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Georgia Shore Stormwater and Shoreline Erosion Assessment

Final Report

August 2, 2021

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I. Disclaimer

The intent of this report is to present the data collected, evaluations, analyses, designs, and cost estimates for the Georgia Shore Stormwater and Shoreline Erosion Assessment under a contract between the Friends of Northern Lake Champlain (FNLC) and Watershed Consulting Associates, LLC (Watershed Consulting). Funding for the project was provided by a grant from the Lake Champlain Basin Program. The plan presented is intended to provide the project's stakeholders a means by which to identify and prioritize stormwater management and shoreline stabilization efforts. This planning study presents a recommended collection of Best Management Practices (BMPs) that would address specific concerns that have been raised for this area, an assessment of shoreline stabilization, and identification of areas where vegetated buffers could be installed. There is great need to reduce stormwater impacts including phosphorus and sediment from stormwater runoff to Lake Champlain Basin considering 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 study area, 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 study area obligated to implement them.

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 gravel wetlands, infiltration basins, and bioretention practices.

Buffers- Protective vegetated areas (variable width) along stream banks or lakes that stabilize sediment, filter sediment, slow stormwater runoff velocity, and shade waters to keep them 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 or stone.

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 the permeability of 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 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.

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. 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. Vermont's lakes, and particularly Lake Champlain, are key resources for the region for recreation, drinking water, and tourism. An estimated 45% of lakeshores on lakes 10 acres or larger have been developed in such a way that negative water quality and aquatic habitat impacts can be observed[1]. Residential density along Vermont lakeshores is more than double that of urban areas of the State. It is clear that something must change. This is where stormwater 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 Why Complete a Planning Project?

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, planning studies that involve a comprehensive review of available data and resources and an assessment of the entire study area are imperative in allocating limited resources to those areas where the projects can most positively impact water quality. 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 planning process. The process allows for assessment and prioritization of 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 also critical to the planning process. As such, working with municipal officials, project stakeholders, and community members is key to implementation of and support for these plans. This planning project seeks to prioritize stormwater solutions, maximize the potential for water quality improvement, erosion reduction, and pollution

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[1] https://dec.vermont.gov/sites/dec/files/wsm/lakes/Lakewise/docs/lp_nsecc_2016_11_Vermont_Lake_Conditions.pdf

prevention using a variety of best management practices (BMPs) and allocating limited funds in a planned and methodical way.

2 Background and Problem Definition

A stormwater master plan was completed for the Town of Georgia in 2012 by Stone Environmental, Inc. While this plan cataloged and identified solutions for many stormwater-related issues in the Town, the focus was on the more developed central areas of Georgia with a focus on designated areas of growth along the I-89 and VT Route 7 Corridor. However, this left the approximately 11 miles of shoreline along Lake Champlain that is accessed by Georgia Shore Road (known as the “Georgia Shore”) largely unassessed. Since that time, there has been increased year-round use and new development which impacts the erosional risk from the roadway and reduced shoreline vegetation on erodible banks. FNLC has received and increasing number of calls from concerned landowners regarding erosion on the lakeside of their properties and have observed variable management methods by landowners including hardening, inappropriate vegetation removal, access points to water, and inappropriate discharge conduits for stormwater flows. FNLC have also received reports from the Department of Public Works (DPW) regarding unauthorized changes to public stormwater infrastructure contributing to localized erosion and flooding issues along Georgia Shore Road.

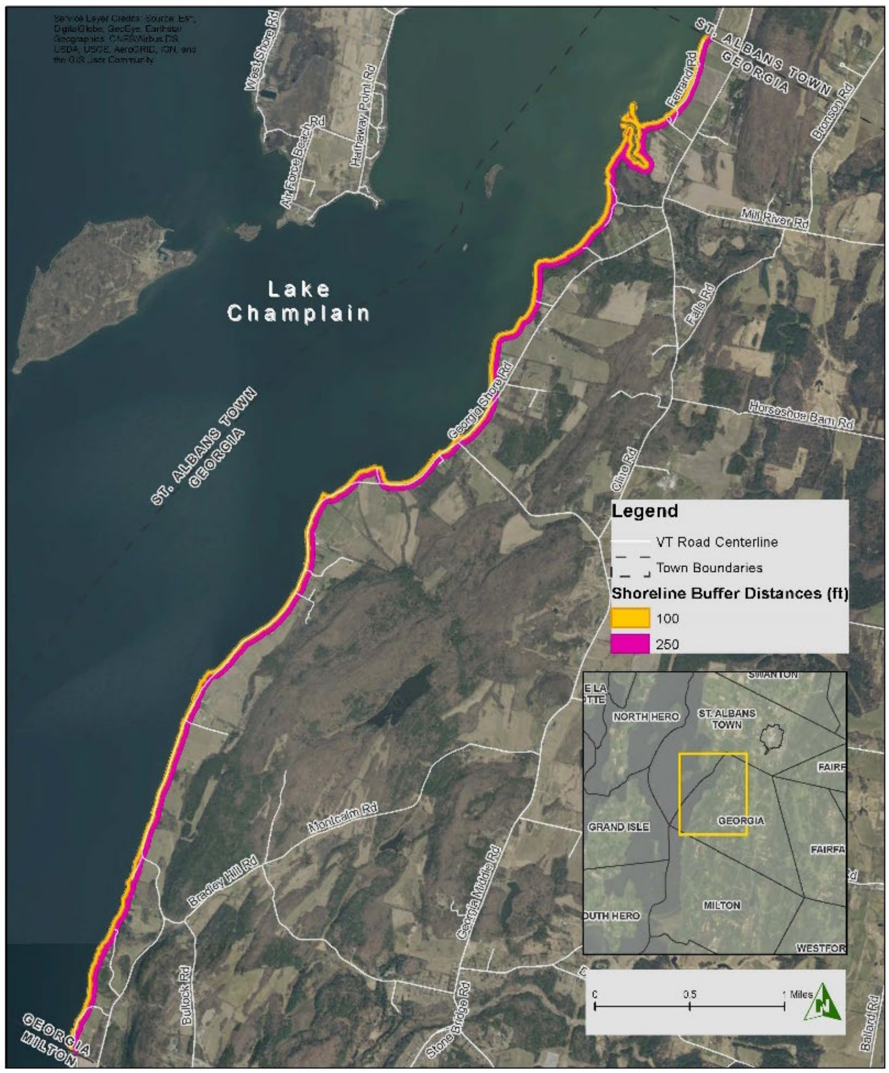

Figure 1. The Georgia Shore study area is shown broken up into the Lakeside Zone (yellow) and the Upland Area (pink).

The project concept originated through discussion with FNLC and the evaluation and conclusions drawn from other nearby lakefront communities. Given the poor soil conditions, historical draining of the land and concentration of flows, and highly constrained drainage outlet points along the Lake as a result of lakeshore development and infrastructure, stormwater discharges are causing erosion and carrying large volumes of sediment and associated nutrients into the Lake. This residential and agricultural runoff drains into St. Albans Bay via direct stormwater discharge or the impaired Mill River close to the northern town boundary with St. Albans Town. Further, these erosive flows have the potential to threaten property and sensitive infrastructure including wastewater disposal systems. Water quality impacts from shoreline erosion and uncontrolled stormwater flow can reduce nearshore habitat quality and feed excess nutrients leading to cyanobacteria blooms, an issue of acute concern in this area of the lake.

This study focuses on the area along the Lake Champlain shoreline in the Town of Georgia with an additional focus on two areas along Georgia Shore: from lakeshore to 100ft (the Lakeside Zone) and from 100ft to 250ft (the Upland Area). These buffer zones capture the "Protected Shoreland Area" described in the 2014 Vermont Shoreland Protection Act (Figure 1).

2.1 Approach

The study was contracted by the Friends of Northern Lake Champlain and funded by a grant from the Lake Champlain Basin Program. A base of accurate mapping information for the community that can be used as a resource for this project as well as other future studies was developed during project development. Specific problem areas where unfavorable or deteriorated conditions are resulting in water quality impacts to Lake Champlain were also identified. Three conceptual plans were created that can be utilized as a base for developing a final engineering design for the selected sites. The 30% designs will put the sites in good standing for potential grant funding for final design development and implementation. The project involved performing a GIS analysis to filter likely problem locations, field mapping of existing culverts using a GPS, identifying problems areas, developing a matrix to prioritize the problem areas, and drafting the three conceptual plans. Community members participated in the process through two community meetings and were encouraged to contact FNCL to learn more about practices they can incorporate on their own properties to improve shoreline stability and water quality. This project built off data summarized in the "Stormwater Management Planning Library" for the Town of Georgia, as prepared by Stone Environmental in 2012. The means of analysis and subsequent results are described below.

3 Methodology and Results

3.1 Identification of Opportunities

3.1.1 Initial Data Review and Project Kickoff

Available documents, tables, and geospatial data relevant to stormwater management and water quality in the Town of Georgia, Vermont with a focus on the shoreline area of study was collected. Geospatial data was obtained from a variety of sources including the Vermont Center for Geographic Information (VCGI) Open Geodata Portal, the US Geological Survey (USGS), VT Culverts (provided by the Vermont Agency of Transportation and the Vermont Regional Planning Commissions), and the US Department of Agriculture. The file geodatabase contains point, polyline, and polygon feature classes as well as raster data. This data contains information related to infrastructure (e.g., roads and stormwater management features), parcels, political boundaries, surface water features, soils, and land cover.

Watershed Consulting held a Kickoff Meeting with FNLC and the Town's Road Foreman in July of 2020 to review the project including the timeline, project goals, and deliverables. A discussion of the study area followed and identified key locations along the Georgia Shore study area for review. A map was presented to the attendees so that they could identify these areas where stormwater issues exist. These locations as well as kickoff meeting minutes can be found in Appendix A.

3.1.2 Desktop Assessment

The Georgia Shore study area spans nearly 11 miles of shoreline. It would be infeasible to assess the entire shoreline, so a methodology was developed to prioritize those areas most at risk for water quality concerns. This analysis employed multiple spatial datasets to identify specific locations of concern within the project area that have multiple risk factors known to contribute to erosion risk, higher runoff potential, and therefore more significant nutrient loading.

This analysis was not intended to replace the need for field data collection, but rather inform and direct that process. All data was clipped to a 250ft buffer zone along the shoreline of Lake Champlain, which functioned as the binding area of interest for this analysis. Two buffer zones were defined within the overall extent, the first extending from the shoreline to 100ft (the "Lakeside Zone") and the second extending 100ft to 250ft (the "Upland Area").

Data was obtained in or converted to raster format for this analysis. The raster layers were scored based on characteristics related to their erosion potential and runoff propensity, where higher scores represented greater water quality risk. Table 1 outlines the source data utilized for this analysis and includes a description of the scoring applied to each input layer.

Table 1. Description of input data layers.

Layer	Source	Data Format	Preparation and scoring details
Stream Buffers	USGS - National Hydrography Dataset (NHD) / Vermont DEC River Corridors Dataset	Vector	Vermont DEC River Corridor mapping was used as a buffer where available, which only applied to Mill River. 50 ft buffers were used on all other NHD mapped streams. Streams buffers were then scored from 1 to 3 as determined by their approximate drainage area sizes as described in the Vermont DEC Stream Alteration Guidance map for the Town (3 being the largest drainage area).
Soils	USDA NRCS Soil Survey Geographic Database	Vector	Soils were scored from 0 to 4 using the soil type's hydrologic soil group (HSG) with 4 being the highest runoff potential (HSG D). A zero score was applied to the small sections mapped as water in the source layer.
Slope	Vermont Center for Geographic Information - LiDAR Program	Raster	The source raster was clipped to the shoreline buffer extent and scored from 1 to 3 (3 being steepest/most erosion risk) as classified via the Jenks Natural Breaks classification method.
Land Use / Land Cover	Manually digitized by Watershed using best available true color and colored infrared satellite imagery	Vector	Six land cover classes were defined: impervious, agricultural, forest, forest/grass combined, grass, and other undeveloped. Classes were then scored using corresponding HydroCAD curve numbers (higher curve numbers having higher runoff potential).

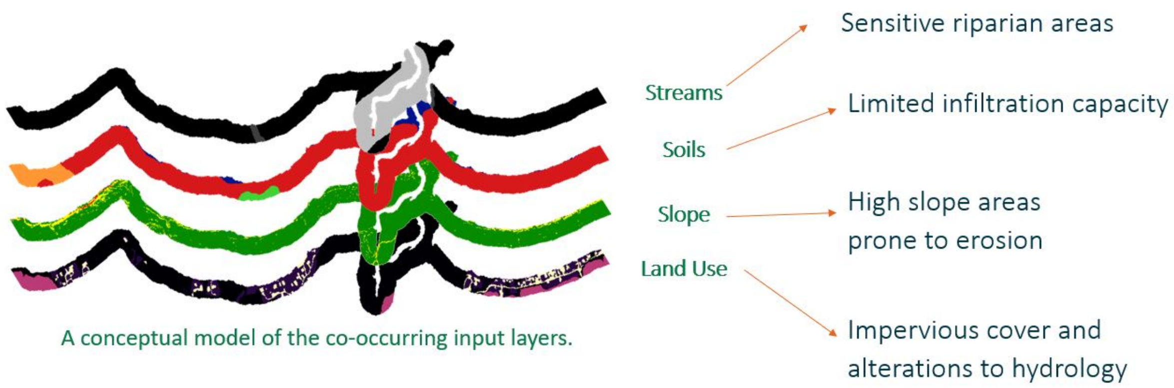

Figure 2. A conceptual model depicting the layers of input data that contributed to the weighting process

Each scored input layer was then normalized to a maximum score of 1 and summed in an equally weighted raster calculation using the QGIS Raster Calculator (Figure 2). Getis-Ord Gi* statistics were calculated using the ArcGIS Hot Spot Analysis tool to determine statistically significant clusters of high raster values. Clusters with a 90% confidence of being "hot" spots were considered high risk. Clusters with a 90% confidence of being "cold" spots were considered low risk. The remaining clusters were defined as moderate risk areas. See Figure 3 for a visualization of these results.

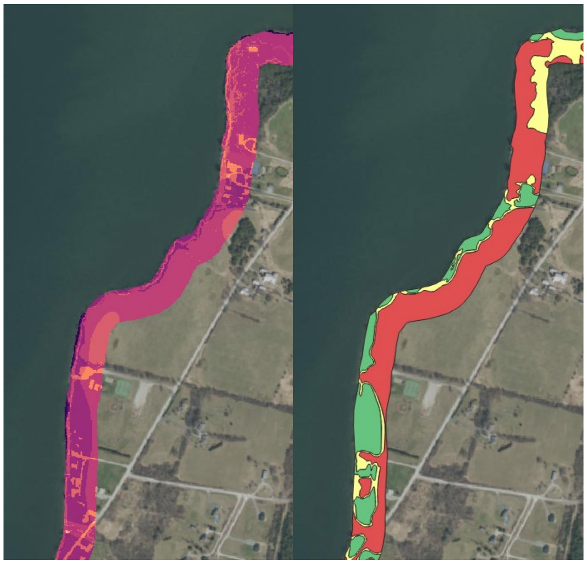

Figure 3. A subset of the raster calculator output (left), where brighter colors represent more risk, and the resulting output of the Hot Spot analysis (right) where low, moderate, and high risk zones are colored green, yellow, and red, respectively.

Features with an area of less than 0.1 acres were dissolved into their nearest neighbor to eliminate insignificantly sized polygons. Figure 4 (left) displays the classified Water Quality Risk Zones. See Appendix B for a larger map displaying the full extent of the Water Quality Risk Zone data layer. This map highlights risk areas within the 100ft Lakeside Zone.

The Water Quality Risk Zones were evaluated during field investigations (described in the following sections below) and any areas where site-specific factors indicated either lower or higher risk to water quality were noted. The area was assessed in the field using a combination of observations made from a kayak along the shoreline, during windshield surveys, and on foot. Photos were taken where water quality indicators were observed including erosion, lack of buffer, or exposed soil. A drone was also used in select areas along the shoreline to collect photos. Observations were also recorded where areas were stabilized with vegetation and were previously mapped as being a high risk water quality zone.

In general, the zones reflected on the ground conditions well, but site-specific indicators of negative impacts to water quality were observed in some areas that were previously mapped as low risk. Conversely, some areas mapped as high risk were observed to be stable. This included the Mill River corridor area, which has been mapped as high risk. However, upon assessment in the field it was observed that this area is naturalized and well protected in the lakeshore area. However, it should be noted that the river is likely an important source of pollutants to the lake due to development upstream of the study area. The Water Quality Risk Zones were then manually edited to reflect the conditions observed in the field (Figure 5 right). In total, 99 acres were classified as High Risk, 15.4 acres were classified as Moderate Risk, and 116.6 acres were classified as Low Risk.

Figure 4. Water Quality Risk Zones were mapped (left), evaluated in the field, and manually corrected where necessary (right).

Note that in Figure 4, the original classifications were largely unchanged in the northern and southern sections of this area from the original (left) to the revised (right) Water Quality Risk Zones. However, the central area was reclassified from moderate and high risk to low risk as field verification revelated that while this area is very steep, it is controlled by bedrock and observed erosion was minimal. Both Water Quality Risk Zone datasets (pre and post field-based corrections) are included in Appendix F.

3.2 Field Assessments

3.2.1 Digital Map and App Preparation

To maximize efficiency in the field and better understand site-specific conditions in the field, digital base maps were created for the study area. The maps show parcel boundaries, public parcels, stormwater infrastructure, hydrologic soils groups, river corridors, hydric soils, and wetlands. Most importantly, these maps depict the Water Quality Risk Zones used in our analysis. 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 SWMP using the Fulcrum platform[2]. A screenshot of the mobile data collection app is shown in Figure 5. The app was also pre-loaded with the locations identified previously (Task 3.1) for the potential BMP sites, which included locations of problem areas and potential opportunities. These points allowed for easy site location and data collection in the field.

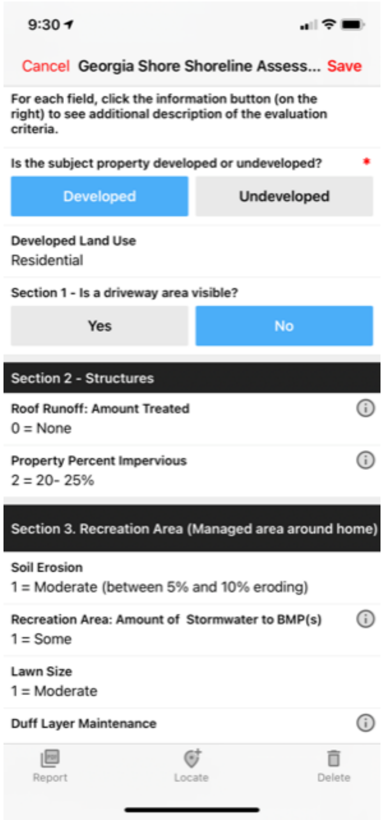

Figure 5. An example screen from the mobile data collection app utilized during field assessments.

[2] www.fulcrumapp.com

3.2.2 Culvert Verification

All the culverts along Georgia Shore Rd were verified in the field to ensure accurate mapping and inform recommendations for stormwater management practices. In total 36 culverts were verified. Each culvert's location was verified using a handheld GPS. The location was adjusted for one culvert and one culvert that was previously unmapped was located and mapped. During this assessment, culvert condition was verified, maintenance needs were recorded (Figure 6, left), and any erosion present was noted (Figure 6, right). The GIS data is included in a geodatabase in Appendix F.

Figure 6.Culvert in need of maintenance (left). Erosion noted around culvert (right).

3.2.3 Shoreline Assessments

Shoreline assessments were completed for 34 locations along the Georgia shoreline. These assessments were primarily completed from a kayak, but drone-collected photos were used to supplement these assessments where access was difficult due to high winds and shallow water levels. Shoreline assessments focused on identifying areas of erosion and lack of vegetated buffer. Each assessment could include multiple parcels with similar conditions (slope, vegetative cover, development type, and stabilization techniques such as sea walls). See Figure 7 for a map of the assessed locations.

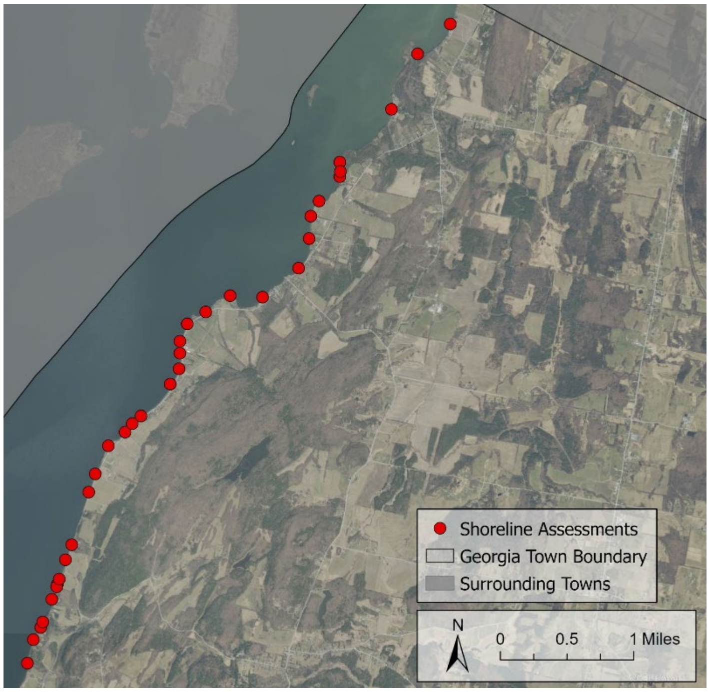

Figure 7. Shoreline assessment locations.

Issues observed during shoreline assessments included development (both roads and structures) very close to the shoreline, preventing establishment of a vegetated buffer and clearing

Figure 8. An example of erosion observed during shoreline assessments.

of vegetation up to the shoreline, which often resulted in erosion (Figure 8). These activities were often made more impactful due to the steep slopes present in several areas along the shoreline.

A larger scale overview map of the locations of the shoreline assessments can be found in Appendix C. Individual field data sheets for the shoreline assessments can also be found in Appendix C. The Shoreline Map ID field on the field data sheets corresponds to the labels on the overview map. Field data sheets provide additional site-specific descriptions and photos.

3.2.4 Structural BMP Assessments

Field assessments were completed in late October 2020 and included site assessments from a vehicle and on foot. The best fit stormwater best management practices (BMPs) were identified considering site-specific constraints, the most restrictive of which was lack of space in the study area. The developed areas along Georgia Shore Rd are fairly dense residential properties bound by Lake Champlain at the lowest point (Figure 9). As water flows downhill, this leaves little area to manage stormwater prior to the lake. Opportunities for stormwater management within the Town right-of-way for Georgia Shore Rd included water quality improvements within the existing wide grassed swales (Figure 10). This approach was deemed the most feasible for the constrained residential areas because they contain significant runoff-producing impervious cover and there is very limited open space to site stormwater BMPs outside of these swale areas. Subsurface practices would likely be challenging in these areas due to the prevalence of bedrock, high water table, and lack of publicly owned properties.

Figure 9. The residential development along Lake Champlain leaves little room for stormwater management practices in this area.

Figure 10. There are a series of grassed swales along Georgia Shore Rd that could be utilized for stormwater management.

Another area of note that was assessed was the intersection of Mill River Rd and Georgia Shore Rd. This area was identified by multiple project stakeholders as an area of concern for the Town. Three BMPs were identified at this intersection. Another area of note was the Georgia Town Beach, which includes a significant amount of impervious cover and is also a high visibility site in the Town. This would allow for an opportunity for public education about stormwater issues in the Town.

In total, 25 potential BMPs were identified and assessed. An overview map of these areas is included in Appendix C. In general, there were two types of BMPs identified. The first 19 sites (labeled S1 – S19 on the map) are filtration or infiltration based linear features (depending on mapped hydrologic soil group) that are proposed to be located within the existing roadside swales. The remaining 6 sites are proposed structural BMPs located in areas of concern (labeled BMP 1 – BMP 6 on the map). The ID numbers included on the map correspond to the BMP Map ID included on the individual field data sheets, also included in Appendix C. The field data sheets include a description of each site and the proposed BMP applicable to the site.

3.2.5 Vegetated Buffer Assessments

During the previously described field assessments, the study area was also assessed to identify areas where vegetated buffers could be implemented. This could include planted and formalized buffers or designating low or no mow areas. Vegetated buffers provide stabilization of the ground surface, slow and filter stormwater, and provide wildlife habitat. Along the Georgia Shore, 44 areas where planted vegetated buffers or low/no mow zones could be located were identified. One striking example was observed where two abutting residential properties with similar topographic and soil conditions had no observable erosion where the vegetated buffer was maintained (Figure 11, left) and significant erosion where the vegetated buffer was removed (Figure 11, right). An overview map of these areas can be found in Appendix C.

Figure 11. Abutting residential properties where vegetated buffers have been maintained (left) and removed (right) resulting in significantly different erosion rates.

3.3 Modeling and Ranking

3.3.1 BMP Modeling and Ranking Results

Hydrologic modeling and priority ranking of 26 potential stormwater BMPs were completed. One additional BMP was added following field assessments to better manage stormwater flows as observed on site. The BMPs proposed would manage stormwater runoff along the Georgia shoreline, providing water quality benefits as well numerous other potential ancillary benefits. BMP locations were chosen based on field observations made in previous stages of this project, where the feasibility of proposed practices was considered. See Appendix D for a map of the locations and drainage area of each proposed BMP.

Four proposed stormwater BMPs are sited near the Georgia Town Park and boat launch. Three are sited near the intersection of Georgia Shore Road and Mill River Road. Nineteen roadside swales along Georgia Shore Road were also included in the modeling process (named S1 through S19).

Contributing drainage areas were delineated for each practice from the interpretation of topographic data, including elevation contours and hillshade, both of which are derived from LiDAR datasets. Models of each proposed BMP's contributing drainage area were then prepared using several spatial input layers including manually digitized land cover data, NRCS soils data, and LiDAR-derived 1-foot contour data.

The Vermont Department of Environmental Conservation's (DEC) Stormwater Treatment Practice was used to estimated phosphorus load reductions for each BMP. The phosphorus load reduction for the gully restoration practice off Mill River Road (See Appendix D BMP Overview Map - BMP ID #6), however, was estimated using the DEC's Road Erosion Inventory phosphorus accounting methodology.

Although the estimated drainage area size of each of the swales BMPs differed, these BMPs are similar in that each of their footprints would be restricted to the road right-of-way. This presents a significant design and sizing constraint on the practice. As the case for every BMP proposed here, additional stages of assessment would be required to determine the feasibility of the swale practices. The 19 swale BMPs were modeled as either infiltration or filtration-based design depending on which NRCS hydrologic soil group was mapped at the swale.

Preliminary BMPs sizing was completed assuming that it would be possible to manage either ½ of the water quality volume or the full water quality volume (WQv or first 1in of rainfall that carries most of the pollutants with it) depending on the space available in the swale and the volume of stormwater runoff associated with the drainage area of the practice. See Appendix D for a practice-by-practice determination. However, it is possible given individual site conditions, adjacent landowner input, potential utilities, and as yet unknown space constraints that these sites may need to be scaled down in size during further design stages, which would reduce the expected pollutant load reductions associated with the BMPs. Information from the hydrologic modeling process, the phosphorus load reduction calculations, and several other metrics concerning land use, soils, cost, and maintenance requirements were all considered in the BMP ranking process (a complete list is provided in Appendix D). The scores were summed and practices with the largest scores were ranked the highest. The complete ranking results spreadsheet for the 26 BMPs is included in Appendix D. These results are summarized below in Table 2. The upper table includes the 19 swale sites, and the lower table includes the seven non-swale BMPs. Note that the costs and design descriptions may differ from those presented in the section regarding the 30% Designs below as the concepts for the three 30% design sites evolved as they received addition investigations, modeling, and design.

Table 2. Preliminary ranking summary table for the 26 assessed BMPs. Swale sites are included in the upper table and the remainder of the BMPs are included in the lower table.

BMP ID	Project Name	Proposed BMP Practice Type	Drainage Area (acres)	Impervious Area Managed (acres)	Impervious (%)	TP Removal (kg)	Project Cost	Annual Cost per kg P Removed (assumed 20-year lifetime)	Total Score
S6	Swale 6	Swale infiltration	17.65	0.88	5.0%	4.35	$27,500	$316	29
S8	Swale 8	Swale infiltration	12.54	0.66	5.3%	3.12	$27,500	$441	29
S7	Swale 7	Swale infiltration	11.63	0.66	5.6%	2.93	$27,500	$469	29
S5	Swale 5	Swale filtration	30.69	3.15	10.3%	4.10	$93,909	$1,146	29
S14	Swale 14	Swale infiltration	19.07	0.09	0.5%	3.89	$27,500	$354	28
S18	Swale 18	Swale infiltration	10.75	0.31	2.8%	2.43	$27,500	$565	27
S19	Swale 19	Swale filtration	12.21	0.71	5.8%	1.41	$27,500	$973	27
S4	Swale 4	Swale filtration	21.66	0.21	1.0%	2.06	$27,500	$667	26
S9	Swale 9	Swale infiltration	8.12	0.33	4.1%	1.93	$27,500	$712	26
S10	Swale 10	Swale infiltration	4.52	0.23	5.0%	1.11	$27,500	$1,235	24
S3	Swale 3	Swale filtration	9.24	0.16	1.7%	0.91	$27,500	$1,510	24
S11	Swale 11	Swale infiltration	3.86	0.13	3.5%	0.90	$27,500	$1,531	24
S15	Swale 15	Swale infiltration	2.36	0.18	7.4%	0.75	$27,500	$1,835	24
S2	Swale 2	Swale filtration	7.74	0.15	1.9%	0.77	$27,500	$1,790	23
S1	Swale 1	Swale filtration	4.22	0.43	10.1%	0.56	$27,500	$2,451	22
S16	Swale 16	Swale infiltration	0.68	0.14	21.3%	0.30	$27,500	$4,565	18
S17	Swale 17	Swale infiltration	0.44	0.11	24.0%	0.20	$27,500	$6,711	15
S13	Swale 13	Swale infiltration	0.47	0.10	21.1%	0.18	$27,500	$7,563	14
S12	Swale 12	Swale infiltration	0.21	0.05	24.9%	0.09	$27,500	$15,585	14

BMP ID	Project Name	Proposed BMP Practice Type	Drainage Area (acres)	Impervious Area Managed (acres)	Impervious (%)	TP Remo val (kg)	Project Cost	Annual Cost per kg P Removed (assumed 20-year lifetime)	Total Score
BMP 2	Mill River Rd Ditch	Gully stabilizatio n	7.48	1.49	20.0%	3.26	$154,282	$2,363	26
BMP 1	Mill River Rd and Georgia Shore Rd N	Gravel Wetland	19.71	1.23	6.3%	2.29	$135,424	$2,954	23
BMP 6	Town Park Swale S	Bioretentio n	2.78	0.36	12.8%	0.50	$38,325	$3,858	20
BMP 7	Town Park Swale N	Bioretentio n	1.54	0.66	42.5%	0.48	$55,564	$5,750	16
BMP 4	Boat Launch Parking	Bioretentio n	0.75	0.21	27.5%	0.18	$27,500	$7,470	14
BMP 5	Boat Launch Paved	Bioretentio n	0.23	0.15	66.3%	0.10	$27,500	$13,796	14
BMP 3	Mill River Rd and Georgia Shore Rd S	Remove berm and install sand filter	0.15	0.09	62.5%	0.06	$27,500	$22,757	13

3.3.2 Shoreline Assessment Ranking Results

34 assessments were completed along the Georgia shoreline (see map, Figure 7). Areas were assessed in groups with similar characteristics and not just as individual parcels. For example, a continuously forested section would be split from a grouping of houses. Assessments, therefore, varied in number of parcels included per assessment.

Scores were assigned for a variety of parameters that pertained to the segment's water quality and erosion risk. These parameters were adapted from the Vermont's Lake Wise assessment protocol and included some additional factors of known importance. These included:

- Shoreline Natural Condition
- Shoreline Stability
- Shoreline Vegetation Width
- Shoreline Erosion
- Stormwater Flow
- Percent Lawn and Cleared Area
- Lake Access Stability
- Vegetation Effectiveness
- Slope to Lake
- Bedrock Controls
- Constructed Structural Stabilization

Additional details regarding these parameters and their scoring are included in the complete ranking spreadsheet (Appendix D). The scores for each parameter were summed to determine a final score for each segment. Ranks were then applied to segments based their final scores (with the highest final score earning the highest rank). Several segments had tying final scores. Ties were resolved by referring to scores for individual parameters which were considered of high relative importance. If ties still remained, scores for the next tiebreaking parameter were referred to, and so on. The parameters for which this tiebreaking process was applied are listed in order below:

1. Shoreline Erosion Score
2. Shoreline Stability Score
3. Shoreline Natural Condition
4. Slope to Lake Score
5. Stormwater Flow Score

A summary table is included below as Table 3. The complete ranking is included in Appendix D. The labels correspond to the overview map also included in Appendix D. Individual field data sheets are also included for each site in this appendix.

Table 3. Shoreline assessment ranking table summary.

	Notes	Shoreline Erosion	Vegetation Effectiveness	Summed Score
6	Unstable slope lacking vegetation slopes down to concrete retaining wall. Recent tree cutting observed. Stone added to unvegetated slope.	Significant (> 10% eroding)	Vegetation effectiveness compromised	41
30	Residential property with concrete retaining wall; erosion noted along lakeshore.	Significant (> 10% eroding)	Vegetation effectiveness compromised	38
31	Residential house has fence around yard and significant erosion below fence towards lakeshore. Note that the water quality risk zone is low for this area as the surrounding areas are well stabilized. Erosion appears to be a result of an individual residential development.	Significant (> 10% eroding)	Vegetation effectiveness compromised	35
1	Stretch of residential properties. Vegetated buffer is very minimal or has been cleared to shoreline. Some stone/ cement retaining walls, rip rap present. Structures are very close to shoreline.	Moderate (5%-10% eroding)	Vegetation effectiveness compromised	35
15	Stretch of residential properties. Vegetated buffer is very minimal or has been cleared to shoreline. Concrete retaining wall present. Boat launch sloped from road to shoreline. Structures are close to shoreline.	Moderate (5%-10% eroding)	Vegetation effectiveness compromised	33
32	Residential house set above a sloped lawn and lake access. Erosion noted by access. Buffer lacking.	Moderate (5%-10% eroding)	Some vegetation still functioning	33
16	Stretch of residential properties. Vegetated buffer is very minimal or has been cleared to shoreline. Some concrete retaining walls, rip rap, and stone walls are present. Structures are very close to shoreline.	Moderate (5%-10% eroding)	Vegetation effectiveness compromised	33
21	Stretch of residential properties including new construction. Vegetated buffer is very minimal or has been cleared to shoreline. Exposed soil noted during assessment (actively under construction).	Minimal (1%-4% eroding)	Vegetation effectiveness compromised	33

Label	Notes	Shoreline Erosion	Vegetation Effectiveness	Summed Score
20	Stretch of residential properties with concrete or brick retaining walls. Most properties do not have any vegetation along shoreline.	Minimal (1%-4% eroding)	Vegetation effectiveness compromised	33
28	Residential property with concrete boat ramp direct to lake.	Minimal (1%-4% eroding)	Vegetation effectiveness compromised	32
19	Stretch of residential properties. Vegetated buffer is very minimal or has been cleared to shoreline. Some concrete retaining walls are present.	Minimal (1%-4% eroding)	Vegetation effectiveness compromised	32
29	Residential property with concrete retaining wall. No vegetation present along shoreline.	Minimal (1%-4% eroding)	Vegetation effectiveness compromised	32
9	Stretch of residential properties. Vegetated buffer is very minimal or has been cleared to shoreline. Cement retaining wall and paved yard area at one property. Structures are very close to shoreline.	Minimal (1%-4% eroding)	Vegetation effectiveness compromised	32
24	Road runs close to shoreline and there is a steep slope down to shore.	Moderate (5%-10% eroding)	Vegetation effectiveness compromised	31
10	Road runs close to shoreline and there is a slope down to shore. Fairly stabilized with rip-rap, but very little buffer.	Moderate (5%-10% eroding)	Vegetation effectiveness compromised	31
3	Stretch of residential properties. Vegetated buffer is very minimal or has been cleared to shoreline. Some concrete retaining walls are present.	Minimal (1%-4% eroding)	Vegetation effectiveness compromised	31
11	Stretch of residential properties. Vegetated buffer is very minimal or has been cleared to shoreline. Some stone retaining walls, rip rap present. Structures are very close to shoreline. Some boat launches that slope to shoreline.	Minimal (1%-4% eroding)	Vegetation effectiveness compromised	31
18	Stretch of residential properties. Vegetated buffer is very minimal or has been cleared to shoreline. Some concrete retaining walls are present. Rip-rap along several properties. Several boat ramps (concrete) slope down to shoreline.	Minimal (1%-4% eroding)	Vegetation effectiveness compromised	30
12	Stretch of residential properties. Vegetated buffer is very minimal or has been cleared to shoreline. Some stone retaining walls, rip rap present. Structures are very close to shoreline.	Minimal (1%-4% eroding)	Some vegetation still functioning	30
13	Stretch of residential properties. Vegetated buffer is very minimal or has been cleared to shoreline. Some stone retaining walls, rip rap present. Structures are very close to shoreline.	Minimal (1%-4% eroding)	Some vegetation still functioning	30
27	Residential house has fence around yard and some erosion below fence towards lakeshore. Limited vegetation, but also significant bedrock.	Moderate (5%-10% eroding)	Most vegetation still functioning	29
14	Road runs close to shoreline and there is a steep slope down to shore. Fairly stabilized because of bedrock, but very little buffer.	Minimal (1%-4% eroding)	Vegetation effectiveness compromised	29
22	Stretch of residential properties including new construction. Vegetated buffer is very minimal or has been cleared to shoreline.	Minimal (1%-4% eroding)	Vegetation effectiveness compromised	29

Label	Notes	Shoreline Erosion	Vegetation Effectiveness	Summed Score
23	Unpaved boat access ramp to shoreline sloped from road to shoreline at about a 45 degree angle, though shoreline is fairly stony.	Minimal (1%-4% eroding)	Some vegetation still functioning	29
33	Rip rap drainage channel with beach area	Minimal (1%-4% eroding)	Vegetation effectiveness compromised	29
34	Very little buffer, but shoreline area is mostly bedrock. Note that the water quality risk zone is listed as high though the site is ranked as a less important site mainly because the area has significant bedrock that is stabilizing the site.	Moderate (5%-10% eroding)	Most vegetation still functioning	28
7	Agricultural field borders shoreline with small, vegetated buffer. Erosion noted in areas where flow channelizes along shoreline.	Minimal (1%-4% eroding)	Most vegetation still functioning	28
17	Road runs close to shoreline and there is a steep slope down to shore. Fairly stabilized with rip-rap, but very little buffer.	Moderate (5%-10% eroding)	Some vegetation still functioning	27
25	Road runs close to shoreline and there is a steep slope down to shore. Erosion noted along this area where buffer is thinnest.	Moderate (5%-10% eroding)	Most vegetation still functioning	26
26	Residential house has fence around yard and some erosion below fence towards lakeshore. Significant bedrock.	Moderate (5%-10% eroding)	Most vegetation still functioning	24
8	Georgia Public Boat Launch area. Mostly stabilized with rip-rap, but one area where erosion was noted on bank. Boat launch slopes to lake.	Minimal (1%-4% eroding)	Most vegetation still functioning	24
5	Residential property that appears to comply with shoreline regulations.	Minimal (1%-4% eroding)	Most vegetation still functioning	23
2	Area where Mill River meets with the lake. Area is stable and well vegetated.	No erosion problems	All vegetation still functioning	14
4	Shoreline is mostly bedrock or stone. Significant vegetated buffer. Good condition.	No erosion problems	All vegetation still functioning	12

This assessment considered qualitative data gathered during field observations made in the fall of 2020. Photographic evidence, field notes, and supplemental desktop assessment were all used to inform scoring decisions. This ranking can function as a tool for the prioritization of future projects and targeted landowner outreach.

3.4 Modeling and Concept Refinement

Based on the BMP ranking described above, discussions with stakeholders, and field observations, three sites were selected for 30% concept design. This design process included additional modeling that allowed for accurate sizing of the three proposed practices as well as a better understanding of the water quality and quantity benefits. Drainage areas were refined as needed based on field observations. Each of the sites was modeled in HydroCAD to determine the appropriate BMP size and resultant stormwater volume benefits. Each of these sites was also modeled to understand the existing pollutant loading and pollutant loading reductions associated with the proposed BMPs. This process is explained below under each specific practice design description.

4 30% Designs

Three 30% designs for proposed BMPs have been completed. These include two projects along Mill River Road and one project at the Georgia Town Beach. Individual field investigations and site surveys were completed for each design site. The 30% designs, cost estimates, pollutant loading reductions, hydrologic modeling information, and overview maps can be found in Appendix E.

4.1 Mill River Road Northwest

The intersection with Mill River Rd and Georgia Shore Rd has been identified by project stakeholders as a high priority area. See Figure 12 for photos of the area and Figure 13 for an overview map. Runoff along Mill River Road has damaged the infrastructure surrounding the road. Erosion has occurred and sediment is transported during rain events. The stormwater currently flows in a ditch along the northern side of Mill River Rd and drains west towards Georgia Shore Rd. The drainage then passes under Georgia Shore Rd in a culvert and drains toward Mill River. Mill River has been noted as a significant source of pollutants to the lake, and reducing stormwater impacts to Mill River is a priority.

Figure 12. Drainage runs west down Mill River Rd (left) to the intersection with Georgia Shore Rd (right) before passing under Georgia Shore Rd.

The proposed BMP includes reshaping the lower approximately 250ft of Mill River Rd to drain to the ditch on the north side of the road and allowing the water to flow in the existing culvert under Georgia Shore Rd. The water would then enter a plunge pool basin. The basin will slow down and spread the water out, allow for some minimal infiltration (infiltration is minimal as soils are not well drained in this area), and allow pollutants to settle out of suspension. The outlet will direct water into the wetland buffer north of the practice.

There are potential modifications to the practice shape and location that should be finalized during the final design. For instance, to relocate the practice outside of the wetland buffer, the practice could be located south of the parking lot along Georgia Shore Rd. The culvert would need to be redirected to this location. However, the practice would then discharge directly to the Mill River as opposed to the wetland buffer where flows can be better mitigated and velocities further reduced. The practice could also be located slightly closer to Georgia Shore Rd, but this would require a steepening of the road shoulder, which could be a hazard for vehicles, particularly in the winter. The 30% design can be found in Appendix E.

Figure 13. The proposed practice is located in the northwest corner of the intersection of Georgia Shore Rd and Mill River Rd. See starred location.

4.1.1 Water Quality Benefits

The VT Department of Environmental Conservation's Stormwater Treatment Practice (STP) Calculator[3] was utilized to estimate the expected total phosphorus (TP) removed by the practice. This model is used within the Lake Champlain Basin for estimation and tracking of BMP pollutant load reductions. This practice has the potential to prevent 3.2 lbs (1.5 kg) of TP from entering Mill River and then Lake Champlain annually. 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) by providing a storage volume of 576 ft^3. See Table 4 for the benefit summary table.

Table 4. Mill River Road Northwest benefit summary table.

TP Removed	3.2 lbs
Impervious Treated	1.3 acres
Total Drainage Area	19.4 acres

[3] https://anrweb.vt.gov/DEC/CleanWaterDashboard/STPCalculator.aspx

4.1.2 Cost Estimates

The total estimate cost for this project is $5,000. Note that these costs reflect the preliminary stage of this design. The itemized cost estimate can be found in Appendix E.

- The cost per pound of phosphorus treated is **$1,563**.
- The annual construction cost per kg of phosphorus removed assuming a 20-year practice lifespan is **$59**. Note that this metric is consistent with VT DEC reporting and does not include the 25% COVID-19 pandemic cost contingency of 25%.
- The cost per impervious acre treated is **$3,846**.

4.1.3 Operations and Maintenance

Ongoing and regular maintenance will be critical for the continued performance of the practice once constructed. The recommended maintenance activities are included on the O&M plan included in Appendix E and summarized below.

Plunge Pool:

- Inspect annually for sediment accumulation and erosion.
- Remove sediment by rake or machine as necessary.
- Re-stone as necessary

4.1.4 Permit Review

A project readiness screening worksheet has been completed for this project and is included in Appendix E. In summary:

- Act 250 Permit
  - The site does not hold an Act 250 permit.
- Local Permitting
  - No local permits are anticipated.
- Other Permits
  - This site should be reviewed by a wetland scientist prior to final design. Wetlands concerns were noted during field investigations and informed by available wetlands mapping data. Gilman Briggs Environmental reviewed the area in the field and flagged areas of wetlands in and adjacent to the proposed BMP location. The wetlands scientist found that there was a wetland immediately north of the parking area, starting out as a ditch near Georgia Shore Rd and then widening to the north where it drains into the tributary stream of Mill River that is crossed by the footbridge on the path down to the waterfall. There are no wetlands to the south of the parking area. A map of the wetlands can be found in Appendix E.
  - This project may require review by the River Scientist prior to final design due to its proximity to potential point source discharge to the Mill River tributary. However, drainage will be more distributed and less concentrated that existing conditions.

4.1.5 Next Steps

Further design will involve refinement of the 30% retrofit concept with respect to size, design details, and routing to ensure that the target volume can be completely managed and that larger storms bypass the system safely. This area where the proposed BMP is located is owned by the Lake Champlain Land Trust (LCLT). LCLT coordinated the acquisition of the parcel and owns a conservation easement on it. Preliminary investigations regarding the allowability of this BMP under the easement were undertaken during this project. Initial responses to the proposed water quality improvements were not favorable. However, due to the negative water quality impacts to Mill River as a result of the stormwater flowing from the developed lands at this intersection, it is recommended that additional discussions are held with the LCLT so that water quality, both in Mill River and Lake Champlain, can be improved.

4.2 Mill River Road Southeast

Runoff along Mill River Road has damaged the infrastructure surrounding the road. A gully has formed (Figure 14) just uphill of Mill River and sedimentation has increased into Mill River while uncontrolled runoff has changed the landscape in this area. The construction of several homes east of the intersection in recent years has increased stormwater volume by increasing impervious cover that prevents stormwater infiltration in this area.

Figure 14. An eroding gully has formed south of Mill River Road.

The proposed management of this area includes two BMPs that will reduce the volume of stormwater reaching the existing gully and stabilize the area to prevent future erosion. The first component of the project includes the installation of subsurface infiltration chambers within the Town right-of-way along Mill River Rd (see eastern starred location in Figure 15). The second component involves stabilizing the gully with stone and allowing for infiltration within the stabilized area (see western starred location in Figure 15).

Figure 15. The proposed practices are located along the southern side of Mill River Rd and to the northeast side of Mill River Rd. See starred locations.

4.2.1 Water Quality Benefits

The STP Calculator was used to estimate the TP reduction for the infiltration chambers while the TP load reduction for the gully restoration practice was estimated using the DEC's Road Erosion Inventory draft phosphorus accounting methodology. These practices have the potential to prevent more than 11.8 lbs (5.3 kg) of TP from entering Mill River and then Lake Champlain annually. The design standard used for the infiltration chambers was infiltration of the Water Quality volume (WQv, or 1 inches of rain in a 24-hour period), equal to 2,346 ft^3 of runoff. See Table 7 for the benefit summary table.

Table 5. Mill River Rd Southeast benefit summary table.

	Infiltration Chambers	Gully Restoration	Total
TP Removed	4.5 lbs	7.3 lbs	11.8 lbs
Impervious Treated	1.1 acres	0.3 acres	1.4 acres
Total Drainage Area	5.7 acres	1.7 acres	7.5 acres

4.2.2 Cost Estimates

The total estimate cost for this project is $36,000. Note that these costs reflect the preliminary stage of this design. The itemized cost estimate can be found in Appendix E.

- The cost per pound of phosphorus treated is **$3,051**.

- The annual construction cost per kg of phosphorus removed assuming a 20-year practice lifespan is **$236**. Note that this metric is consistent with VT DEC reporting and does not include the 25% COVID-19 pandemic cost contingency of 25%.
- The cost per impervious acre treated is **$25,714**.

4.2.3 Operations and Maintenance

Ongoing and regular maintenance will be critical for the continued performance of the practice once constructed. The recommended maintenance activities are included on the O&M plan included in Appendix E and summarized below by practice component.

Plunge Pool:

- Inspect annually for sediment accumulation and erosion.
- Remove sediment by rake or machine as necessary.
- Re-stone as necessary

Stone Channel:

- Inspect annually for erosion.
- Repair/re-stone as necessary.

Stormtech Infiltration Chambers:

- Inspect annually via observation port for sediment.
- Schedule maintenance once sediment depth reaches >3".
- Use JetVac truck to remove sediment.
- See ADS Stormtech Isolator Row O&M Manual for more detailed instructions.

4.2.4 Permit Review

A project readiness screening worksheet has been completed for this project and is included in Appendix E. In summary:

- Act 250 Permit
  - The site does not hold an Act 250 permit.
- Local Permitting
  - No local permits are anticipated.
- Other Permits
  - This site should be reviewed by a wetland scientist prior to final design. Wetlands concerns were noted during field investigations and informed by available wetlands mapping data. Gilman Briggs Environmental reviewed the area in the field and flagged areas of wetlands in and adjacent to the proposed BMP location. The wetlands scientist found that there was a wetland formed by runoff from the eroding gully off the south side of Mill River Rd. There is also an unstable seep slope that contributes to the wetland. A map of the wetlands can be found in Appendix E.
  - This project may require review by the River Scientist prior to final design due to its proximity to potential point source discharge to the Mill River corridor area. However, drainage will be reduced from the existing conditions.

4.2.5 Next Steps

Further design will involve refinement of the 30% retrofit concept with respect to size, outlet design, and routing to ensure that the target volume can be completely infiltrated in the infiltration chambers and that larger storms bypass the system safely. The location of the infiltration chambers is within the Town right-of-way. However, it is recommended that the adjacent landowner be included in early discussions regarding the construction of the practice. The gully is located on private property south of Mill River Rd. Efforts were made to contact this landowner during this project, but the landowner could not be reached. It is recommended that this outreach is continued until the landowner can be contacted. At that time, interest in the project can be gauged. As the existing condition of the gully and the location adjacent to Mill River make the property unusable for most purposes, it is expected that landowner support could be obtained. An agreement with the landowner should be secured prior to final design.

4.3 *Georgia Town Beach*

A bioretention practice has been designed for the Georgia Town Beach (Figure 16). This site was deemed important due to its education and outreach potential, significant amount of impervious cover, and location adjacent to Lake Champlain. This area includes a boat launch area, ball fields, tennis courts, and a playground. The facility's pavilion can also be rented for events. Many residents and visitors recreate in this area. This BMP will be highly visible and should include educational signage when implemented. The bioretention can be designed with plants that are also aesthetically pleasing and can serve an example for other private landowners to see the type of practices that are possible for their properties. The sign can provide information about BMP functionality, design, and the benefits that will be vital for this area. This will help to get landowners 'on-board' with stormwater practices that will mitigate stormwater issues on their property as well as contributing to the overall runoff and erosion issues along the Georgia Shoreline. As this area is dominated by individual residential development, adoption of stormwater best practices by these residential sites will be critical. This is unlike areas that are dominated by large parcels with many acres of impervious cover that could be managed in one large practice.

Figure 16. A bioretention practice is proposed in the starred location at the Georgia Town Beach.

4.3.1 Water Quality Benefits

The VT DEC STP Calculator was utilized to calculate TP reductions for the proposed bioretention practice. This practice has the potential to prevent 1.6 lbs (0.7 kg) of TP from entering Lake Champlain annually. 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 2,608 ft^3 of runoff. See Table 6 for the benefit summary table.

Table 6. Georgia Town Beach benefit summary table.

TP Removed	1.6 lbs
Impervious Treated	1.1 acres
Total Drainage Area	2.9 acres

4.3.2 Cost Estimates

The total estimate cost for this project is $40,000. Note that these costs reflect the preliminary stage of this design. The itemized cost estimate can be found in Appendix E.

- The cost per pound of phosphorus treated is **$25,000**.
- The annual construction cost per kg of phosphorus removed assuming a 20-year practice lifespan is **$1,955**. Note that this metric is consistent with VT DEC reporting and does not include the 25% COVID-19 pandemic cost contingency of 25%.
- The cost per impervious acre treated is **$36,364**.

4.3.3 Operations and Maintenance

Ongoing and regular maintenance will be critical for the continued performance of the practice once constructed. The recommended maintenance activities are included on the O&M plan included in Appendix E and summarized below by practice component.

Bioretention:

- Check to ensure the filter surface remains well draining after storm events after every major storm event for the first three months following installation and then annually.
- Check inlet, stone overflow, and outlet structure for leaves and debris quarterly for the first year and then annually.
- Inspect inlet, stone overflow, and outlet structure for evidence of deterioration and evidence of concentrated flow and erosion. Check that water is overflow via the stone overflow and outlet structure quarterly for the first year and then annually.
- Check for animal borrows and short circuiting in the system quarterly for the first year and then annually.
- Check for robust vegetation coverage throughout the system and dead or dying plants annually or as needed.

Grass swales:

- Inspect annually for signs of erosion and sediment accumulation.
- Reseed grass and rake out sediment as necessary.

- Inspect Check dams annually for signs of deterioration.
- Repair/reshape stone, add stone as necessary.

Forebay:

- Inspect annually for sediment accumulation and erosion.
- Remove sediment by rake or machine as necessary.
- Reseed as necessary.

4.3.4 Permit Review

A project readiness screening worksheet has been completed for this project and is included in Appendix E. In summary:

- Act 250 Permit
  - The site has an existing Act 250 permit (6F0106) for the "development of public beach facility, driveway, parking, bathhouse, stairway access to beach, picnic area". Construction of the practice may require an amendment to this Act 250 permit.
- Lakeshore Permitting
  - This project will need review by the Lake and Shoreland Regional Permit Analyst prior to final design.
- Local Permitting
  - No local permits are anticipated.
- Other Permits
  - No other permits are anticipated.

4.3.5 Next Steps

Further design will involve refinement of the 30% retrofit concept with respect to size, outlet design, and routing to ensure that the target volume can be completely filtered and that larger storms bypass the system safely. As this area is owned by the Town of Georgia, it is recommended that the Town pursue final design and implementation of the project. It is recommended that grant funding for these next phases is pursued.

4.4 30% Design Benefits Summary

In total, the three sites selected for 30% design will prevent 16.6 lbs (7.5 kg) of TP from entering Lake Champlain annually. They manage 3.8 acres of impervious cover and have a total drainage area of 29.8 acres. See Table 7 for details regarding the three designs.

Table 7. 30% design summary table. Note that the Mill River Rd Southeast project includes two practices, infiltration chambers and a gully stabilization. The practices are included in the table both individually (italicized) and combined.

Project Name	Drainage Area (acres)	Impervious Area (acres)	Impervious (%)	Storage Volume (ft^3)	TP Removal (lbs/kg)	TP Removal (%)	Project Cost	Annual Cost per kg of TP Removed*
Mill River Rd Northwest	19.4	1.3	6.7%	576	3.2/ 1.5	65.0%	$5,000	$59

Mill River Rd Southeast (infiltration chambers)	*5.7*	*1.1*	*19.3%*	*2,346*	*4.5 / 2.0*	*93.6%*		
Mill River Rd Southeast (gully stabilization)	*1.7*	*0.3*	*17.6%*	*N/A*	*7.3 / 3.3*	*95%*		
Mill River Rd Southeast	7.5	1.4	18.7%	--	11.8 / 5.3	--	$36,000	$236
Georgia Town Beach	2.9	1.1	38%	2,608	1.6 / 0.7	41.3%	$40,000	$1,955

*This metric summarizes the cost per kg of TP removed by the practice over its anticipated 20-year lifespan, does not include the COVID-19 25% contingency, and is consistent with VT DEC reporting metrics.

5 Community Outreach and Education

Two virtual public outreach meetings were held to inform community members and receive input. Residents were invited to the meetings via postcards (Figure 17) and through the FNLC Facebook page. The first meeting had a more general focus and included project methodology as well as a description of stormwater issues. The second meeting was more focused on specific problem areas. During both meetings, residents were invited to provide input and discuss any particular sites of concern.

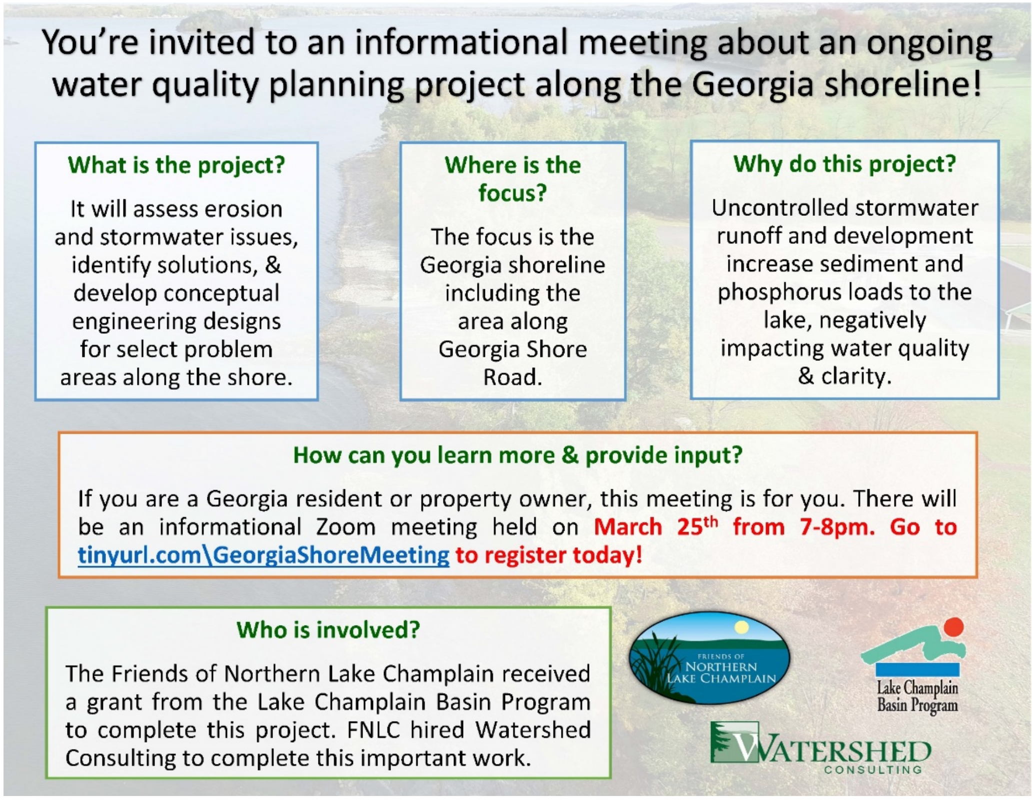

Figure 17. Postcards were sent for both the first overview meeting (upper) and the second more site-specific focused meeting (lower).

6 Final Recommendations

This project has highlighted the need for the implementation of stormwater BMPs along the Georgia Shore area. It is recommended that the identified BMPs are advanced through the design phases. For the Top 3 sites where 30% designs were completed, this would mean final design followed by implementation. For the remainder, this would mean preliminary and final design followed by implementation. Grant funding would likely be available for these tasks.

Many of these projects are located fully or partially in public land to increase the likelihood of successful implementation. However, several of the projects, though located in the Georgia Shore Rd Town right-of-way, abut private properties. It is recommended that these adjacent landowners be contacted prior to advancing design of these swale based BMPs to ensure that the landowners are in support of the projects. These landowners could also serve as either official or unofficial stewards of the practices, ensuring that minor maintenance is carried out (i.e., weeding, removal of small amounts of sediment) and alerting the Town of more substantial needed maintenance or repair.

Another important finding of this study is the prevalence of private residential properties that either have opportunities for stormwater management practices or are actively eroding and contributing pollutants to Lake Champlain. Public property is very limited along the Georgia Shore, limiting the progress that can be made towards water quality goals utilizing only public land. While each private property generally had small scale erosion issues (with a few notable exceptions where significant erosion is occurring), all of this distributed erosion has a cumulatively large impact to the lake. As such, each one of these residencies is one important piece of the Georgia Shore water quality puzzle and each one could be a part of the solution. It is recommended that targeted outreach be carried out for these lakeshore landowners with a focus on the high priority sites identified during the shoreline assessments as well as any landowners who express interest in implementing stormwater solutions on their own properties or who may be willing to serve as stewards to the aforementioned swale based BMPs.

The issues identified and cataloged along the Georgia Shore area are not unique to Georgia. Many communities along Lake Champlain have a similar makeup of residential properties abutting the lake and the resultant water quality impacts. It is recommended that additional municipalities along the lake complete a similar study to identify, catalog, and rank water quality issues and solutions so that other communities can work to address the issues.