18	PRECAST REINFORCED CONCRETE DROP INLET WITH CAST IRON GRATE	EACH	1	$ 4,009.29	$ 4,009.29
	PLANTING (ABOVE CHAMBERS IN GREENSPACE)				
651.15	SEED	LB	2	$ 7.66	$ 15.32
653.20	TEMPORARY EROSION MATTING	SY	10	$ 2.20	$ 22.00
	CHAMBERS - LUMP SUM COSTS				
	DC780	EACH	12	$ 234.60	$ 2,815.20
	SC740 PLAIN END CAP	EACH	5	$ 48.30	$ 241.50
	SC740 24B END CAP	EACH	1	$ 337.58	$ 337.58
	12" 90 BEND	EACH	1	$ 57.10	$ 57.10
	12" TEE	EACH	1	$ 109.70	$ 109.70
	12" COUPLER	EACH	5	$ 8.29	$ 41.46
	24" COUPLER	EACH	1	$ 33.20	$ 33.20
	12" N12 AASHTO FOR MANIFOLD	LF	20	$ 7.75	$ 155.02
	24" N12 AASHTO FOR ISOLATOR ROW	LF	20	$ 22.54	$ 450.80
	315WTK FOR SCOUR PROTECTION	SY	500	$ 0.72	$ 362.25
	601TG TO WRAP SYSTEM	SY	1000	$ 0.82	$ 816.50
	12X6 INSPECTION PORT KIT	EACH	1	$ 430.10	$ 430.10
	6" RED HOLE SAW	EACH	1	$ 172.17	$ 172.17
				Subtotal:	$ 14,101.18

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
	Buffer Enhancement				
	PLANTING				
N/A	WILDFLOWER PLANT SEEDS	LBS	3	$ 125.00	$ 375.00
651.15	SEED	LB	6	$ 7.66	$ 45.96
656.25	EVERGREEN SHRUBS	EACH	7	$ 73.38	$ 513.66
656.35	DECIDUOUS SHRUBS	EACH	7	$ 49.95	$ 349.65
651.25	HAY MULCH	TON	0.5	$ 597.15	$ 298.58
				Subtotal:	$ 1,582.85
New Infrastructure For Conveyance of Runoff to Practice					
	EXCAVATION				
203.28	EXCAVATION OF SURFACES AND PAVEMENTS	CY	9	$ 21.94	$ 197.46
				Subtotal:	$ 197.46
				Subtotal:	$ 17,430.89
	Construction Oversight**	HR	16	$ 125.00	$ 2,000.00
	Construction Contingency - 10%**				$ 1,743.09
	Incidentals to Construction - 5%**				$ 871.54
	Minor Additional Design Items - 5%**				$ 871.54
	Final Design	HR	40	$ 125.00	$ 5,000.00
	Permit Review and Applications (exclusive of permit fees)	HR	12	$ 125.00	$ 1,500.00
				Total (Rounded to nearest $1,000)	**$ 29,000.00**

4.4.4 Next Steps

The Town received permission from the owners of the Annex Building, the Women's Fire Department Auxiliary, and they have expressed their willingness to allow further design. Further design will involve refinement of the retrofit design with respect to size, outlet design, and routing to ensure that the target volume can be completely managed and that larger storms bypass the system safely.

4.4.5 Permit Needs

A project readiness screening worksheet has been completed for this project and is included in Appendix C15 - Permit Review Sheets. In summary:

Stormwater Permit
It is not expected that a stormwater permit will be required at this time.

The site should qualify for an Erosion Prevention and Sediment Control permit (3-9020) under the Low Risk categorization if the following guidelines are followed:

- Less than 2 acres of disturbance at any one time.
- All soils must be stabilized (temporary or final) within 7 days.
- Runoff from the site must pass through a 50' vegetated buffer prior to entering any Water of the State.

Local Permitting

No local permits are anticipated.

Other Permits
This project should be reviewed by a River Scientist prior to final design due to the project's location in the river corridor. However, it should be noted that this project will not result in any net fill within the river corridor. No Act 250 permitting or wetlands concerns are anticipated for this project.

4.5 Fire Station and Post Office

4.5.1 30% Concept Design Description

The Town of Woodbury's Post Office (3655 VT-14) and the Woodbury Fire Department (3665 VT-14) are located on VT-14 south of Valley Lake Rd. This site includes the Post Office and Fire Department, and the large paved parking lot between the two buildings. Stormwater currently sheet flows through this area to a paved swale which drains directly to the Kingsbury Branch southwest of the Fire Department. Erosion was observed between the end of the paved swale and along the bank where runoff enters the Kingsbury Branch. The Town noted this site as a stormwater problem area.

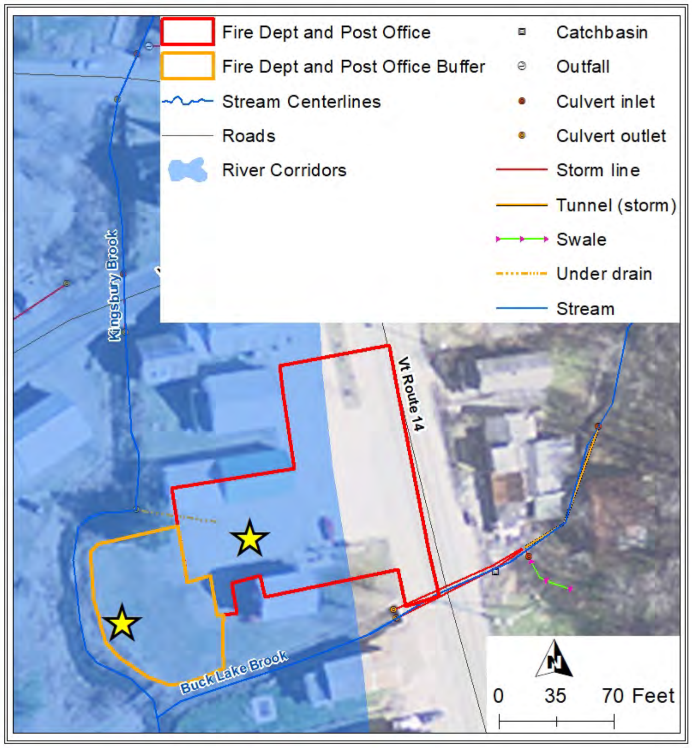

Figure C28. Proposed retrofits include subsurface infiltration (red drainage area) and a riparian buffer improvement (orange drainage area).

The retrofit concept for this site includes installing a subsurface chamber infiltration system in the low spot of the parking lot prior to the paved swale (see starred location within red drainage area in Figure C28). The system will overflow to the Kingsbury Branch and the installation should be done in coordination with the Town's anticipated paving project. It is recommended that an educational sign be installed at this site to educate the general public. This cost is not reflected in the estimated project cost itemized below. Approximately $500 should be budgeted for this sign. The design also includes removing the existing paved swale and revegetating the riparian area and stabilizing any existing erosion. The buffer restoration includes the area along the Kingsbury Branch, south of the Post Office, along Buck Lake Brook. See the photos and associated descriptions in Figure C29. The owners of the Fire Department and Post Office have expressed their willingness to proceed with further design.

Stormwater runoff from the Fire Station and Post Office flows through the parking lot to a paved swale.

Paved swale directing runoff into the Kingsbury Branch. Subsurface infiltration is proposed where the parking lot meets the paved swale.

Where drainage from the paved swale enters the Kingsbury Branch. This area is actively eroding.

A buffer restoration is proposed along the edge of the Kingsbury Branch behind the Post Office building.

Figure C29. The proposed retrofits are described in the above photos.

Figure C30. A hand auger and shovel were used to assess soil conditions and infiltration potential.

Figure C31. Soils were generally sandy and loamy.

Soils are mapped as being good at this site (Hydrologic Group B), so an analysis was conducted to evaluate the potential for an infiltration practice. Soils were assessed using a hand auger and shovel (Figure C30) and were found to be generally loamy with a high percentage of sand and many coarse fragments (Figure C31). Soils conditions observed during analysis did not prompt a need to alter the proposed retrofit design. See Appendix C14 for this site's complete soil log.

A rendering of the proposed stormwater improvements was created to bring a concept to life in ways that engineering plans cannot. This rendering is one possible configuration for this site. This graphically engaging rendering visually communicates the plans and can be used by the Town and the CVRPC to help advance designs toward implementation. This rendering can be found in Appendix C16 - Site Renderings.

The drainage area that flows to the proposed road improvements is 0.4 acres, approximately 63% of which is classified as impervious. The design standard used for this retrofit was full infiltration of the Channel Protection volume (CPV, 2.02 inches of rain in a 24-hour period), equal to 1,786 ft^3 of runoff.

An updated BMP summary sheet is included in Appendix C11 - Top 5 Sites. A 30% design plan is provided in Appendix C13 - 30% Designs.

4.5.2 Pollutant Removal and Other Water Quality Benefits

A retrofit of this site has the potential to prevent 1,177 lbs of total suspended solids (TSS) and 0.35 lbs of total phosphorus (TP) from entering receiving waters annually (Table C15).

Table C15. Fire Station and Post Office benefit summary table.

TSS Removed	1,177 lbs
TP Removed	0.35 lbs
Impervious Treated	0.3 acres
Total Drainage Area	0.4 acres

4.5.3 Cost Estimates

Cost projections, which are detailed in Table C16, total $27,000. Note that these costs are very preliminary. This amount differs from the amount initially projected for this site as design-specific amounts and costs were used. This project will likely be eligible for a Vermont Better Roads Grant Program Category A grant.

- The cost per pound of phosphorus treated is $77,143.
- The cost per impervious acre treated is $90,000.
- The cost per cubic foot of runoff treated is $15.12.

Table C16. Fire Station and Post Office project initial construction cost projection.

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
Site Preparation					
N/A	MOBILIZATION	LS	1	$ 500.00	$ 500.00
653.55	PROJECT DEMARCATION FENCE	LF	150	$ 1.17	$ 175.50
649.51	GEOTEXTILE FOR SILT FENCE	SY	30	$ 4.13	$ 123.90
N/A	CONSTRUCTION STAKING	HR	4	$ 125.00	$ 500.00
				Subtotal:	$ 1,299.40
Chambers - Excavation and Materials					
	EXCAVATION				
203.15	COMMON EXCAVATION	CY	150	$ 9.86	$ 1,479.00
	MATERIALS				
	BASE / COVER / SURROUNDING STONE				
629.54	CRUSHED STONE BEDDING (3/4" - 1 1/2" STONE)	TON	75	$ 34.04	$ 2,553.00
	STRUCTURES AND APPURTENANCES				
604.18	PRECAST REINFORCED CONCRETE DROP INLET WITH CAST IRON GRATE	EACH	1	$ 4,009.29	$ 4,009.29
	CHAMBERS				
	DC780	EACH	9	$ 234.60	$ 2,111.40
	SC740 PLAIN END CAP	EACH	5	$ 48.30	$ 241.50
	SC740 24B END CAP	EACH	1	$ 337.58	$ 337.58
	12" 90 BEND	EACH	1	$ 57.10	$ 57.10
	12" TEE	EACH	1	$ 109.70	$ 109.70
	12" COUPLER	EACH	5	$ 8.29	$ 41.46
	24" COUPLER	EACH	1	$ 33.20	$ 33.20
	12" N12 AASHTO FOR MANIFOLD	LF	20	$ 7.75	$ 155.02
	24" N12 AASHTO FOR ISOLATOR ROW	LF	20	$ 22.54	$ 450.80
	315WTK FOR SCOUR PROTECTION	SY	500	$ 0.72	$ 362.25
	601TG TO WRAP SYSTEM	SY	1000	$ 0.82	$ 816.50
	12X6 INSPECTION PORT KIT	EACH	1	$ 430.10	$ 430.10
	6" RED HOLE SAW	EACH	1	$ 172.17	$ 172.17
	PAVEMENT REPLACEMENT (ABOVE CHAMBERS IN PAVED AREAS)				
401.10	AGGREGATE SURFACE COURSE	CY	24	$ 43.60	$ 1,046.40
				Subtotal:	$ 13,360.06
New Infrastructure For Conveyance of Runoff to Practice					
	EXCAVATION				
203.28	EXCAVATION OF SURFACES AND PAVEMENTS	CY	9	$ 21.94	$ 197.46
				Subtotal:	$ 197.46

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
Buffer Enhancement					
PLANTING					
N/A	WILDFLOWER PLANT SEEDS	LBS	3	$ 125.00	$ 375.00
651.15	SEED	LB	5	$ 7.66	$ 38.30
656.25	EVERGREEN SHRUBS	EACH	2	$ 73.38	$ 146.76
656.35	DECIDUOUS SHRUBS	EACH	2	$ 49.95	$ 99.90
651.25	HAY MULCH	TON	0.5	$ 597.15	$ 298.58
				Subtotal:	$ 958.54
				Subtotal:	$ 15,815.46
	Construction Oversight**	HR	16	$ 125.00	$ 2,000.00
	Construction Contingency - 10%**				$ 1,581.55
	Incidentals to Construction - 5%**				$ 790.77
	Minor Additional Design Items - 5%**				$ 790.77
	Final Design	HR	40	$ 125.00	$ 5,000.00
	Permit Review and Applications (exclusive of permit fees)	HR	12	$ 125.00	$ 1,500.00
				Total (Rounded to nearest $1,000)	**$ 27,000.00**

4.5.4 Next Steps

As this site is owned and operated by the Town of Woodbury, it is recommended that the Town proceed with further design of this retrofit. Further design will involve refinement of the retrofit design with respect to size, outlet design, and routing to ensure that the target volume can be completely managed and that larger storms bypass the system safely.

4.5.5 Permit Needs

A project readiness screening worksheet has been completed for this project and is included in Appendix C15 - Permit Review Sheets. In summary:

Stormwater Permit
This site is not expected to need a stormwater permit.

The site should qualify for an Erosion Prevention and Sediment Control permit (3-9020) under the Low Risk categorization if the following guidelines are followed:

- Less than 2 acres of disturbance at any one time.
- All soils must be stabilized (temporary or final) within 7 days.
- Runoff from the site must pass through a 50’ vegetated buffer prior to entering any Water of the State.

Local Permitting
No local permits are anticipated.

Other Permits

This project should be reviewed by a River Scientist prior to final design due to the project's location in the river corridor. However, it should be noted that this project will not result in any net fill within the river corridor. No Act 250 permitting or wetlands concerns are anticipated for this project.

5 Final Recommendations

The results of this SWMP have identified a number of potential BMP concepts and locations that would have a positive impact on water quality in Calais, East Montpelier, and Woodbury and their receiving waters. Although designs were only advanced for the top 5 projects per municipality, this plan also serves to highlight other opportunities throughout the study areas. As such, the momentum developed during this study should be strengthened and continued.

The practices proposed in this study all stand to have a substantial impact on abating water pollution and setting a precedent for integrating GSI into the landscape. It is our recommendation that the municipalities, in partnership with the CVRPC, move to implement the Top 5 practices, but also move forward with additional design and implementation of the other projects presented in this plan (see Appendices with Top 20 Site Final Rankings: A9, B9, and C9). As these practices are the result of a stormwater master planning effort under a Clean Water Fund grant, they are well-suited as candidates for an implementation grant from this same source. We recommend the following steps in proceeding with this:

- For priority projects already at the 30% concept level, consider grant requests for final design and implementation.

- Following implementation of the priority projects, submit grant funding requests for higher-scoring projects that may include both preliminary and final design.

It is further recommended that each Town look into alternative road surface materials to increase stability and longevity of municipal unpaved roads. We encourage road crews to consider the use of crushed ledge product with a mix of small angular particles (as opposed to bank run gravel with rounded stones) and over 50% fine particles to encourage compaction and cohesion. This product goes by several names such as StayMat, SurePack, or 'plant mix.' This material should be placed on the surface of the road, above a gravel subbase compacted to 90-95 Proctor density. The road surface material should be rolled and compacted to 90-95 Proctor. Another acceptable material is crusher-run gravel which, while it contains fewer fine particles than the aforementioned material, does not have rounded stones like bank run gravel. Where StayMat (or similar) is not available or is prohibitively expensive, crusher run gravel can be used and is preferred to bank run. Compaction procedures should mimic the process outlined for StayMat.

The Vermont Agency of Transportation (VTrans), as part of their Transportation Separate Storm Sewer System (TS4) General Permit, will be completing their own retrofit assessment of VTrans-owned impervious surfaces throughout the region. Projects determined in this plan should be coordinated with the VTrans TS4 permitting efforts to allow for potential collaboration.