Stormwater Master Plan for the Town of Milton, Vermont

FINAL REPORT

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1.0 Introduction

In 2018 the Chittenden County Regional Planning Commission (CCRPC) received grant funding from the Vermont Agency of Natural Resources (VTANR) Clean Water Initiative Program to supplement funds from the Town of Milton to develop a Stormwater Master Plan (SWMP) for Milton. Fitzgerald Environmental Associates, LLC (FEA) was hired by the Town and CCRPC in the summer of 2018 to develop the plan. This final SWMP report for the Town of Milton represents significant efforts and collaborations over the last year between the Town, FEA, CCRPC, VTANR, and other partners, including private landowners and business owners, interested in mitigating stormwater and improving water quality.

1.1 Stormwater Master Planning

Stormwater runoff is caused by precipitation, both in the form of rain or melting snow/ice, that is not infiltrated into the ground, absorbed by wetlands, or otherwise intercepted by plants. Human alteration of our landscapes in the form of impervious surfaces (i.e., pavement, rooftops) and compaction of soils disrupts natural hydrology and causes increased stormwater runoff. Increased stormwater runoff leads to higher magnitude flood flows and greater erosive power in stream channels, increased delivery of sediment, nutrients, and other pollutants to waterways, and increased flooding conflicts with improved properties downstream. Increased stormwater runoff is directly linked to the quality of water in our streams, rivers, ponds, and lakes that we depend on for drinking water, healthy fisheries, and recreation.

Stormwater master plans can prevent problems from happening either by mitigating impacts before they create problems or by avoiding the creation of problems; in other words, prevention is cheaper than restoration. If we are to avoid the high cost of restoring degraded surface waters, we must better manage stormwater runoff before waters become impaired. Plans are developed with public involvement and comment and should be as comprehensive as possible in listing all known problems. Plans are based on a prioritized list of projects or a strategic approach and are therefore more likely to succeed than a reactionary approach that addresses problems as they arise. Historically almost all Vermont municipalities have responded to stormwater runoff or drainage problems the latter way, and frequently during an emergency or after a structural failure has occurred. Stormwater management plans contain important information about preserving natural features and functions of a watershed and provide a list of evaluated alternatives such as using traditional pipe (gray) infrastructure versus green stormwater infrastructure.

1.2 Project and Town Background

The Town of Milton is the 8th largest community in Vermont with dense residential and commercial development in and around the town core. The Lamoille River and Lake Champlain are significant waterbodies within the Town and have been important drivers for development and the Town economy. The recently completed Town Road Erosion Inventory (REI) found that almost 90% of the hydrologically connected road segments were in compliance with standards in the VTDEC Municipal Roads General Permit (MRGP). Many of the high-priority road segments that did not meet the MRGP standards have since been addressed by the Town Highway Department. The Clean Water Roadmap identifies stormwater as a primary source of nutrient and sediment loading to Allen Brook and to the Lower Lamoille River, and Streeter Brook is listed as “stressed” due to stormwater.

The Town operates under a Municipal Separate Storm Sewer System (MS4) Permit and will be required to prepare a town-wide Phosphorus Control Plan (PCP) by April 2022. The primary goal of the PCP is to identify eligible opportunities to reduce phosphorus loading to Lake Champlain and its tributaries, primarily from town-owned and managed land. The required phosphorus load reduction for the Town of Milton is calculated from the total developed lands phosphorus target reduction from the Lake Champlain Total Maximum Daily Load (TMDL). The target varies by lake segment, with most of Milton draining to Mallets Bay (20.5% reduction) and the remainder draining to the Northeast arm (7.2% reduction). The Town will be responsible for meeting these reduction targets for all properties owned or maintained by the Town.

1.3 Project Goals

The goal of this project was to identify and prioritize stormwater improvement projects throughout the Town, with a focus on Town owned properties. Project prioritization followed the Unified Scoring Metrics recently developed by VTDEC (2018a). Conceptual design plans (30% design) were prepared for 15 high-priority projects. Additional phosphorus loading and removal estimates were completed to assist the Town with planning for future efforts to prepare the PCP.

2.0 Study Area Description

Milton is a 61 square mile town located in northwestern Chittenden County in northern Vermont (Fig. 1). Milton is bordered by 3 towns in Chittenden County (Colchester, Essex, and Westford), Fairfax and Georgia in Franklin County, and Lake Champlain to the west with the Grand Isle towns of South Hero and Grand Isle across the northeast arm of the lake often referred to as the “Inland Sea”. Approximately 8.0 square miles (13.0%) of the town area is occupied by Lake Champlain. The Town drains entirely to Lake Champlain, through direct drainages such as Malletts Creek, Allen Brook, and Trout Brook and via the Lamoille River. The Lamoille River winds from northeast to southwest through the town, before emptying into Lake Champlain at the Sandbar National Waterfowl Management Area just south of the Route 2 bridge to South Hero. The Town has a total population of 10,352 as of the 2010 Census (U.S. Census Bureau, 2011).

Land cover data based on imagery from 2016 National Land Cover Dataset (Yang et al., 2018) are summarized in Table 1. The Town of Milton has areas of dense commercial development along the Route 7 corridor and dense residential development along Route 7 and Middle Road. The eastern and western portions of the Town are

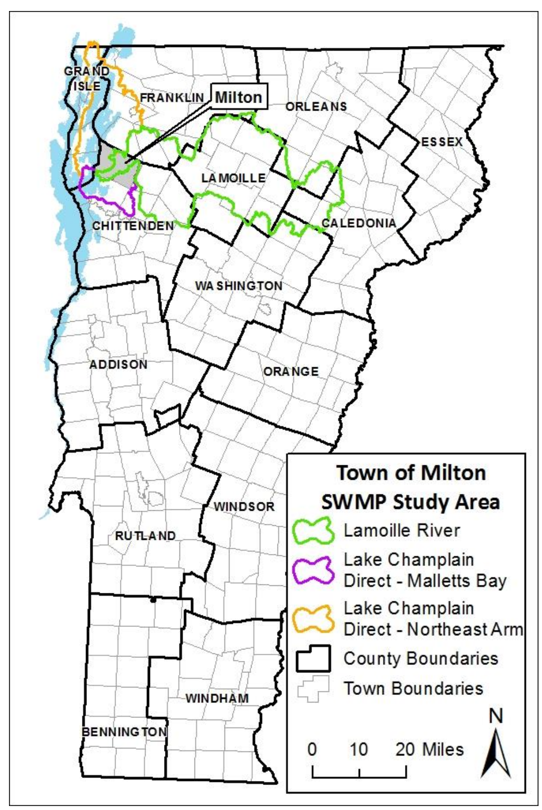

Figure 1: Town of Milton location map.

predominantly forested with areas of light residential development and agricultural fields. There are 163.9 miles of roads in Milton (Table 2), made up mainly of town highways (64.9%), private roads (19.0 %) and highways (15.2%). Road distances are based on road centerline data from VTrans (2017).

Table 1: Road length by AOT class in Milton (VTrans, 2017)

AOT Class	Description	Length (miles)	% of Town Road Length (excluding discontinued)
2	Class 2 Town Highway	33.2	20.3
3	Class 3 Town Highway	67.5	41.2
4	Class 4 Town Highway	5.6	3.4
7	Legal Trail	1.6	1.0
8-9	Private Road	31.1	19.0
40-49	US Highway	11.6	7.1
50-59	Interstate	13.3	8.1
96	Discontinued Road	4.7	-

Table 2: Land cover in Milton (Yang et al., 2018)

Land Cover/Land Use Type	% of Town
Agriculture	15
Developed	9
Forest	48
Open Water	15
Shrub/Scrub	0
Grassland/Herbaceous	1
Wetland	12

The Town is primarily underlain by heavier soils (Hydrogroup C and D) with poor drainage, however the Route 7 corridor follows a band of well drained sandy soils (Hydrogroup A). As a result, over 50% of the developed lands within the Town are located on well-drained A type soils (Table 3). These soils are preferred for stormwater treatment and likely lessen the potential water quality impacts from areas of dense urban and commercial development.

Table 3: Summary of town-wide and developed lands soil drainage

Soil Hydrogroup	Town of Milton (acres)	Developed Lands (acres)
A	7,091	2,023
B	2,765	350
C	5,696	540
D	16,228	692
Other	2,152	148
Total	33,932	3,753

3.0 Stormwater Management Planning Library

3.1 Mapping Data

VTDEC Hydrologically Connected Road Segment Data

VTDEC created a statewide inventory of roads that are likely to be hydrologically connected to surface waters (link). The road network was split into 100-meter segments and then checked for proximity to surface waters and river corridors. Variables including road slope, adjacent hill slope, and soil erodibility were used to create a preliminary "road erosion risk rank". These rankings provide a good starting point for identifying areas of potential sediment generation from erosion of road surfaces and ditches. Road erosion risks are predicted to be low along low-gradient and paved roads, such as Lake Road. Moderate and high risk segments are more prevalent along roads in close proximity to streams and in the relatively steep portions of town (see attached map).

Light Detection and Ranging (LiDAR)

LiDAR returns for Chittenden County were collected in a series of flights conducted between November 2014 and April 2015 as part of the VT LiDAR Initiative. The data meet the National Digital Elevation Program Quality Level 2 specifications for accuracy satisfactory for generation of a 0.7-meter Digital Elevation Model (DEM) and 1-foot contours. Derivations of LiDAR data, such as DEMs, terrain models, and contours are useful tools for stormwater feature identification and site design. The 0.7-meter DEM assists with culvert watershed delineation and the design of stormwater management projects (link). Terrain models also assist in remote identification of erosion features, such as stormwater gullies.

Town of Milton Stormwater Infrastructure Mapping

CCRPC completed stormwater infrastructure mapping for the Town of Milton in 2005. The dataset includes storm lines (pipes and culverts) and point data describing stormwater structures (catch basins, manholes, dry wells, etc.). The point data also includes condition and maintenance requirements at the time of data collection. The Town of Milton has since updated the mapping and is using the database to track inspections and improvements.

Bridge and Culvert Data

Most bridge and culvert data for Town roads were collected in 2015, with some 2018 data available (vtculverts.org). Data include the structure type, material, dimensions, extent of erosion, and overall condition. Structure data for Interstate 89 and Routes 2 and 7 are available from VTrans. Additional bridge and culvert data are available for areas where Phase 2 Stream Geomorphic Assessments (SGA) were completed by Fitzgerald Environmental Associates (FEA) in 2010, along Allen (Petty) Brook, and Malletts Creek and one tributary. The areas of Phase 2 SGA are listed below on page 5. This data includes an assessment of geomorphic compatibility and aquatic organism passage.

Road Erosion Inventory (REI) Data

The 2018 Municipal Roads General Permit (MRGP) requires a Road Erosion Inventory (REI) be conducted on all hydrologically connected town-maintained roads. REI data for Milton were collected by CCRPC in

2017. In relation to the MRGP standards, 3.6% of segments did not meet the standards, 8.1% partially met the standards, and 81% fully met the standards. The remainder of the roads inventoried were curbed. High priority segments that did not meet the standards are located on Beebe Hill Road, Cadreact Road, Reynolds Road, McMullen Road, and Westford Road. FEA completed concept designs for portions of McMullen Road and Cadreact Road in 2017, and portions of Beebe Hill and Westford Road in 2018. Other segments not meeting the standards and identified as high and moderate priority were visited during the project identification process.

Clean Water Roadmap

The Clean Water Roadmap tool apportions Total Phosphorus (TP) loads to land cover classifications (anrweb.vt.gov/DEC/CWR/cwr-tool.vbhtml). Agricultural nutrients associated with cropland, hay and pasture contribute the lion's share of TP to Trout Brook, Malletts Creek, and Stone Bridge Brook. In contrast, TP loads in Allen Brook and lower portions of the Lamoille River are primarily associated with roads and developed lands.

Other Relevant Layers

The initial FEMA Flood Insurance Study (FIS) for Chittenden County became effective in July 2011 and the revised FIS became effective in August of 2014, including digital maps (i.e., DFIRMs). The original Milton hydrologic and hydraulic analysis was performed by DuBois & King for a July 1981 FEMA study. Although the hydrologic and hydraulic analysis was not updated since the original 1981 study, the mapping was improved through the use of LiDAR. Low-lying areas in Milton near the Lamoille River and its tributaries as well as the shore of Lake Champlain are mentioned as problem areas for flooding.

The NRCS soils survey dataset is also valuable for stormwater master planning (websoilsurvey.sc.egov.usda.gov). As part of our initial SWMP problem area scoping, we will screen areas based on the NRCS hydrologic soil groupings (HSG). The HSGs indicate the infiltration potential of the native soil type, which is useful for identifying areas of excessive runoff potential (e.g., HSG D-type) or good infiltration (e.g., HSG A-type) where stormwater infiltration practices should be explored.

3.2 Watershed Planning

Lamoille Tactical Basin Plan

The basin plan discusses the current condition of surface waters in the Lamoille River watershed, recommended actions to preserve and restore water quality, and relevant permit requirements (VTDEC, 2016). Permit requirements relevant to Milton include the Lake Champlain phosphorus TMDL, the MS4, the VTDEC stormwater general permit, and regulations pertaining to wastewater treatment facilities.

Ecological Hotspots

The approximately 1,400-acre wetland complex at the mouth of the Lamoille River was listed as a Class I wetland in 2016. A Class 1 wetland is "exceptional or irreplaceable in its contribution to Vermont's natural heritage" and merit the highest level of protection. In addition, a number of important wetlands are located in Milton including Hidden and Towne Swamps near the Westford Town line. The lower undammed portion of the Lamoille River is mentioned as important spawning and nursery habitat with high biological diversity, including for endangered Lake Sturgeon and multiple threatened fish species.

Water Quality Stressors

Milton water quality planning objectives include the inventory and prioritization of erosion on hydrologically connected municipal roads and reduction of stormwater discharges from villages and town centers. The 6 miles of the Lamoille River below Arrowhead Mountain Lake are listed as impaired due to flow alteration from three hydroelectric dams located on the main stem in Milton. The lower 8.5 miles of the Lamoille River and Arrowhead Mountain Lake are listed as impaired for mercury and Tributary #4 to the Lamoille River is impaired for metals associated with an old landfill. Arrowhead Mountain Lake is also altered due to the presence of Eurasian milfoil and Streeter Brook is stressed due to stormwater.

Recommended projects in Milton include working with agricultural communities to prioritize and implement best management practices, identifying sources of stormwater runoff and nutrients in developed areas and implementing projects to mitigate these inputs, assessing the shoreline condition of Arrowhead Mountain Lake, updating wetland mapping, and planning for flood resiliency.

Northern Lake Champlain Tactical Basin Plan

Ecological Hotspots

Milton Pond is highly ranked for water quality and an overall assessment of lake parameters (VTDEC, 2017).

Water Quality Stressors

Recommended projects in Milton include implementation of Better Backroads BMPs, promoting the use of a portable skidder bridge available from Cyr lumber, implementation of agricultural BMPs, and implementation of projects identified in the Mallets Creek and Allen Brook river corridor plan. The Lake Champlain TMDL identifies large TP reductions in this basin, particularly from agricultural lands.

Malletts Creek & Allen (Petty) Brook Phase 1 & Phase 2 Stream Geomorphic Assessment (SGA) Report

The SGA report for Malletts Creek and Allen Brook was prepared by FEA in 2011 (link). These streams were identified for geomorphic assessments based on the CCRPC and Town's review of zoning and areas of potential development pressure. The primary objective of the project was to collect that data needed to draw Fluvial Erosion Hazard (FEH) Zones for planning and zoning purposes. In addition, potential river corridor restoration projects were identified and scoped along the assessed reaches. The project types included "passive" approaches such as river corridor and floodplain protection, as well as recommendations for culvert replacements and retrofits, stormwater management in upslope areas, and plantings within the stream buffer. The river corridor project areas will be cross-referenced with identified stormwater problem areas to help prioritize our final list of projects in the SWMP.

Additional Phase 2 SGA data were collected for Trout Brook and Streeter Brook in 2005 as part of a UVM environmental science course taught by Evan Fitzgerald. A summary of all reaches with Phase 2 SGA data is provided below.

Table 4. SGA Phase 2 reaches and selected attributes in Milton, VT

Stream	Reach	Year Assessed	Location	Habitat Condition	Geomorphic Condition
Malletts Creek Main Stem	M14-A	2010	South of Kingsbury Crossing	Good	Good
	M15-B	2010	North of Kingsbury Crossing	Fair	Fair
	M16	2010	Along East Road (to west)	Good	Good
	M17-A	2010	Above/below East Road	Fair	Fair
	M17-B	2010	Above East Road	Good	Good
Allen (Petty) Brook	T1.05	2010	At Milton-Colchester Town line	Reference	Reference
	T1.06-A	2010	South of Allen Road	Reference	Good
	T1.06-C	2010	South of Allen Road	Fair	Fair
Unnamed Tributary to Malletts Creek	T6.01-A	2010	Southwest of Main St-East Road intersection	Fair	Fair
	T6.01-C	2010		Fair	Fair
	T6.02	2010	Northwest of Main St-East Road intersection	Fair	Fair
Streeter Brook	R2T1.01-0	2005	From Sanderson Rd south to the Lamoille River	Reference	Good
Trout Brook	M01	2005	Mouth to old bridge remains	Fair	Good
	M02	2005	West of Cadreact Road	Reference	Good
	M03	2005	Above/below Cadreact Road	Reference	Good
	M04	2005	East of Cadreact Road	Good	Reference
	M07	2005	Along Sanderson Road	Good	Reference

3.3 Town Planning and Permitting

Milton Town Plan

The Town Plan discusses priorities around the protection of natural resources, including water quality in the Town's watersheds, lakes and rivers (Town of Milton, 2018). The plan mentions the need to protect water quality through continued stormwater management on Town-owned properties, and through its zoning ordinances. There is also a discussion of the need to continuously meet the requirements of the EPA's Phase 2 NPDES permit.

Town of Milton Unified Development Regulations

The Town's development regulations have a section (3010) dedicated to stormwater management (Town of Milton, 2017c). The regulations are intended to minimize/control the quantity and quality of stormwater runoff by promoting best management practices (BMPs) which limit development's impact on downstream hydrology, prevent excessive clearing and soil erosion, and protect infrastructure. Any proposed development which exceeds 5,000 square feet of new impervious surface must generally meet the following requirements:

- Demonstrate that low-impact site design (LID) and green stormwater infrastructure (GSI) techniques will be utilized to the maximum extent practicable.

- Minimize the amount of impervious surface for roadways and parking areas, within the constraints of the Town's Highway Department specifications.
- BMPs must be sized to capture runoff from the 1-inch rainstorm.
- All disturbed areas not covered by impervious surfaces must generally meet the same post-construction soil depth and quality requirements outlined in the Vermont Stormwater Management Manual.

Town of Milton All-Hazards Mitigation Plan

The Town's All-Hazards Mitigation Plan (HMP) describes specific actions the Town has planned to mitigate flooding and erosion hazards, as well as adverse impacts on water quality, through the management of stormwater (Town of Milton, 2017a). Key actions related to the SWMP work are:

- Catch basin and street sweeping program – the Town recently completed an inventory of catch basin conditions and is prioritizing inadequate structures for retrofit or replacement. Street sweeping is ongoing as part of MS4 permit requirements.
- Land development proposal review and regulation – this is an ongoing effort to ensure that proposed land development meets the standards described above for mitigating stormwater.
- Phosphorus control plan (PCP) – see below for further information on the PCP requirements under the Town's MS4 permit. This SWMP will contribute to advancing elements of the PCP through the identification of priority stormwater improvements on Town-owned land.

Municipal Separate Storm Sewer System (MS4) & Phosphorus Control Plan (PCP)

The MS4 General Permit was issued in 2012 and reissued in 2018 with additional requirements (VTDEC, 2018b). The updated permit also expands the permit area to the entire town. The permit requires towns with stormwater-impaired waters to develop Flow Restoration Plans. This first requirement currently does not apply to any waterways in Milton. The updated permit requires towns in the Lake Champlain watershed to keep track of reductions in phosphorus loads associated with the implementation of Best Management Practices (BMPs), applicable to the entire town of Milton. The Town of Milton stormwater management plan outlines actions it will take to comply with the 2012 MS4 general permit. These actions include public outreach efforts, implementing programs for illicit discharge detection and elimination (IDDE) and construction site stormwater runoff control, and reducing pollutant runoff through road maintenance. Attachment 4 to the management plan includes specifications for stormwater infrastructure design, materials, and installation.

The PCP is intended to reduce phosphorus loads from developed land. The required reductions of each municipality are calculated based on those required for developed land by the Phosphorus Total Maximum Daily Load (TMDL) for Vermont Segments of Lake Champlain (2016), and are scaled based on the size municipally-owned lands. Reductions may include implementation of Municipal Road Standards, street sweeping and catch basin cleaning, and stormwater retrofits. The first annual report was due in April 2019, with the PCP completed in April 2021 and implementation complete by June 17, 2036. The Municipal Road Standards are described above in the Road Erosion Inventory section.

Stormwater Funding Scenarios

In 2006, Stone Environmental prepared a report for the Town of Milton in preparation for compliance with the MS4 Phase 2 permit. The report outlined current sources of stormwater funding and how they were allocated for administration, maintenance, and education. Three scenarios are outlined for scaling up the budget to meet the initial MS4 permit covering a portion of the town. Various funding sources are explored, including taxes and user fees.

Stormwater Management Advisory Report

This report was prepared by Gina Clithero, a UVM summer intern for the Town of Milton in 2017. It includes background on stormwater management, information on stormwater permitting, and an overview of tools and strategies for managing stormwater (Town of Milton, 2017b). Anticipated challenges and necessary actions associated with compliance to the 2018 update to the MS4 permit include monitoring and maintenance complications associated with the privately-owned stormwater systems included in the expanded permit area, tracking TP removal and BMP implementation, and the development and implementation of the PCP. Recommendations of the report include developing a stormwater master plan that identifies stormwater retrofits for existing developments, particularly those which are high impact and cost-effective. A selection of demonstration sites for GSI projects are suggested with descriptions of the problem areas (Cherry Street, School Street, Milton High School, and the Milton Municipal Campus).

3.4 Data Gaps

The data sources and information describing stormwater and watershed management in the Town of Milton are thorough and primarily up to date. An updated stormwater infrastructure inventory which covers stormwater features not previously mapped (i.e., grass swales, outfalls, etc.) would be highly beneficial to the Town's ongoing stormwater management efforts.

4.0 Stormwater Problem Areas

One of the primary objectives of the SWMP is to "develop a comprehensive list of stormwater problems" within the Town of Milton. FEA completed a total of seven (7) field tours of the project area including multiple field visits with Milton Town Highway Department staff to identify existing problem areas, evaluate and prioritize sites, and recommend potential solutions.

4.1 Identification of Problem Areas

The initial round of problem area identification began with the identification of stormwater related projects using a desktop exercise scanning the watershed with aerial imagery, NRCS soils data, Town stormwater infrastructure mapping, contour data, and road erosion inventory results in a GIS. Potential project areas were identified and mapped for review during site visits. The priority assessment areas identified in the project scope were the focus of the field assessment effort. The priority areas are listed below (abbreviations are shown in parentheses):

- Town property, including roads and rights-of-way (TP)
- Husky Injection Molding Campus (H)
- Railroad Street Neighborhood (RR)

- Beaver Brook Neighborhood (BB)
- Route 7 Corridor (Rt7)
- Stacy Street (SS)
- Streeter Brook Watershed (SB)
- Allen Brook Watershed (AB)

A total of 65 stormwater problem areas were identified and assessed in the field (see map in Appendix A and table in Appendix B). The majority of these (50) were located within the project priority areas. We grouped the problem areas into five (5) project categories described below.

- **BMP Installation –** Sites were identified where sediment and nutrient loads could be reduced through the implementation of stormwater best management practices in areas of concentrated surface runoff or stormwater drainage infrastructure.
- **BMP Retrofit –** Sites were identified where existing BMPs could be improved to increase sediment and nutrient removal efficiency.
- **Road Drainage Improvement –** Potential areas of sediment and nutrient loading from the erosion of roads and their associated infrastructure were identified during field visits. Typically, these sites were characterized by steeper gravel roads with increased sediment and nutrient loading due to ditch erosion.
- **Gully Stabilization –** Areas where concentrated runoff has initiated gully erosion. Typically, these projects focus on stabilizing the gully to stop further erosion, and do not
- **Stream/Wetland Restoration –** Areas where buffer plantings, channel stabilization, or restoration of natural hydrology would reduce sediment and nutrient inputs to surface waters and improve habitat features.

4.2 Evaluation and Prioritization of Problem Areas

The 65 projects described in the master project table (Appendix B) were prioritized based on the potential for each project to improve water quality, reduce environmental impact, project feasibility, and co-benefits. Estimated project cost and the phosphorus removal efficiency ($/lb of P) were included. We followed the Unified Scoring Prioritization for Stormwater Master Plans document developed by VTDEC (VTDEC, 2018a), with an adjustment to the phosphorus loading and phosphorus reduction criteria. This method includes a total of 19 criteria divided into 3 categories. The final score is expressed as a percent of the total score, with slightly different criteria applied to road drainage projects. Total scores were out of a maximum of 50 points (Table 5). Two scoring categories are not applicable to road erosion/road drainage projects, which had a maximum score of 44 points. The projects in Appendix B ranged from a low score of 2 (functioning dry well receiving runoff from a gas station), to 36 points (Figure 2).

Criteria	Proposed Weight	Max points
Water Quality/Environmental impact		
Sediment reduction (using STP calculator for sediment) (not yet developed)	0-4 (natural groupings within the range of sediment reductions for proposed projects for a specific plan. 0=very low reduction, 4= very high sediment reduction)	4
Phosphorus/nutrient reduction (using STP Calculator)	0-4 (natural groupings within the range of phosphorus reductions for proposed projects for a specific plan. 0=very low p reduction, 4= very high P reduction)	4
Impervious area managed	1-4 (natural groupings within the range of impervious surface managed for proposed projects for a specific plan. More impervious treated gets more points)	4
Percent of Water Quality & Channel Protection Volume treated*	0-3 (0= no WQ treated, 1= ½ WQV treated, 2=meeting WQV, 3=meets WQV and CPV). Do not apply to road projects.	3
Percent of Recharge criteria met *	0-3 (0 = no infiltration, 1 =infiltrates less than recharge volume, 2= meets full recharge, 3= exceeds recharge 1.5 times or more) Do not apply to road projects.	3
Streambank or other gully erosion mitigation	0-2 (calculate volume= Length x avg. width x avg. depth, use natural groupings to divide volume into 3 categories)	2
Green infrastructure opportunity	0-1 (0=no, 1=yes)	1
* WQV, CPV and Recharge criteria as outlined in 2017 Vermont Stormwater Management Manual		
Total Water Quality Score (out of 21, or 15 if road project)		
Feasibility Criteria		
Public land or Private Landowner support	0-3 (3=public land, 2=willing private land owner, 0=unwilling or unknown willingness of private landowner)	3
Project and Permitting complexity (number of permits required)	0-2 (2= simple permitting, 0= complex permitting-potential denial)	2
Infrastructure conflicts	1 (Y= 0, N=1)	1
Total Estimated Project Cost)	Enter engineering estimate+ construction estimate (no points)	
Project efficiency ($/lbs. of P removed)	1-12 (Use natural grouping of $/lbs. removed)	12
Ease of O&M and ease of access for O&M	0-2 (based on municipal input on what is easiest to maintain, 0=high maintenance, 2=easy maintenance)	2
Total Feasibility Score (out of 20)		
Other considerations/Co-benefits (0=doesn't address concern, 1=addresses concern)		
Educational benefits and or Recreational benefits	1	1
Natural habitat creation/protection	1	1
Infrastructure improvement (culvert replacement)	1	1
Outfall erosion control	1	1
Connected to receiving water	3=all runoff infiltrates on site, 2= runoff receives some treatment before reaching receiving water. 1=runoff drains via infrastructure directly to receiving water with no erosion or additional pollutant loading, 0 =runoff drains directly to receiving water	3
Flood mitigation (known problem)	1	1
Existing local concerns	1	1
Total Co-benefits Score (out of 9)		
Overall Score (out of 50 or 44)		

Table 5: Unified scoring prioritization for stormwater master plans, developed by VTANR (VTDEC, 2018a).

Figure 2: Two sites had the highest score (36 out of 50). Project O-1 (left) is located along North Rd where a large agricultural drainage flows to a roadside ditch with areas of erosion. The size of the drainage area and erosion along flowpaths into the ditch yield the highest estimated phosphorus load of all projects. Project SS-1 (right) is located on Stacy Street where a roadway drainage network is piped to a very large and active gully.

GIS-Based Site Screening

Using the field data points collected with sub-meter GPS during our watershed tours, we evaluated key characteristics for each site indicating the potential for increased stormwater runoff and pollutant loading, among several other factors described below. These GIS-based observations, along with field-based observations of site characteristics, are summarized in the project prioritization table (Appendix B).

The following geospatial data were reviewed and evaluated as part of the GIS-based screening:

- **Subwatershed Mapping –** The contributing drainage area to each problem area was mapped based on field observations and 1-foot contours derived from the 0.7 2014 LiDAR elevation surface.
- **Aerial Photography** – We used the 0.15 m imagery collected for Northern Vermont in 2018 to review the site land cover characteristics (i.e., forest, grass, impervious).
- **Impervious Surfaces Data** – We used the 2011 high-resolution impervious surfaces dataset developed by the UVM Spatial Analysis Laboratory for the Lake Champlain basin to measure the total impervious area in acres draining to the project area as identified in the field. Projects with impervious surface expansion after the 2011 data collection were manually measured.
- **NRCS Soils** – We used the Chittenden County Soils data to evaluate the inherent runoff and erosion potential of native soil types (i.e., hydrologic soil group, erodible land class). For project sites with potential for green stormwater infrastructure (GSI), we assessed the general runoff characteristics of the drainage area based on hydrologic soil group (HSG).

- **Parcel Data** – We used the parcel data available through VCGI to scope the limits of potential projects based on approximate parcel boundaries and road right-of-way.
- **CCRPC Stormwater Infrastructure Mapping** – Where available, we used 2005 stormwater infrastructure GIS layers to aid in field locating outfalls and other drainage features as well as the determination of drainage areas and flow paths of stormwater features.
- **VTDEC Hydrologically Collected Road Segment Data –** We used a statewide inventory of road erosion risk and hydrologic connectivity of road segments to prioritize areas of potential sediment loading to visit for field surveys.

Phosphorus Loads from Sediment

Land cover-based phosphorus loading estimates included in the Lake Champlain TMDL are based on generalized assumptions of sediment mobilization, however we believe that phosphorus loading from active erosion areas may be underestimated for some of the stormwater problem areas. Other project types such as stream bank restoration or gully stabilization do not fit into the VTDEC Unified Scoring framework. We developed a simple adjustment to the overall phosphorus loading and phosphorus reduction criteria to account for excess sediment mobilization. Our proposed adjustment is based on a best professional estimate of annual soil loss (in cubic feet) and an estimate of soil phosphorus content. Two studies of streambank soils in Chittenden County have found an approximate total phosphorus concentration of 615-620 mg TP/kg soil (DeWolfe et al., 2004 and Ishee et al., 2015). These numbers align closely with the US average of 600mg/kg (Abrams and Jarrell, 1995). Based on these numbers we assumed that soils are 0.06% phosphorus by weight. The Ishee study found local streambank soil bulk density to range from 62 to 75 lbs/ft^3 (2015). Based on these findings in local watersheds, we estimate that a ft^3/year of soil erosion is equivalent to 0.04lb/year of increased phosphorus load. We specified additional phosphorus load and removal for 27 projects. These loads represented all of the phosphorus load for the road drainage projects and 10-85% of the phosphorus load for the subset of BMP installation/retrofit projects.

BMP Unit Costs and Adjustment Factors

BMP unit costs (2016 $) and adjustment factors were derived from recent stormwater master plans completed by Watershed Consulting Associates (2018). These numbers were primarily based on research completed by the Charles River Watershed Association and the Center for Watershed Protection (EPA, 2016), as well as updates based on actual construction costs in Vermont (Table 6). The unit cost estimates include a 6% inflation adjustment based on the 3-year Consumer Price Indicator Inflation Calculator. Unit construction costs for road drainage projects were based on the estimates provided in the Road Erosion Site Prioritization and Remediation Project Summary (Fitzgerald Environmental Associates and Milone and MacBroom, Inc., 2017). Additional multipliers for site type (Table 7) and level of permitting and engineering required (Table 8) are also shown below.

Table 6: BMP Unit Costs ($)

BMP Type	Cost/ft^3 Treatment Volume
Grass conveyance swale	6.61
Surface infiltration basin	6.61
Subsurface infiltration	6.63
Rain garden/bioretention	16.39
Wet pond	7.21

Table 7: Site Type Cost Adjustment

Site Type	**Cost Multiplier**
Existing BMP retrofit	0.25
New BMP in undeveloped area	1.00
New BMP in partially developed area	1.50
New BMP in developed area	2.00

Table 8: Permitting and Engineer (P&E) Cost Adjustment

Level of P&E Required	**Cost Multiplier**
None	1.00
Low	1.20
Moderate	1.25
High	1.35

Problem Area Summary Sheets

Problem area summary sheets were developed for 30 of the high-priority project sites, and are provided in Appendix C. These sites were selected based on the prioritization categories shown in the Problem Area Table in Appendix B, and from input from project stakeholders during several meetings and field tours.

4.3 Conceptual Designs

FEA and the Town held a meeting with representatives from CCRPC and VTANR in January 2019 to discuss project prioritization and selection of 15 projects for conceptual design development. The consensus from this meeting was to focus concept designs on projects that would represent the most cost-effective phosphorus reductions for Town-owned and maintained lands. Development of these projects would have the greatest benefit to the upcoming Town PCP efforts. Thirteen (13) projects were selected at this meeting for concept designs, and a short-list of additional projects were selected for further investigation. Two additional projects were identified in the spring of 2019 by FEA and the Milton Town Highway Department and were selected for concept designs. FEA completed 6 site visits to collect survey data, map drainage infrastructure, collect preliminary soil information for BMP considerations, and improve BMP designs and cost estimates for the 15 projects selected for concept design (Figure 3). Descriptions for the stormwater problem areas selected for concept designs are provided in Table 9 below.

Figure 3: FEA staff collecting survey data and soils data for a grassed swale BMP along Nancy Drive (Project RT7-16)

Table 9: Summary of 15 projects selected for 30% concept designs

Project	Location	Description	Est. Town P Load Reduction*	Estimated Project Cost
AB-2	Allen Drive	Surface infiltration feature and catch basin retrofits	1.31	$ 53,600
AB-3	Allen Drive	Underground infiltration feature on existing stormline	0.89	$ 38,814
BB-1	Emile Drive	Retrofit grassed swale to enhance infiltration, roadside drainage improvements	1.27	$ 12,296
BB-2	Woodcrest Circle	Install new drywells and additional drainage improvements	0.55	$ 42,908
BB-4	Hemlock Road	Install new drywells, improve swales, retrofit existing drywells for pre-treatment	0.38	$ 31,940
BB-5	Kingswood Drive	Improve swales and install shallow sand filter with underdrain	0.52	$ 52,580
O-6	River Street Park	Shallow bioretention/rain gardens to treat parking lot runoff	0	$ 12,580
RR-5	Railroad Street	Retrofit existing ditch to create a tiered wet pond	0.49	$ 6,760
RT7-4	Lamoille Terrace	Install new catch basins to improve road drainage and a new underground infiltration feature	0.65	$ 41,360
RT7-16	Checkerberry Square	Grassed swale improvements, drainage improvements, and a surface installation feature	1.53	$ 31,976
SS-1	Stacy Street	Retrofit existing catch basins to direct WQv to new underground infiltration	4.9	$ 102,080
TP-1	Town Garage	Install a sediment trap around existing catchbasin behind garage	1.41	$ 6,284
TP-2	Town Garage	Install a grassed swale and sand filter to treat runoff from front half of building and parking area	1.63	$ 22,640
TP-5	Town Transfer Station	Drainage improvement and erosion stabilization practices along town access road from transfer station to dump	1.0	$ 44,320
TP-7	Municipal Complex	Install bioretention/rain gardens at the west end of front parking lot	0.33	$ 5,876

* See Section 5.0 for discussion of Town P Load and Reduction Estimates

The projects selected for conceptual designs primarily treat runoff from Town property. However, many of these projects will require private property easements to provide the space necessary to install features with sufficient treatment volume. Preliminary details and property owner information area provided in Table 10. Landowner information comes from parcel data provided by the Town of Milton and Vermont Center for Geographic Information, and may not be current.

Table 10: Easement requirements and landowner information for concept designs

Project	Proposed Treatment Feature	Landowner Information
AB-2	The surface infiltration feature is entirely located on private property adjacent to Allen Drive.	Landowner information is not provided for this large parcel wrapping around The Ledges neighborhood. This land is assumed to be associated with the neighborhood's homeowners association.
AB-3	The subsurface infiltration feature is partially located within the ROW, the remainder extends on private property adjacent to Allen Drive.	Landowner information is not provided for this large parcel wrapping around The Ledges neighborhood. This land is assumed to be associated with the neighborhood's homeowners association.
BB-1	The infiltration feature is located on private property. **FEA spoke with the landowners and they are supportive of the project.**	Wayne and Donna Delphia 9 Emile Dr Milton, VT 05468
BB-5	The southern sub-surface infiltration feature may partially extend onto private property.	Niilo and Karen Korpi 4 Hemlock Rd Milton, VT 05468
O-6	The proposed bioretention features are located on the River Street Park property	Green Mountain Power Corp 2152 Post Rd Rutland, VT 05701
RR-5	The proposed check dams are located within the railroad ROW	New England Central Railroad Division
RT7-16	The proposed infiltration basin may extend onto the vacant building lot north of Checkerberry Drive. The existing driveway culvert will be upgraded and replaced	Professional Development Associates Inc PO Box 24 Milton, VT 05468
TP-2	The swale and sand filter are located on private property adjacent to the Town garage.	Green Mountain Power Corp 2152 Post Rd Rutland, VT 05701

5.0 Considerations for Future Phosphorus Control Plan

The Town of Milton will need to prepare a Phosphorus Control Plan (PCP) by April 2021 following guidance in the VTANR MS4 permit (VTDEC 2018b). This SWMP represents a significant step forward by the Town in identifying projects and strategies that will help the Town meet its annual phosphorus (P) loading reduction targets. As part of the SWMP effort, we have assisted the Town in estimating its P loads and reduction target following current guidance from VTANR. In addition, we have put the P reduction estimates associated with the projects identified in the SWMP into the context of the PCP loads and target reductions. The following section summarizes considerations for the future development of the PCP, including non-structural BMPs (i.e., street sweeping and catch basin cleaning) and implementation of Municipal Road Standards.

5.1 Preliminary PCP Loads and Reductions

The final VTANR MS4 permit states that phosphorus reduction targets required for a PCP will be based on phosphorus loads from municipally owned and controlled developed lands. The developed lands are defined by the 2011 Lake Champlain Impervious cover dataset and the National Land Cover Dataset. Town-owned and controlled lands include municipal roads, the municipal road right-of-way, and municipally-owned parcels. Loading rates specific to each category of developed land from the Lake Champlain TMDL are used to calculate the municipal load. The municipal load reduction is based on the lake segment developed lands reduction target from the TMDL (20.5% for Malletts Bay and 7.2% for Northeast Arm). The Town of Milton municipal phosphorus load and reduction targets are estimated in Table 11. It is important to note that paved and unpaved roads represent most of the municipal phosphorus load.

Table 11: Preliminary calculations for PCP annual loads and reduction targets for the Town of Milton

	Municipal Lands	Area (ac)	P Load (lb/yr)	P Reduction (lb/yr)
Mallets Bay (includes Lamoille River)	Developed Impervious	42.65	94.05	19.28
	Developed Pervious	234.24	68.62	14.07
	Paved Roads	209.04	460.89	94.48
	Unpaved Roads	12.18	54.32	11.14
			Mallets Bay Subtotal	**139.0**
Northeast Arm	Developed Impervious	4.15	10.47	0.8
	Developed Pervious	57.46	37.75	2.7
	Paved Roads	36.53	92.13	6.6
	Unpaved Roads	28.15	128.28	9.2
			Northeast Arm Subtotal	**19.3**
			Town of Milton Total	**158.3**

Based on preliminary calculations the municipal phosphorus reduction target for Town owned and controlled impervious surfaces will be approximately 158lbs per year, to be achieved by 2036. The development of a Town PCP will quantify the costs and reduction credits for a wide range of improvement options within each lake segment. Reduction opportunities include:

- Construction or retrofit of stormwater treatment practices
- Catch basin cleaning and street sweeping programs
- Implementation of Municipal Road General Permit (MRGP) requirements
- Municipal takeover of stormwater systems for 3-acre permit sites

5.2 Reductions from Stormwater Treatment Practices

The projects described in this SWMP represent a starting point for the required load reductions. The concept designs included in Appendix D describe 14 projects which include municipal phosphorus reductions totaling approximately 17lbs/yr of reduction credit (approximately 11% of the required Town P load reduction). The amount of municipal load phosphorus reduction across the 14 projects ranges from 0.3 to 4.9lbs/yr and total costs range from $4,500 to $130,000. The average cost/lb of phosphorus is approximately $24,000.

5.3 Reductions from Non-Structural BMPs

VTANR is in the process of developing guidance for P-reduction credits for non-structural BMPs, i.e., street sweeping and catch basin cleaning practices. VTANR has indicated they are considering the use of simple empirical equations described in the MS4 TMDL regulations for Massachusetts and Wisconsin. These methods utilize simple P-reduction factors based on the type and frequency of non-structural BMP implementation. Preliminary calculations indicate that enhanced street-sweeping practices may be a feasible, yet expensive, method for achieving significant phosphorus load reductions. Accurate estimates for these methods will require development of additional GIS data to populate the empirical equations. We made some initial assumptions to populate the equations and calculate the potential P reduction credits for enhanced non-structural BMPs in Milton.

- Assuming twice annual (Spring/Fall) street sweeping with vacuum of all paved Town roads in Milton, annual P credit would be approximately 10 lb/year.
- Assuming 100-200 catch basins cleaned twice/year, annual P credit would be approximately 1 lb/year.
- Assuming implementation of the Massachusetts method prescribed leaf litter and organic waste collection on all paved roads, the annual P credit would be approximately 20-30 lb/year.
- Assuming implementation of the Wisconsin method prescribed leaf litter and organic waste collection on qualifying paved roads, the annual P credit would be approximately 15-20 lb/year.

Supporting calculation details for non-structural BMP load reduction estimates are provided below.

<u>Enhanced Street Sweeping</u>

The MA Method (US EPA 2016) uses a simple reduction factor based on the type of street sweeper and the frequency of sweeping. This reduction factor is applied to the total P load from paved Town roads. For this calculation we assumed twice annual street sweeping with a vacuum assisted sweeper for a 0.02 phosphorus reduction efficiency factor (MA Method Table 2-3)

- VT ANR Town ROW paved road load: **544.3 lb/year**
- Annual Street Sweeping Credit = Annual Load * 0.02
- **Potential P Reduction Credit: 10.9 lb/year**

MA Method Appendix F Table 2-3 (US EPA 2016): Phosphorus reduction efficiency factors ($PRF_{sweeing}$) for sweeping impervious areas

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

Catch Basin Cleaning

The MA Method (2016) uses a simple reduction factor (0.02) based on an assumption of twice annual catch basin cleaning. This reduction factor is applied to the total P load of impervious surfaces draining to each catch basin.

- VT ANR Load Approximation
  - VT ANR Town ROW paved and unpaved road load: **722.3 lb/year**
  - Number of road segments in Milton (VT ANR Hydrologically Connected Road Segments Layer): **1810**
  - Load per road segment: **0.4 lb/year**
  - Assume 1 catch basin drains half of one road segment
  - Approximate load per catch basin: **0.2 lb/year**

MA Method Appendix F Table 2-4 (US EPA 2016): Phosphorus reduction efficiency factor (PRF_{CB}) for semi-annual catch basin cleaning

Frequency	Practice	PRF CB
Semi-annual	Catch Basin Cleaning	0.02

- Annual Catch Basin Cleaning Credit = Annual Load * 0.02
  0.004 lb/catch basin/year

- **100-200 catch basins cleaned twice/year to get approximately 1 lb/year of P Reduction Credit**

Enhanced Organic Waste and Leaf Litter Collection (MA Method)

The MA Method (US EPA 2016) uses a simple reduction factor (0.05) applied to the total P load of impervious surfaces in the enhanced collection Area.

- Collection P Reduction Credit = Annual Load * 0.05

Potential P Reduction Credit with VT ANR Paved Road Load: 27.2 lb/year

Potential P Reduction Credit with VT ANR Paved Road and Impervious Load = 625.9 lb/year*0.05 = 31.3 lb/year

Specifications from the MA method (2016): "In order to earn this credit (Credit leaf litter), the permittee must gather and remove all landscaping wastes, organic debris, and leaf litter from *impervious roadways and parking lots at least once per week during the period of September 1 to December 1 of each year. Credit can only be earned for those impervious surfaces that are cleared of organic materials in accordance with the description above. The gathering and removal shall occur immediately following any landscaping activities in the Watershed and at additional times when necessary to achieve a weekly cleaning frequency. The permittee must ensure that the disposal of these materials will not contribute pollutants to any surface water discharges."*

Enhanced Organic Waste and Leaf Litter Collection (WI Method)

The WI Method (WI DNR 2018) uses a simple reduction factor (0.17) based on an assumption 40% P reduction from the collection applied to the Fall contribution representing 43% of the annual P load. This reduction factor is applied to the total P load of paved roads in medium density residential areas.

- Assume half of Milton paved roads have medium density residential setting
  - ½ V T ANR Town ROW Paved Road Load: **272.2 lb/year**
- Assume 40% of areas have 35% tree canopy in ROW
  - ½ VT ANR Town ROW Paved Road Load * 0.4: **108.9 lb/year**
- Collection P Reduction Credit = Annual Load * 0.17
  - **Potential P Reduction Credit: 18.5 lb/year**

5.4 Reductions from Municipal Road General Permit (MRGP) Compliance

MRGP compliance is assessed along 100-meter road segments as mapped in the hydrologically connected road segments layer available from the Vermont Center for Geographic Information. The road erosion inventory (REI) data collected by CCRPC in 2017 provided the baseline assessment of road segment compliance for hydrologically connected town-maintained roads. A dashboard of MRGP road segment compliance is available from CCRPC (Link). In addition to upgrading segments deemed "Very High Priority" by the MRGP, the Town is required to upgrade 15% of non-compliant road segments by January 2023. The segments chosen will be included in an implementation table developed by the Town, outlining a plan for complying with the permit by the December 31, 2036 deadline.

VTANR is developing a new method for load allocation from Town roads that will likely increase the proportion of load from hydrologically connected segments, and subsequently decrease the load from non-connected segments. As this method is still in development, we performed a preliminary and simplistic analysis to quantify the total road P-load by road segment and estimate potential P-reduction credit based on road improvements.

According to the results of the REI, Milton is required to upgrade 82 road segments that partially met or did not meet the MRGP standards. The Town ROW paved and unpaved road load in Milton is approximately 722 pounds of phosphorus (P) per year. Divided by 1,810 segments, the load associated with each road segment is approximately 0.4 pounds of P. The noncompliant segments represent a load of 33 pounds of P per year. In recent correspondence with VT ANR, they have stated that roads mapped as "did not meet" will receive an 80% P reduction credit, and roads maps as "partially meets" will receive a 40% P reduction credit, when brought up to MRGP compliance. This would amount to a potential P reduction credit of 17.5 pounds for upgrading the 82 segments. Any future updates to the loading calculation will increase the P-load reduction credit for improving these segments to MRGP standards. In addition, the Town will receive P-reduction credits for any road improvements completed on hydrologically connected road segments after 2010. Guidance has not yet been provided for this process; however, we anticipate that review and documentation of previously completed work will provide a significant P-reduction credit.

5.5 Potential Reductions from Roadway Disconnections

As part of the SWMP field work FEA staff have observed many areas where municipal roads appear to be effectively disconnected per standards in the VTANR Stormwater Management Manual (VTANR, 2017), i.e., runoff from the road sheds to a naturally vegetated areas where it can infiltrate into vegetated ground. Given that over 50% of the developed lands and associated municipal roads within the Town are located on well-drained A type soils (see Table 3 on page 3), we wondered how many road segments may meet the disconnection criteria under Section 4.2.2.4 of the Manual.

To answer this question in the context of PCP loads and target reductions, FEA performed a GIS-based screening of municipal roadside elevation, soils, slope, and vegetation. The methods used to estimate disconnected municipal road segments, which included field work to validate and adjust the GIS screening, are described in Appendix E. We estimated that 6% of road segments in Milton potentially meet disconnection criteria. Overall, we feel this screening provides a conservatively low estimate for the number of road segments in Milton where stormwater is treated by an infiltrative vegetated buffer.

The Town load for paved roads, unpaved roads, developed pervious, and developed impervious land in Milton is approximately 812 pounds of phosphorus (P) per year. Divided by 1,810 segments, the load associated with each road segment is approximately 0.45 pounds of P. The 201 road segment halves represent a load of 44 pounds of P per year that could potentially be removed from the Town load or be counted towards as P-reduction through stormwater treatment.

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