WATERSHED ACTION PLAN – KEELER BAY

South Hero, Vermont

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Executive Summary

Keeler Bay, nestled in the northeast arm of Lake Champlain and surrounded by the town of South Hero, contains roughly 2 square miles of sheltered waters and a scenic backdrop for the northern village. It provides opportunities for fishing, boating, and swimming; plays a crucial role in supporting the local economy and numerous businesses reliant on tourism and recreation; and serves as a source of drinking water for the town. The 6.8-square mile watershed directs water from small streams, ditches, lawns, and parking lots into the lake. As it crosses the South Hero landscape, water may collect fertilizer, oil, pesticides, bacteria, lose debris from erosion, and various other pollutants. Water that doesn't evaporate or filter into the ground eventually reaches Keeler Bay, presenting challenges such as elevated phosphorus levels. Most phosphorus is washed off the landscape and although it is an essential nutrient for life, excess amounts are harmful to water quality and aquatic life. This affects everyone who lives nearby. Our actions—whether along the shorelines or miles inland—have the potential to impact the bay.

What is a watershed?

A watershed (or basin) is the area of land where all the water draining from it converges into a common body of water, such as a lake, river, stream, or ocean. Watersheds offer essential resources like drinking water, wildlife habitat, soil for agriculture, and more. Watersheds come in all sizes. We all live in a watershed.

In the pages ahead, you will review the *Keeler Bay Action Plan*, the culmination of three years of dedicated work aimed at achieving cleaner water in Keeler Bay. This assessment and planning tool provides an in-depth analysis of the watershed's landscape, encompassing shorelines, streams, roads, and more. Through a combination of data and mapping reviews, field tours, and landowner insights, the project team has collaborated with willing landowners to identify a range of projects and actions, varying in scale, all geared toward the overarching goal of addressing and mitigating the most critical threats to the bay's ecosystem. The identified projects, upon implementation, are expected to improve the water quality in the bay, enhance its surrounding ecosystem, and provide the community with opportunities for engagement and education on this important topic.

Though the plan was finalized in January 2024, our commitment extends beyond its completion. In the years to come we look forward to collaborating with landowners to bring these projects to life, while at the same time creating opportunities for the greater community to get involved. Fortunately, there are countless ways to make a difference, such as volunteering to monitor bay conditions, volunteering with SHLT to plant trees and remove invasive species, cleaning up your pet waste, raising your mower blade height, planting native trees and shrubs along waterways on your property, expressing concerns or ideas to the town or local organizations like ours, sharing this plan and related initiatives with neighbors, participating in free voluntary property assessments like Lake Wise or Stream Wise, and so many more.

Visit vacd.org/KeelerBayActionPlan to learn about the plan and all the ways you can help Keeler Bay, and/or feel free to get in touch with us! We will happily connect you with resources to get you started. Furthermore, if you have a project idea for your land that's not been identified in the

plan, we can assist you in navigating the subsequent steps, offer valuable resources, and explore potential funding opportunities to support the implementation of your envisioned project.

Finally, we express our gratitude to the South Hero community for their support of this plan. Its success is a direct result of the community's collective efforts and desire to protect the bay. We appreciate the invitations to explore their properties, engagement in all phases from education to identification, and their openness to considering how they can play a role in achieving clean water in Keeler Bay.

Sincerely,

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1.0 Introduction

The Keeler Bay watershed is located in Grand Isle County, Vermont, and drains portions of the Town of South Hero. The Bay is valued by residents and visitors for its natural resources, drinking water, recreation, and fishing opportunities. In 2021, the Grand Isle County Natural Resources Conservation District (GICNRCD), in partnership with South Hero Land Trust (SHLT) sought funding for a watershed plan to address concerns about high phosphorus (P) level concentrations observed in the bay. In 2022, GICNRCD initiated the process of hiring a consultant to develop a Lake Watershed Action Plan (LWAP) for Keeler Bay.

GICRNCD hired Fitzgerald Environmental Associates (FEA) to develop the LWAP for Keeler Bay. FEA was tasked with conducting shoreline, stream, and stormwater assessments and accompanying project prioritization and concept designs. The Keeler Bay Action Plan follows the approach described in the VTDEC LWAP technical guidelines (VTDEC, 2022).

Stream and shoreline assessments were conducted to evaluate water quality impacts and threats to wildlife habitat in the riparian and shoreland zones. The approach in upland (i.e., non-shoreland) areas of the watershed generally followed the guidelines included in the Vermont Agency of Natural Resources documentation for Stormwater Master Plans (VTANR, 2013) with a hybrid 1c and 3b approach to address potential site-specific green stormwater infrastructure (GSI) retrofits (template 1c) as well as the rural road focus template (3b). The Watershed Action Plan was developed over the course of 2021 through 2023 through extensive field work, engaging with diverse stakeholders from GICNRCD, SHLT, and VTANR, as well as local residents, farmers, and business owners. This collaborative effort aimed to identify and prioritize projects, followed by comprehensive analysis and design work.

1.1 Watershed and Planning Background

The goal of the Keeler Bay LWAP was to identify and evaluate water quality stressors to Keeler Bay, and to identify projects to mitigate inputs of sediments and nutrients. Environmental concerns and stressors identified by stakeholders included channel erosion, road/ditch erosion, lakeshore encroachment, invasive species, soil erosion, and nutrient loading. The watershed assessment focused on the evaluation of the shoreland, tributary, and roadway sources of sediment and nutrients (Figure 1), as well as other concentrated sources of stormwater runoff in the watershed.

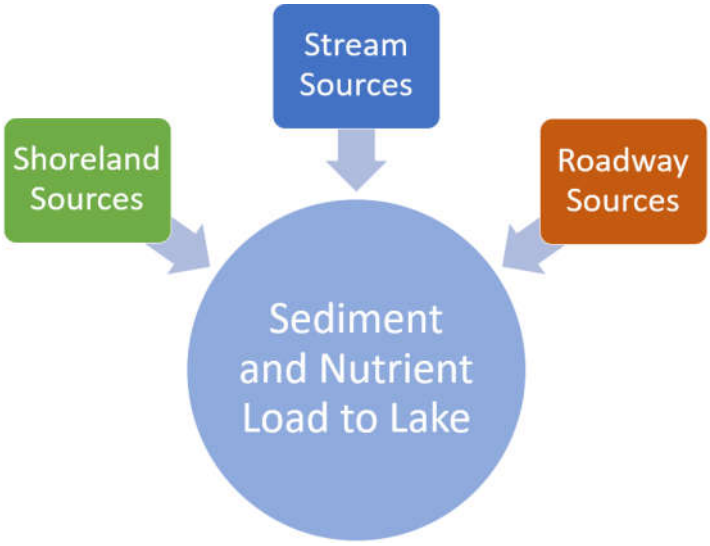

Figure 1: Conceptual diagram of primary water quality stressors on Keeler Bay.

1.2 Keeler Bay Project Goals

The goal of this project was to evaluate the Keeler Bay watershed (Figure 2) to identify sources of increased stormwater runoff and associated sediment and nutrients. Erosion and phosphorus mitigation projects are of particular importance given the water quality concerns within the watershed. The work involved identifying sources of water quality impacts, prioritizing sources based on various environmental, economic, and social criteria, and designing projects to mitigate those sources. Stormwater mitigation projects are aimed at reducing or eliminating stormwater at the source through Green Stormwater Infrastructure (GSI) approaches, retrofits of older and underperforming stormwater features, back road erosion projects, and increasing natural shoreland vegetation to stem sediment and nutrient loading to the lake.

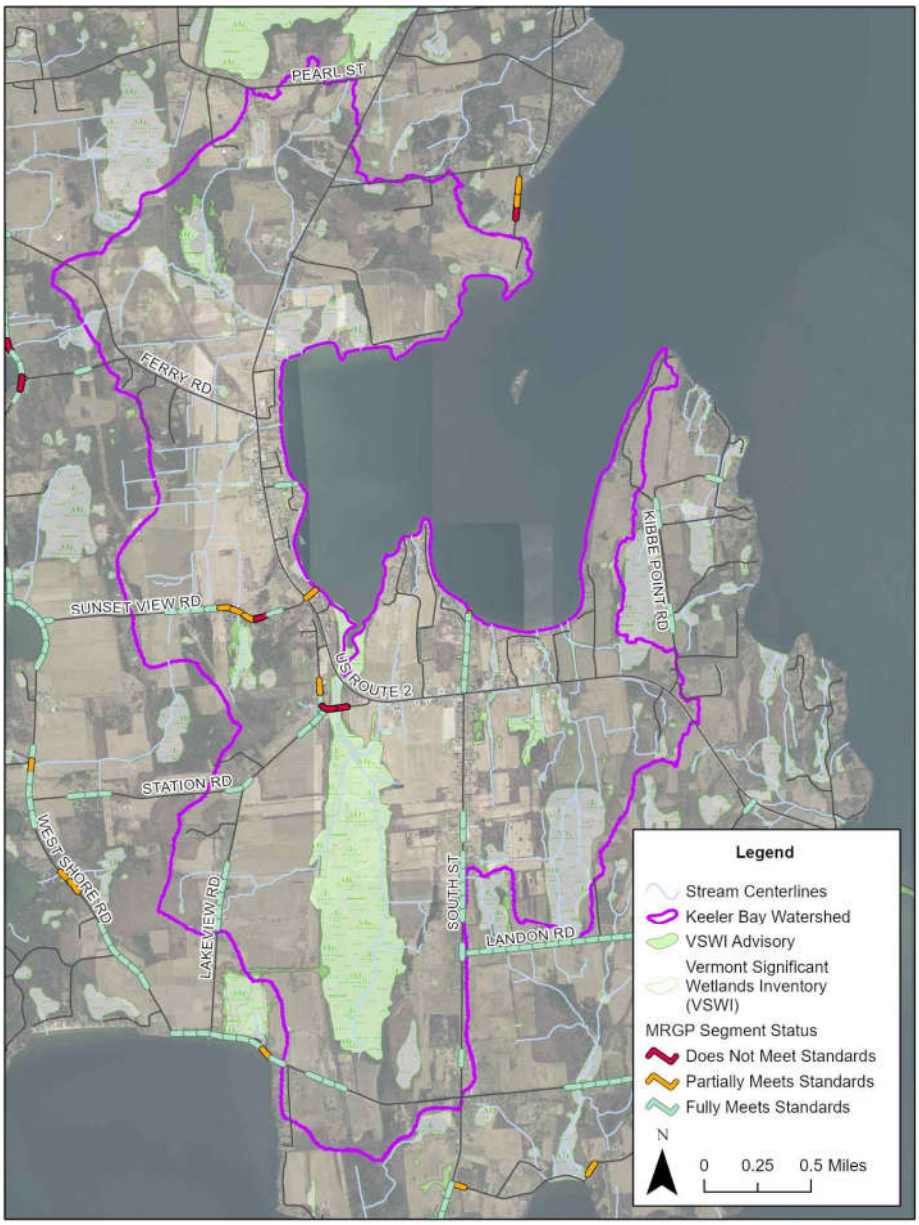

Figure 2: Keeler Bay watershed study area.

Stream and lakeshore projects can include stormwater treatment practices, erosion stabilization, floodplain restoration, and vegetation/habitat restoration. Near-channel and near-shore projects are especially important to improving water quality due to the high potential for transport of sediment and nutrients to adjacent waterbodies. The initial project goals were to identify approximately 30 projects and to create conceptual designs (roughly 30% design) for at least six (6) projects.

2.0 Study Area Description

Keeler Bay is part of the Northeast Arm of Lake Champlain and is encompassed by the Town of South Hero (Figure 3). The sheltered bay has an area of approximately 2 square miles, and the contributing watershed area is approximately 6.8 square miles. South Hero has a population of 1,676 people (U.S. Census Bureau, 2020).

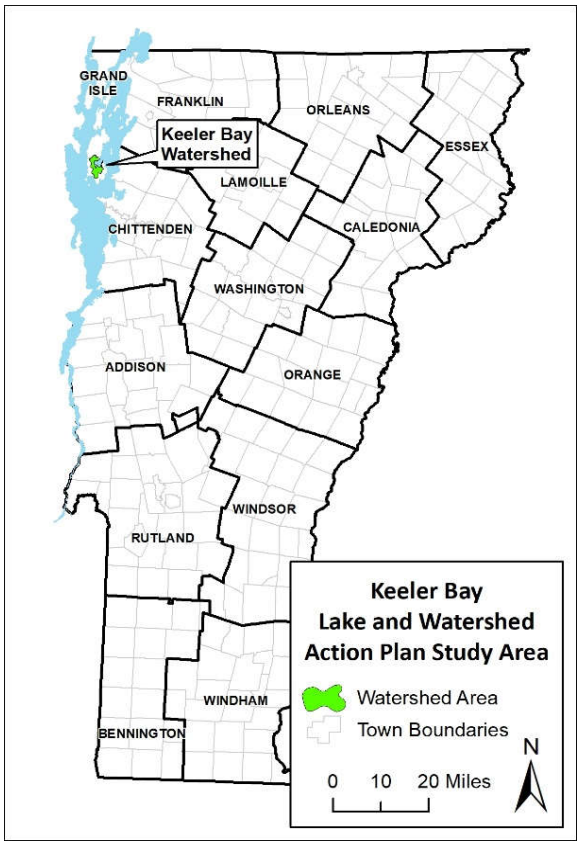

Figure 3: Keeler Bay watershed location map.

There are 21.7 miles of roads in the Keeler Bay Watershed (Table 1). Land cover data, based on imagery from the 2019 National Land Cover Database (Dewitz & USGS, 2021), are summarized in Table 2. Roads are included in the developed lands category of the National Land Cover Database. The predominant land cover in the watershed is agricultural. Areas mapped as the Pasture/Hay NLCD category also include large apple orchards within the watershed. Development is primarily concentrated along the Route 2 corridor in the South Hero and Keeler Bay village centers. Wetlands make up a relatively large portion of the watershed at approximately 20%. We included land cover distributions in Table 2 for other watersheds where FEA has completed LWAPs. These watersheds typically have high forest cover and significantly less development and agricultural lands.

Table 1: Road length by AOT class in the Keeler Bay Watershed (VTrans, 2022)

AOT Class	Description	Length (Miles)	% of Watershed Road Length
2	Town Highway Class 2	3.7	17.1
3	Town Highway Class 3	3.9	17.8
8	Private Road	8.4	38.5
30	State Highway	1.2	5.7
40	US Highway	4.6	21.0

Table 2: Land cover in the Keeler Bay Watershed (Dewitz & USGS, 2021).

Land Cover/Land Use Type	% of Keeler Bay Watershed	% of Other LWAP Lake Watersheds (Yang, 2018)			
		Elmore	Eden	Dunmore	Fern
Water	**0.4**	4.6	4.4	9.0	13.3
Developed	**12.1**	4.7	4.4	3.0	9.6
Barren Land	**<0.1**	< 0.1	0.1	<0.1	-
Forest	**14.4**	72.9	87.2	82.6	71.8
Shrub/Scrub	**0.1**	0.8	1.6	0.1	0.4
Grassland/Herbaceous	**0.1**	0.5	0.5	0.2	0.5
Pasture/Hay	**45.1**	8.5	0.6	1.0	3.0
Cultivated Crops	**8.2**	< 0.1		<0.1	-
Wetlands	**19.6**	8.0	1.2	4.1	1.4

The Protected Shoreland Area defined by the VTDEC applies to land within 250' feet of the mean water level of a lake greater than 10 acres in size. Land cover classifications vary based on the method used to process the remotely sensed data, which may include satellite imagery (true color and infrared) and LiDAR topography data. The primary high resolution land cover and impervious mapping data source covering the State of Vermont was generated by the UVM Spatial Analysis Laboratory (2016). The 1-meter resolution of the UVM land cover data is a vast improvement over 30-meter resolution NLCD data. However, in areas where there is tree cover over lawns and impervious surfaces (i.e., buildings, roads, and driveways), the full extent of developed pervious and impervious surfaces may be underestimated.

Based on the high-resolution land cover and impervious mapping from UVM (2016), Keeler Bay's shoreland zone has a lower percentage of impervious surfaces and a high percentage of grass/shrubland (i.e., lawns) compared to other lakes where we have used the Watershed Action Plan/Stormwater Master Plan approach. The higher level of grass/shrub cover relative to tree cover is due to the level of development (lawns), agricultural land use, and the wetland at the south end of the bay (Table 3).

Table 3: Lake characteristics and shoreland land cover for lakes studied by FEA with the Watershed Action Plan/Stormwater Master Plan approach.

Lake	**Watershed Area (sq. mi.)**	**Waterbody Area (acres)**	**Waterbody Perimeter (miles)**	**Land Cover in 250-Foot Buffer (Approximate Shoreland Area)**		
				Tree Canopy	**Grass/ Shrubs**	**Impervious**
Keeler Bay	**6.8**	**1,275**	**6.9**	**42%**	**49%**	**9%**
Lake Bomoseen	37.5	2,415	22.9	61%	26%	13%
Lake Dunmore	20.8	1,040	11.5	74%	14%	12%
Lake Eden	7.2	198	6.1	65%	22%	13%
Lake Elmore	8.4	222	3.3	50%	34%	16%
Fern Lake	0.8	67	2.3	84%	8%	8%
Little Lake/ Lake St. Catherine	14	1,085	16.0	58%	30%	12%

3.0 Watershed Data Library

We began our assessment efforts by gathering and reviewing information and documentation related to lake and shoreland conditions, stormwater runoff, and watershed management within the Keeler Bay watershed. Below is a summary of available data, mapping, and documentation at the local and state level. The planning library is included in Appendix A. Sources for this information include:

- **Town and Regional Plans and Datasets**
  - South Hero Town Plan – 2015
    - A new Town Plan was released in 2023 (not included in this review)
  - South Hero Municipal Road Erosion Inventory - 2018
  - Northwest Regional Plan - 2017
  - Northwest Regional Planning Commission Culvert Inventory - 2004 to Present
  - Post-2011 Lake Champlain Flooding NRPC Assessment and Designs - 2012 to 2013
- **State and Federal Plans and Datasets**
  - Northern Lake Champlain Tactical Basin Plan - 2017
  - Light Detection and Ranging (LiDAR) Topography Data - 2017
  - VT ANR Clean Water Roadmap
  - NRCS Soils Survey
  - VTDEC Stormwater Infrastructure Mapping - 2018
  - FEMA Flood Hazard Mapping
  - VTDEC River Corridor Mapping

4.0 Water Quality Problem Areas

One of the primary objectives of the lake watershed assessment is to identify and assess priority areas for stormwater, erosion, and flood hazards. FEA conducted field tours of the project area in 2022 and early 2023, including a lakeshore assessment, stream walks on selected tributaries to the lake, and assessments of public and private roads and other impervious surfaces.

4.1 Identification of Problem Areas

The initial round of problem area assessment began with the identification of priority areas for field assessments using a desktop exercise. This involved scanning the watersheds with aerial imagery, NRCS soils data, LiDAR contour data, road erosion inventory data, and culvert data in a GIS. Potential project areas were identified and mapped for review during site visits.

Field tours of the priority areas identified and assessed 28 project opportunities. The problem areas are shown on the map included in Appendix B. We grouped the problem areas into four (4) project categories described below.

- **Lakeshore** – Areas where lakeshore erosion or stormwater inputs are a significant nutrient and sediment source, or where improved lakeshore natural communities could reduce sediment and nutrient loads to receiving waters.

- **Stream** – Areas where stream bank erosion is a significant nutrient and sediment source, or where improved stream/wetland function could reduce sediment and nutrient loads to receiving waters.
- **Stormwater, Including:**
    - **Green Stormwater Infrastructure (GSI) BMP Installation/Retrofit** – Opportunity to reduce nutrient and sediment loads through the installation of a new stormwater best management practice (BMP). Sites where nutrient and sediment reductions could be improved through the retrofit of existing stormwater BMPs.
    - **Road, Driveway, and Trail Drainage Improvement/Stabilization** – Areas of high sediment and nutrient loading due to driveway, trail/campsite, road, embankment, and ditch erosion. Includes areas of erosion at road cross-culverts.
- **Wetland** – Areas where invasive management or restoration practices would improve wetland natural communities.

The stream walk assessment focused on four (4) blue-line tributaries to Keeler Bay, covering 1.7 miles of channel. The extent of stream walks was lower than anticipated due to limitations on landowner responsiveness to requests for access. Stressors identified in the stream walks included a severely eroding headcut, bank erosion, channel incision, stormwater inputs, and lack of vegetated buffers.

A boat tour of the bay was conducted to identify potential water quality impacts along the lakeshore, including:

- Erosion of lakeshore and lakeshore stabilization practices (e.g. hard armor)
- Additional linear features of interest (buffers < 25')
- Point features of interest (e.g. stormwater inputs)
- Invasive vegetation.

The overall lakeshore conditions on Keeler Bay are variable and depend on the degree of shoreline development and the steepness of the landscape. Areas of cedar cliff shoreline vegetation on the east side of the bay were identified as exemplary natural areas. Lakeshore areas of lawn and hardscaping tended to be concentrated in neighborhoods, suggesting a cultural and geographic component to lakeshore landscaping practices. Erosion was observed on the northern and northeastern shores of the bay. There is potential for significant water quality improvement to the shoreline zone the lakeshore project areas described in the Appendices, which should be a focal area for future Lake Wise assessments and projects.

4.2 Evaluation and Prioritization of Problem Areas

4.2.1 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 tables (Appendix C).

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

- **Subwatershed Mapping** – The contributing drainage area to each project opportunity was mapped based on field observations and 1-foot contours derived from the 0.7 2013 LiDAR elevation surface.
- **Aerial Photography** – We used the 0.6 m NAIP imagery collected in 2021 and VCGI imagery collected for Grand Isle County in 2018 to review the site land cover characteristics (i.e., forest, grass, impervious).
- **Impervious Surfaces Data** – We used the 2016 statewide high-resolution impervious surfaces data layer developed by the UVM Spatial Analysis Lab.
- **Stormwater Infrastructure** – We used the stormwater infrastructure mapping prepared by VTDEC for South Hero and VTrans structure data for state highways.
- **NRCS Soils** – We used the Grand Isle 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.
- **VTDEC Hydrologically Collected Road Segment Data and Road Erosion Inventories** – We used a statewide inventory of road erosion risk and hydrologic connectivity of road segments and the road erosion inventories for South Hero to prioritize areas of potential sediment loading to visit for field surveys.

4.2.2 Phosphorus Loads

We used the following VTDEC Standard Operating Procedures (SOP) for tracking and accounting of phosphorus associated with:

- Developed lands regulatory projects and non-Regulatory clean water projects to estimate phosphorus loading and reduction associated with town road improvements and stormwater best management practices (VTDEC 2022a).
- Natural resources restoration projects to estimate phosphorus loading and reduction associated with lakeshore and stream restoration (VTDEC 2022b).

Estimates for total phosphorus removal (lb/year) are provided in Appendix C.
Phosphorus removal values were estimated using spreadsheet tools developed by VTDEC.

- BMP Tracking Tool (3/13/2020): Spreadsheet used for p-removal estimates for stormwater treatment practices. Phosphorus load is calculated based on loading rates for pervious and impervious areas within a specified TMDL Lake Segment (Northeast Arm Direct Drainage). Phosphorus removal rates are estimated based on the size of the proposed treatment feature and phosphorus removal efficiency calculations for each type of BMP.

- Interim Phosphorus Reduction Calculator Tool (V10): Spreadsheet with separate calculations for a range of practices. For this project we used Lake Shoreline Stabilization, Riparian Buffer Planting, Buffer Revegetation, Floodplain Reconnection, Gully Stabilization, and Private Road Erosion Remediation.
- **Note - Several projects received phosphorus credits from more than one tool or category.**

4.2.3 Evaluation and Prioritization of Problem Areas

Areas identified during field tours of the Keeler Bay watershed were assigned several numerical scoring metrics that are weighted to assist in prioritizing each project based on water quality benefits, project feasibility, maintenance requirements, costs, and additional benefits as identified by local stakeholders. The maximum possible score is 30. Each category is described below and includes a description of the scoring for each criterion. Landowner support for project development and implementation is an important consideration for project prioritization. Landowner contact (yes/no) is listed in the prioritization table based on outreach efforts from GICNRCD, SHLT, and FEA.

- **Water Quality Benefits (15 points total)**
  - **Phosphorus (P) Reduction Effectiveness (8 points)** – Degree of P removal potential with project implementation, this accounts for both the existing P loads and the removal efficiency and capacity of the proposed treatment. P loading and reductions will be quantified using the VTDEC "Interim Phosphorus Calculator Tool."
    - 0 points – No P source and/or no increased treatment (0 lb/yr)
    - 2 points – Minor P source and/or minor increase in treatment (0 – 0.25 lb/yr)
    - 4 points – Moderate P source with some increase in treatment (0.25 – 0.5 lb/yr)
    - 6 points – Moderate P source with significant increase in treatment (0.5 – 1 lb/yr)
    - 8 points – Major P source with significant increase in treatment (> 1 lb/yr)
  - **Drainage Area (1 point)** – Approximate drainage area to site is greater than 2 acres
  - **Percent Impervious in Drainage (3 points)** – Score based on percentage of impervious surfaces in the watershed draining to the practice relative to other projects. All projects in the plan are ordered and grouped into quartiles. More treated impervious is assigned more points.
    - 0 points – Percentage of impervious surfaces is in the 1st quartile
    - 1 point – Percentage of impervious surfaces is in the 2nd quartile
    - 2 points – Percentage of impervious surfaces is in the 3rd quartile
    - 3 points – Percentage of impervious surfaces is in the 4th quartile
  - **Connectivity to Surface Waters (3 points)**
    - 0 points – Runoff currently infiltrates on site
    - 1 point – Runoff currently receives some treatment before reaching receiving waters
    - 2 points – Runoff currently drains into drainage infrastructure that directly outlets to receiving waters (assumes no erosion or additional pollutant loading to discharge point)
    - 3 points – Runoff currently drains directly into receiving waters (typically runoff draining directly into a large wetland is assigned 2 points)
- **Operation and Maintenance Requirements (2 points)**
  - 0 points – Project will require significantly increased maintenance effort
  - 1 point – Project will require some increased maintenance effort
  - 2 points – Project will require limited or no additional maintenance effort

- **Cost and Constructability (6 points) –** This score is based on the overall project cost (low score for high cost) and accounts for additional design, permitting requirements, and implementation considerations, such as site constraints and utilities, prior to project implementation.
    - 1 point – >$50,000; Complex design/permitting
    - 2 points – >$50,000; Simple design/permitting
    - 3 points – $20,000 - $50,000; Complex design/permitting
    - 4 points – $20,000 - $50,000; Simple design/permitting
    - 5 points – <$20,000; Complex design/permitting
    - 6 points – <$20,000; Simple design/permitting
- **Additional Benefits (7 points total) –** Description of other project benefits, total score is roughly a count of the number of additional benefits. Additional benefits considered in the prioritization are as follows:
    - **(1) Chronic Problem Area** – The site requires frequent maintenance and/or is an ongoing problem affecting water quality.
    - **(2) Seasonal Flooding** – The site is affected by or contributes to seasonal flooding.
    - **(3) Educational** – The site provides an opportunity to educate the public about natural resources and stormwater treatment practices.
    - **(4) High Visibility or Potential to Influence Community** – The site is highly visible and will benefit from aesthetically designed treatment practices. - or - The site involves stakeholders who would be influential in effecting change in the watershed.
    - **(5) Agricultural Land Use Compatibility** – The practice complements other existing best practices on the property (i.e., results in net water quality gain)
    - **(6) Improves BMP Performance** – Project implementation will improve the performance of existing water quality improvement practices that receive runoff from the site
    - **(7) Enhances Lakeshore Natural Communities** – Project implementation will promote a native vegetated lakeshore buffer and/or provide wildlife habitat along the lakeshore

Figure 4: Wetland vegetation management/restoration of a Town Fire Pond received one of the lowest prioritization scores (left photo, Project W-1-REC). Opportunities to establish buffer vegetation along the lakeshore and tributaries to Keeler Bay received some of the highest problem area scores (right photo, Project L-4-HRRD).

4.2.4 Problem Area Summary Sheets

Problem area summary sheets were developed for 25 of the project sites, and are provided in Appendix D. These sites were selected based on the prioritization categories shown in the Problem Area Table (Appendix C) and input from local stakeholders. Problem areas and prioritization strategies were discussed and refined with input from the advisory group in various meetings. The one-page summary sheets found in Appendix D include a site map and description, site photographs, and prioritization categories.

4.3 Sediment and Nutrient Loads to Keeler Bay

Summary of Sources

Based on the distribution of project types, as well as each project's watershed location, size, and existing nutrient/sediment load, we estimated the relative anthropogenic load from each of the primary "sectors" of the Keeler Bay watersheds. We arrived at these estimates by reviewing the breakdown of estimated P loads and reductions from the projects described in this LWAP. These estimates may be viewed as a guide for areas to focus on for future project implementations.

Given the level of development in the Keeler Bay watershed, it is our opinion that stormwater from developed lands represents the largest anthropogenic contribution of sediment and nutrients to the Lake (Figure 5). There is an extensive network of private gravel roads, driveways, and parking areas near the lakeshore as well as development and agricultural land use in the contributing watershed. Due to the heavy soils and land use patterns, extensive drainage, and conveyance systems (ditches and swales) are found throughout the watershed, quickly and efficiently delivering runoff to Keeler Bay. This is different from most of the lakes FEA has studied with the LWAP approach, which often had steeper forested headwaters with areas of concentrated development limited to the shoreline (Table 2).

Streams are also a significant source of sediment and nutrients to the bay. The streams investigated have a history of channelization, agricultural land use, and development. Additional sources of phosphorus located along the shoreline areas include stormwater runoff and erosion from near-shore lawns and impervious areas such as parking lots and driveways (paved and gravel).

Wastewater systems were not investigated for this project; however, they can be a significant source of phosphorus to receiving waterbodies. The Vermont Department of Environmental Conservation is assisting the town of South Hero to address inadequate individual onsite wastewater treatment on small, challenging sites through the planning and development of solutions, including community wastewater systems or innovative/alternative onsite systems. South Hero received a Clean Water State Revolving Fund loan for the preliminary design of a community wastewater system. This was preceded by a CWSRF loan supported Community Wastewater Feasibility and Preliminary Engineering Investigation. These wastewater efforts are focused on the Route 2 corridor and would reduce wastewater phosphorus sources in the upper portions of the watershed. Heavy soils and the high-water table found along the developed shoreline areas will present an ongoing challenge for addressing potential phosphorus loading from wastewater systems.

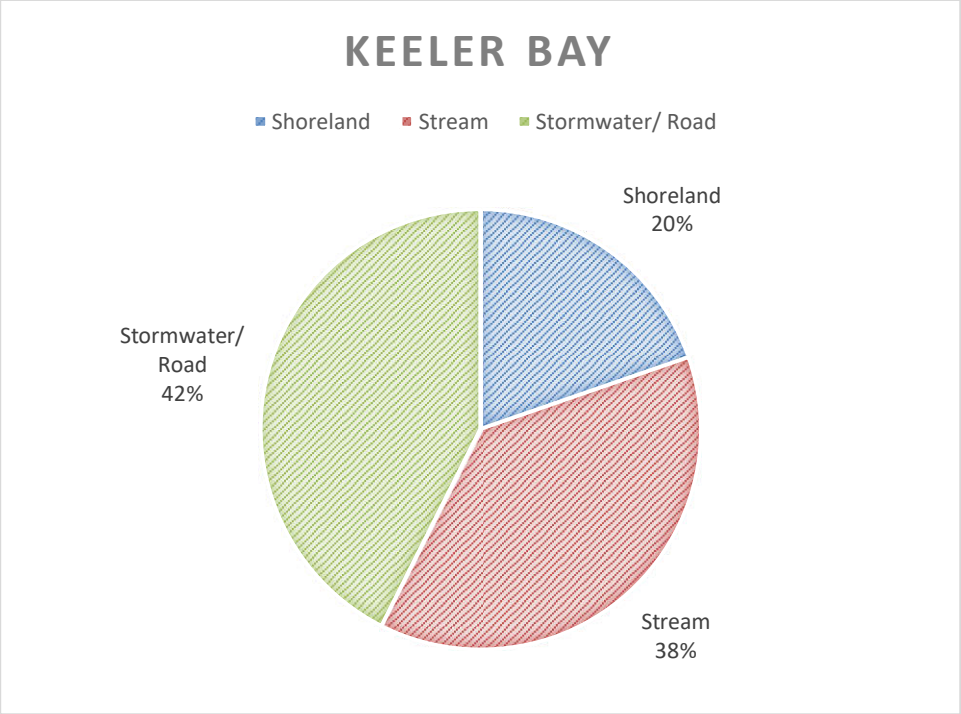

Figure 5: Estimated relative anthropogenic contribution of sediment/nutrients to Keeler Bay from each of the primary "sectors" targeted under the LWAP.

4.4 Project Prioritization and Conceptual Designs

The Keeler Bay Watershed Action Plan partners reviewed and commented on the list of preliminary projects during various meetings and email correspondences. From the list of 28 projects described in the plan, a subset of high-priority projects was discussed for further development. Based on stakeholder input and the prioritization categories shown in the Problem Area Table in Appendix C, six (6) projects were chosen for conceptual design development (30% design). The projects focus on the priorities outlined in Figure 5, with 3 of the 6 designs addressing runoff from developed impervious surfaces including parking areas (Figure 6).

30% Conceptual Designs

Six (6) of the highest priority projects were selected for the development of 30% concept designs (Appendix E). Concept designs include:

- A site plan with contours, existing stormwater infrastructure, and proposed design elements
- Where relevant, hydrologic, and hydraulic modeling data of the contributing drainage area and proposed BMP sizing and design specifications
- Typical details for proposed practices
- A preliminary cost opinion.

The projects chosen for 30% conceptual design were:

1. **Project SW-2-VTFW: Vermont Fish and Wildlife Boat Launch** – The large gravel parking lot is pitched toward Keeler Bay. The swale along the south side of the boat launch is filled in and there is evidence of erosion down the ramp. The ramp is over widened with little vegetation along the shore. Stormwater treatment and vegetation restoration approaches were selected for their water quality, ecological, and education benefits.

2. **Project SW-7-FOL: Town Parking Lot Adjacent to Folsom School** – The gravel parking lot is pitched toward the wetland. There is an opportunity to reduce direct runoff from the parking lot to the wetland by establishing a linear forebay and treatment basin along the east side of the parking lot. The selected approach yields water quality benefits while providing an excellent educational opportunity for students and visitors.

3. **Project SW-6-GAR: South Hero Town Garage** – The sand and salt storage pile is located next to an intermittent stream. The pile will be re-located to a storage shed as part of an ongoing project. This provides an opportunity to restore the area and install a basin to treat runoff from the garage.

4. **Project ST-5: South Hero Village Center** – A headcut is present in the intermittent stream between Two Heroes Brewery and the Town Complex. The erosion threatens buried septic force mains. A channel and floodplain restoration approach were selected to provide ecological and water quality benefits while protecting existing infrastructure.

5. **Project SW-12-LDLN: Lombard Lane** – Runoff from a large agricultural field and a road concentrate to a cross-culvert at the bend on Lombard Lane. Installing a filter strip and water and sediment control basin would provide significant water quality benefits.

6. **Project L-2-SUN: Sunrise Drive** – The shoreline along the west side of the bay is eroded and threatens existing trees along the shore. Three neighboring landowners are interested in a bioengineering approach to shoreline stabilization to protect and restore native shoreland vegetation. The selected approach will yield ecological and water quality benefits in a high visibility area.

Figure 6: Runoff from the gravel parking area at the VT Fish & Wildlife Boat Launch. The concept design for this area describes BMPs that would slow and treat stormwater runoff and reestablish native vegetation along the lakeshore.

Figure 7: Runoff from the sand/salt pile at the South Hero Town Garage. The concept design for this area describes BMPs that would slow and treat stormwater runoff.

Figure 8: Eroded channel and headcut at the South Hero village center complex. The concept design for this area describes BMPs that would stabilize erosion and create floodplain access.

5.0 Next Steps

Plan Implementation

This watershed action plan represents an extensive effort to identify, describe, and evaluate water quality problem areas affecting the Keeler Bay watershed. For each project recommendation, we provided a preliminary cost estimate and a site rating to aid GICNRCD, SHLT, and Towns in planning and prioritizing restoration efforts. The problem area descriptions for Town roads (e.g., roadside ditches) will aid the Town Highway Department in proactively stabilizing and maintaining these features to avoid future stormwater problems, and to come into compliance with the VTANR Municipal Roads General Permit.

We recommend that GICRNCD continues to work with SHLT, the Town and VTDEC to secure funding for the high priority projects described in Appendices C, E, and F. Based on the level of scoping and design work already completed to date, overall project prioritization, and past stakeholder input, we recommend that the following projects are prioritized for further work in the near term.

- **Projects SW-2-VTFW:** Vermont Fish and Wildlife Boat Launch (30% design already complete)
- **Project SW-7-FOL:** Town Parking Lot Adjacent to Folsom School (30% design already complete)
- **Project SW-6-GAR:** South Hero Town Garage (30% design already complete)
- **Project ST-5:** South Hero Village Center (30% design already complete)
- **Project SW-12-LDLN:** Lombard Lane (30% design already complete)
- **Project L-2:** Sunrise Drive (30% design already complete)

Additionally, we recommend that VTDEC and GICNRCD reach out to a selection of landowners with properties appearing likely to receive a Lake Wise designation and assisting them as needed to obtain the designation for their properties. The lakeshore signage and interpersonal discussion of the program could steer the future culture of landscape management toward one incorporating more native vegetation and habitat enhancement.

Additional Research

The Lake Watershed Action Plan outlines a path forward for reducing the phosphorus load to Keeler Bay by addressing sources of nutrients from developed lands, roads, and streams. Further research on additional nutrient sources is needed to quantify and mitigate these loads and adapt the management plan as needed. Two areas to explore further include internal loading from P accumulated in lake sediment and the influence of P dynamics on aquatic plant growth in the sheltered bay.

The overall effect of watershed P loading on P concentrations and lake ecology is influenced by the waterbody's P loading capacity. Internal and external P loading processes over many time scales come together to make the resulting P concentration trend. This includes historical land uses and associated P loading that pre-date our modern era of environmental regulation (e.g., on-site wastewater treatment, stormwater, and lakeshore permitting), and processes in the lake today that might be interacting with this historical load (e.g., increased activity in the shallow

waters stirring up sediment). The Lake Champlain TMDL documentation also indicates that increasing P concentrations don't necessarily correlate with increased P loading, both in terms of magnitude and timing.

Increased levels of aquatic vegetation, including invasive Eurasian milfoil, is a major concern to users of the bay and may be tied to nutrient and sediment accumulation. Continuation of P concentration monitoring in Keeler Bay and its tributaries is important to understanding short- and long-term trends in water quality. Monitoring and recording the timing and quantity of vegetation as well could yield insights into the environmental factors that proliferate growth.

Permitting Considerations

Many of the restoration projects recommended in this report will require permitting review from numerous potential agencies. Hydric soils and existing VSWI and Wetland Advisory mapping cover much of the Keeler Bay watershed, wetland review and potentially permitting will be required for most of the projects. Any projects within 250 feet of the Lake shoreline will require Shoreland Permit review. Historical preservation review may be required for some projects based on location and the source of implementation funding.

Conclusion

The range of projects presented in this report include many cost-effective options for reducing phosphorus loads in the Keeler Bay. These projects will be loaded into the State of Vermont's Watershed Projects Database and may move onto the next steps for seeking additional grant funding. Meanwhile, additional monitoring and analysis to understand the effectiveness of cumulative efforts to reduce P is needed. This process of implementing projects with demonstrable P load reductions, while seeking additional opportunities to mitigate P loading, provides a framework for an adaptive management approach that is responsive to new information on watershed P dynamics.

6.0 References

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APPENDIX A

Keeler Bay **Watershed Data Library**

(8½”x11”)

Fitzgerald Environmental Associates, LLC.

Applied Watershed Science & Ecology

MEMORANDUM

To: Grand Isle County Natural Resources Conservation District
From: Evelyn Boardman and Evan Fitzgerald
Re: Keeler Bay Watershed Data Library
Date: September 6, 2022

As a first step in the development of a Lake and Watershed Action Plan for Keeler Bay, we gathered and reviewed information and documentation related to lake and shoreline conditions, stormwater runoff, and watershed management. This document summarizes available documentation and other potential sources of information we explored. Much of this information is from previously completed studies in the bay's watershed. Other potential sources of data and data gaps are also addressed. A series of maps with relevant data are attached for reference.

Study Area Description

Keeler Bay is part of the Northeast Arm of Lake Champlain and is encompassed by the Town of South Hero (Figure 1). The sheltered bay area is approximately 2 square miles, and the contributing watershed area is approximately 6.8 square miles. South Hero has a population of 1,676 people (U.S. Census Bureau, 2020).

There are 21.7 miles of roads in the Keeler Bay Watershed (Table 1). Land cover data based on imagery from 2019 National Land Cover Database (Dewitz & USGS, 2021) are summarized in Table 2. Roads are included in the developed lands category of the National Land Cover Database. The predominant land cover in the watershed is agricultural. The Pasture/Hay NLCD category includes areas which are known orchards in the watershed. Development is primarily concentrated along the Route 2 corridor in the South Hero and Keeler Bay village centers. Wetlands make up a relatively large portion of the watershed at approximately 20%.

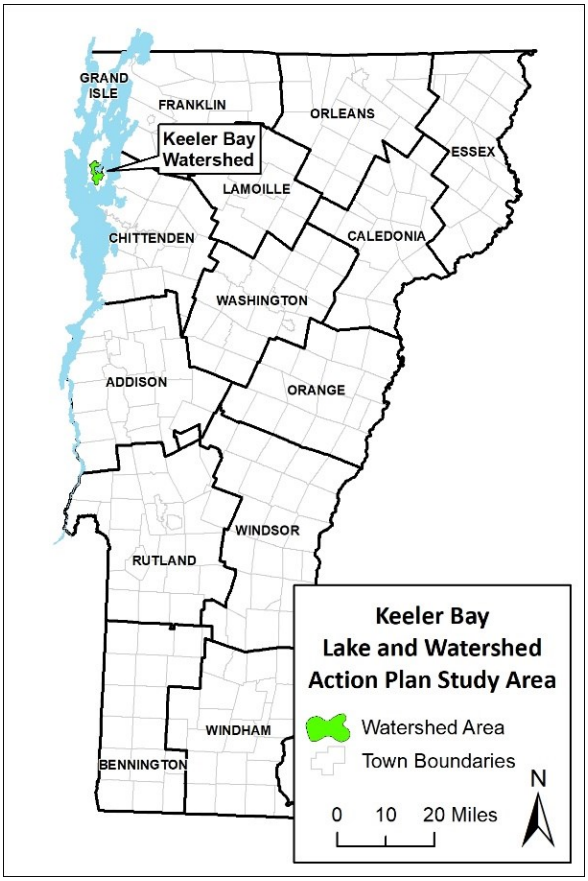

Figure 1: Keeler Bay watershed location map.

Table 1: Road length by AOT class in the Keeler Bay Watershed (VTrans, 2022)

AOT Class	Description	Length (Miles)	% of Watershed Road Length
2	Town Highway Class 2	3.7	17.1
3	Town Highway Class 3	3.9	17.8
8	Private Road	8.4	38.5
30	State Highway	1.2	5.7
40	US Highway	4.6	21.0

Table 2: Land cover in the Keeler Bay Watershed (Dewitz & USGS, 2021).

Land Cover/Land Use Type	% of Keeler Bay Watershed
Water	0.4
Developed	12.1
Barren Land	<0.1
Forest	14.4
Shrub/Scrub	0.1
Grassland/Herbaceous	0.1
Pasture/Hay	45.1
Cultivated Crops	8.2
Wetlands	19.6

Mapping Data

VTDEC Municipal Roads Program

A Road Erosion Inventory (REI) for the Town of South Hero was conducted by Municipal Public Works Consulting in 2018. The REI was developed for municipalities to fulfill requirements of the VTDEC Municipal Roads General Permit (MRGP). In this inventory, segments of road deemed hydrologically connected to surface waters are field assessed for drainage and erosion parameters and given a road erosion compliance score. This score is determined from characteristics of the roadway and of the stormwater drainage features associated with it (crown, berm, ditch, conveyance stability, culverts, etc). The score ranges from "Fully Meets" and "Partially Meets" to "Does Not Meet", to reflect the current level of conformance with the MRGP standards. Of the 166 hydrologically connected segments inventoried in South Hero, 137 (83%) fully met MRGP standards, 22 (13%) partially met MRGP standards, and 7 (4%) did not meet MRGP standards (link). Eight (8) additional segments had incomplete data. Eight (8) segments were reported as upgraded on the VTDEC MRGP Report Viewer as of August 9, 2022.

Most hydrologically connected road segments in South Hero within the Keeler Bay watershed fully met MRGP standards. Within the Keeler watershed, one (1) segment on Tracy Road does not meet MRGP standards and two (2) segments on Hill Road and Lavigne Road partially meet MRGP standards. One additional segment on the Hill Road lake access that partially met MRGP standards has since been upgraded. The work needed is primarily drainage improvements and drainage or driveway culvert improvements. The non-compliant areas identified in the REI are potentially good targets for corrective measures to reduce erosion and sediment delivery to the lake.

Light Detection and Ranging (LiDAR)

LiDAR returns for Grand Isle County were collected in a series of flights conducted in between November 2013 and November 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 Digital Elevation Models (DEMs), terrain models, and contours are useful tools for stormwater feature identification and site design. The 0.7-meter DEM can assist in culvert watershed delineation and the design of stormwater management projects (link). Terrain models can assist in remote identification of erosion features, such as stormwater gullies.

Bridge and Culvert Data

Culvert and bridge data collected by the Northwest Regional Planning Commission (NRPC) for town roads in the Keeler Bay watershed are available online (https://vtculverts.org/). Most of the structures were inventoried in 2004. The Keeler Bay watershed contains no bridge records for town roads and 71 culvert records for town roads. The data set includes the structure dimensions and overall conditions. Forty-nine (49) of the culverts in the Keeler Bay watershed were rated as good or excellent, 17 were rated as poor or fair, and 5 were in critical condition or worse. We will review the culvert data to refine the selection of non-stream culverts we focus on during field surveys. We will also coordinate with the Town of South Hero Highway Department to understand which culverts have been upgraded or replaced since the data was posted.

All structures within the Keeler Bay watershed on Route 2 and Route 314 are in the VTrans Ultrashorts culverts database. The database contains 121 records within the Keeler Bay watershed. The data set includes the structure dimensions, conditions, and severity of erosion.

Clean Water Roadmap

The Clean Water Roadmap tool hosted by VTDEC ANR is a web-based tool that models loading rates of Total Phosphorus (TP) across the Lake Champlain watershed and its sub watersheds. (anrweb.vt.gov/DEC/CWR/cwr-tool.vbhtml). Keeler Bay is covered by the Clean Water Roadmap tool and the tool can be used to explore contributions of TP to surface waters within each lake watershed. In the model, TP loads are related to land cover classifications. The roads land cover category includes public and private roads as mapped in the VTrans Road Centerline GIS dataset and driveways as mapped in the VT Emergency E911 GIS dataset (Tetra Tech, 2015). The NHDPlus catchment area that includes most of the Keeler Bay watershed also includes a small watershed near Cold Spring Road in Milton, Fish Bladder Island, Cedar Island, and Kellogg Island (Figure 2).

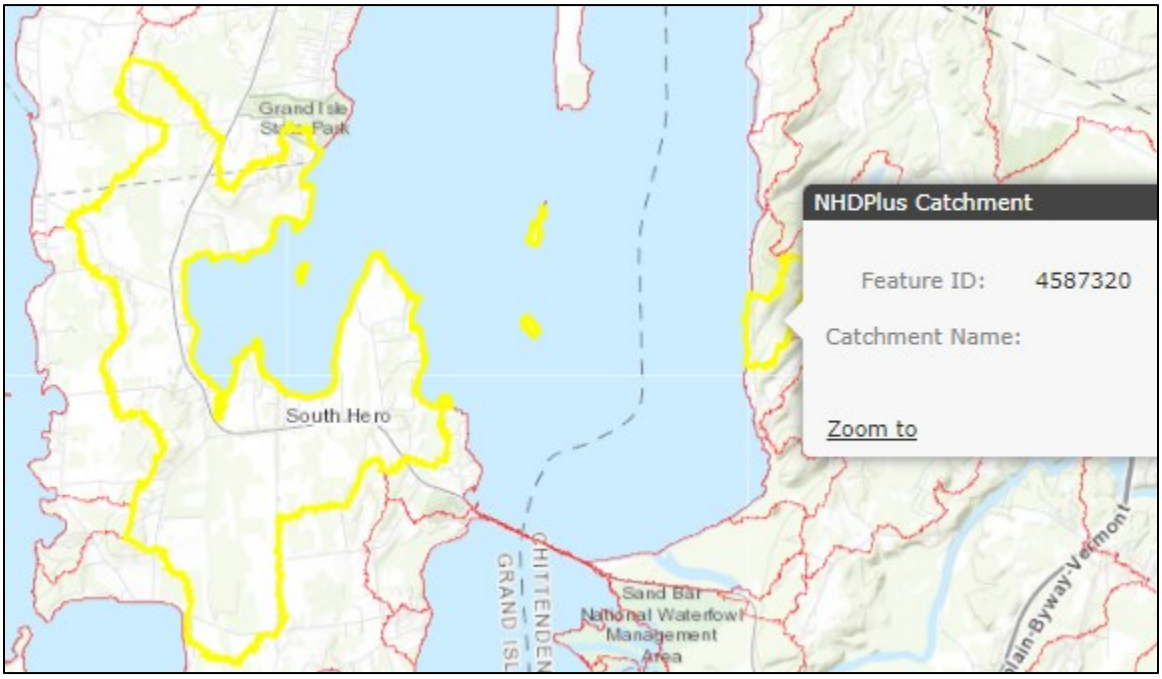

Figure 2: NHDPlus Catchments (red) with the Catchment including Keeler Bay Highlighted (yellow).

The Keeler Bay NHDPlus catchment has similar levels of agricultural (crop and hay) and natural (forest, grass/shrubland, and wetland) land cover. However, forests and wetlands contribute lower phosphorus loads per area compared to other types of land cover such as roads, developed land, cropland and hay/pasture. According to the load allocation, agricultural land covers approximately 43% of the Keeler Bay watershed land area but contributes 75% of the TP load. In general, the tool shows that yields of phosphorus (in units of kg/ha/y) increase significantly as cover types other than forests and wetlands increase.

The overall TP load of 2,348 kg/yr is in the 99th percentile for the Lake Champlain Basin and the area normalized load (yield) of 0.52 kg/ha/yr is in the 76th percentile for the Lake Champlain Basin.

Table 3: Clean Water Roadmap Load Allocation for Keeler Bay NHDPlus Catchment

TP Load (kg/y)	Mean TP Yield (kg/ha/y)	Area (ha)	Total P Load (kg/y) and Proportion of Total Subwatershed Load (%) by Land Cover Class					
			Agriculture	Developed	Roads	Forest	Grass/ Shrub Land	Wetlands
2,348	0.52	4,480	1785.9 (76.0%)	208.6 (8.9%)	184.8 (7.9%)	107.3 (4.6%)	5.9 (0.3%)	55.26 (2.4%)

South Hero Stormwater Infrastructure Mapping Project

This dataset was produced by the VTDEC Clean Water Initiative Program, Watershed management Division in April 2018 and us available online (link). The Stormwater Infrastructure Mapping Project documents the connectivity of stormwater infrastructure on private and public land within the South Hero and Keeler Bay village centers. The data also shows the overland flow paths of stormwater from different areas of impervious surfaces. This dataset will be crucial for the LWAP road assessments as it includes information on all stormwater features within the village centers. The report includes project recommendations to reduce erosion and sediment loading into Keeler Bay. These recommendations include proposed practices to treat runoff from impervious areas at the Folsom School, along Hill Road, and the Town Garage.

South Hero Illicit Discharge Detection and Elimination Project

Stone Environmental completed an IDDE assessment for the Town in 2020 and 2021, results were published in a report available here: https://dec.vermont.gov/sites/dec/files/wsm/erp/docs/IDDE/Statewide%204%20IDDE%20Final%20Report.pdf

The study found 2 storm lines with evidence of wastewater connections. Both storm lines were located along Route 2. Specific locations of the illegal connections was shared with the Town and the VTDEC Regional Wastewater Engineer.

Natural Resources Conservation Service (NRCS) Soils Survey

The NRCS soils survey dataset is valuable for watershed planning (websoilsurvey.sc.egov.usda.gov). As part of our initial scoping, we will screen problem areas based on the NRCS hydrologic soils group (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.

Flood Hazard Mapping

The FEMA DFIRM flood hazard dataset categorizes areas based on their potential for floods and is available through the VTANR atlas (https://anrmaps.vermont.gov/websites/anra5/). This dataset can inform planning on where high flow volumes will occur during major storm events. This dataset can also be used to inform BMP designs and location. BMPs for areas that are at high risk of flooding and therefore have the potential for severe erosion and runoff issues.

River Corridor Mapping

River corridor maps were produced by the Vermont Agency of Natural Resources and is available through the VTANR atlas (https://anrmaps.vermont.gov/websites/anra5/). These data display both the river channel and the active corridor through which a river can be expected to meander over time. This

distinction can inform stormwater mitigation efforts by pointing out where rivers and streams might flow during flood events. This dataset also identifies areas where the river channel has been altered or confined. These problem areas are prone to erosion and flooding.

Watershed Planning

Northern Lake Champlain Tactical Basin Plan

The basin plan discusses the current condition of surface waters in the Northern Lake Champlain (Basin 5) watershed, recommends actions to preserve and restore water quality, and outlines regulations relevant to agricultural production, maintaining roads and infrastructure, and discharges from developed lands (VTDEC, 2017).

The Keeler Bay watershed is within the Champlain Islands Subbasin. In addition to the impairment due to P enrichment addressed by the Lake Champlain TMDL, Lake Champlain is also listed as impaired due to Mercury and PCBs and altered due to the presence of zebra mussels and eurasian water milfoil.

The plan discusses the basis for the Lake Champlain Phosphorus TMDL and the reductions that must be met in the sectors contributing P loads to the Northern Lake Champlain Basin. Keeler Bay is considered part of the Northeast Arm Segment of Lake Champlain and therefore is subject to the following reductions:

Lake Segment	Total Overall	Wastewater	CSO	Developed Land[1]	Agricultural Production Areas	Forest	Streams	Agricultural Nonpoint
Northeast Arm[2]	12.5%	-	-	7.2%	80.0%	5.0%	-	20%

[1]Includes reductions needed to offset future growth
[2]Lake Champlain segment drainage completely within North Lake Basin

Appendix E of the Tactical Basin Plan indicates ongoing or planned actions and programs in the Northeast Arm associated with the Lakes and Ponds program include locating a LakeWise BMP demonstration site, a Vermont Invasives Patrollers volunteer program and the Lay Monitoring Program.

Town Planning and Permitting

South Hero Town Plan (2015)

The South Hero Town Plan offers guidelines for growth and development while preserving town resources and natural resources. While covering many topics, the report emphasizes the need to manage land appropriately to preserve local assets (South Hero Town Plan, 2015). Lake Champlain is cited as an important community asset, with Keeler Bay singled out as a prime fishing area. A stated goal of the plan is supporting Lake Champlain cleanup efforts through participation in Federal, State, and local water quality improvement efforts and through the Town Development Regulations.

The plan discusses the prevalence of lakefront residences. It states that as of 2013, 39% of parcels had lake frontage. Approximately half of the parcels had a year-round residence. The plan states that most of the land at high risk of flooding is privately owned. The plan sets a goal of encouraging floodplain, wetland, and forest protection and restoration to attenuate flooding and erosion. One strategy proposed in the plan to meet this goal is investigating the adoption of River Corridor or Fluvial Erosion Hazard regulations.

The South Hero Marsh Wildlife Area to the west of South Hero village is a 100-acre wooded wetland that drains to Keeler Bay. Mapping in the Town Plan shows Rare, Threatened, and Endangered species and natural communities in the wetland and around the outlet in Keeler Bay.

Northwest Regional Plan (2017)

One of the overall goals of the Regional Plan is to protect significant natural resources and maintain or improve the quality of surface and groundwater (Northwest Regional Plan, 2017). Low Impact Development, vegetative buffers, and floodplain development regulations are noted as policies to support the region's natural resource goals.

Reducing losses from all-hazards events is another stated goal of the plan. Strategies identified to meet this goal include avoiding, relocating, and retrofitting development that worsens flooding and fluvial erosion and the protection and restoration of floodplains and forested areas.

Post-2011 Lake Champlain Flooding NRPC Assessment and Designs (2012 – 2013)

FEA reviewed two properties on the Keeler Bay shoreline for bioengineering alternatives for an NRPC program providing assistance to landowners with shoreline erosion exacerbated by the flooding of Lake Champlain in 2011. One of the properties did not move on to the design phase, a full (100%) design was developed but not implemented for the second property.

Data Gaps

This watershed library describes the available documents, reports, and datasets that characterize water quality, shoreline, stormwater, and flooding concerns within the Keeler Bay watershed. The datasets offer valuable information on areas within the watersheds that may exhibit erosion, instability, or flow restrictions contributing to stormwater problem areas and downstream water quality impacts.

No geomorphic assessment has been conducted on the tributaries into Keeler Bay. Phase 1 and 2 SGA studies are best suited for areas of stream corridor that have substantial human conflicts (urban/agricultural land use), and the projects that are identified during SGA studies (floodplain reconnections/easements) are geared toward these manipulated settings.

As an alternative/complement to a full phase 1 and 2 SGA, a more narrowly focused SGA Lite approach will be employed to identify and evaluate areas of channel instability that may be contributing to sediment and phosphorus loading Keeler Bay. Eight tributaries to Keeler Bay have been preliminarily identified for a "stream walk" assessment. VT DEC Stream Geomorphic Assessment Lite protocols will be utilized. These are a pared down version of the VT DEC Stream Geomorphic Assessment Phase 2 protocols, to the steps listed below. The Phase 2 Stream Geomorphic Assessment field forms will be used to document steps 1.5 (Confinement), 2.1a-c (Bankfull Width and Width -to-Depth Ratio), 2.7 (Entrenchment), 2.8 (Incision), 2.14 (Channel Type, Stream Type and Bed Form), and 7.1-7.7 (Rapid Geomorphic Assessment, Channel Evolution Stage, and Stream Sensitivity). Six to eight miles of stream and tributary networks will be assessed.

Areas of greatest overlap between development (roads, homes, farming) and surface waters within a watershed are places where stormwater problem areas are most likely to be found and where improvements may be most beneficial. Based on the reports and datasets compiled in this watershed library, we expect these areas to include the agricultural streams/ditches to be included in the SGA Lite Assessments, developed areas in the two village centers, and public lake access points. Another major area of interest includes the private roads around the bay including Wally's Point Road, Kibbe Farm Road, Sunrise Drive, and more. These roads may not meet town road standards and could therefore be a major source of unchecked nutrient and sediment runoff.

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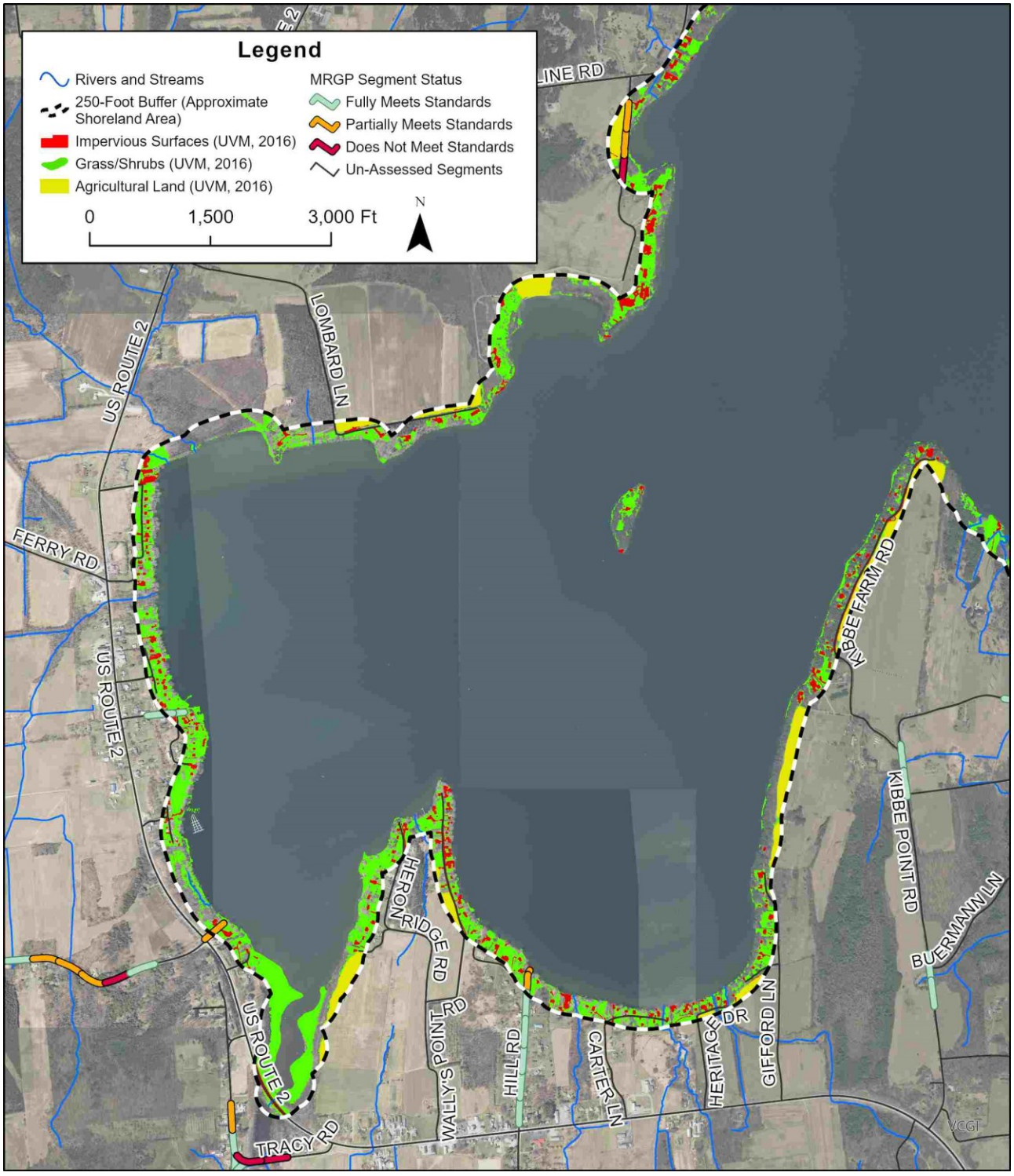
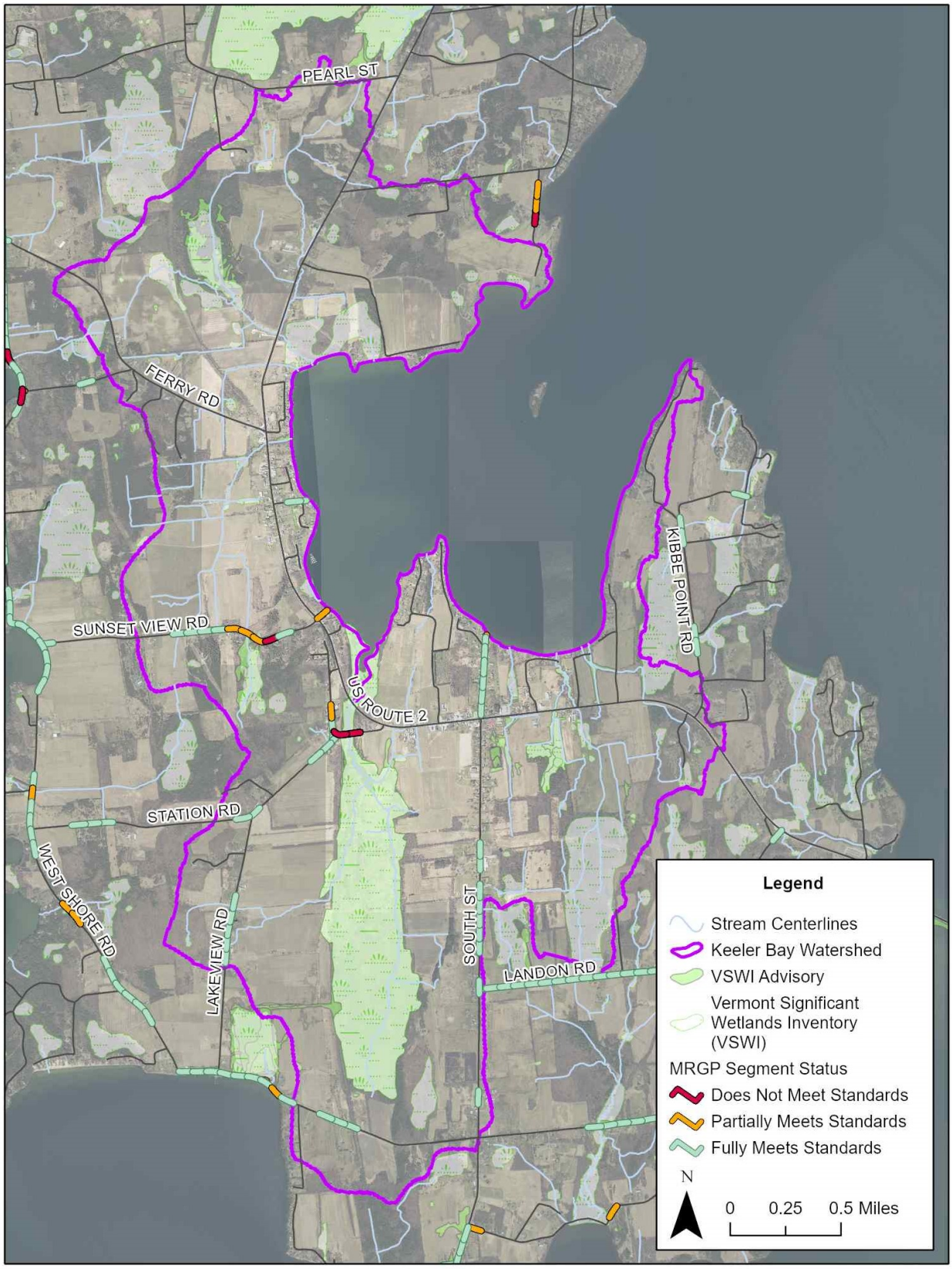
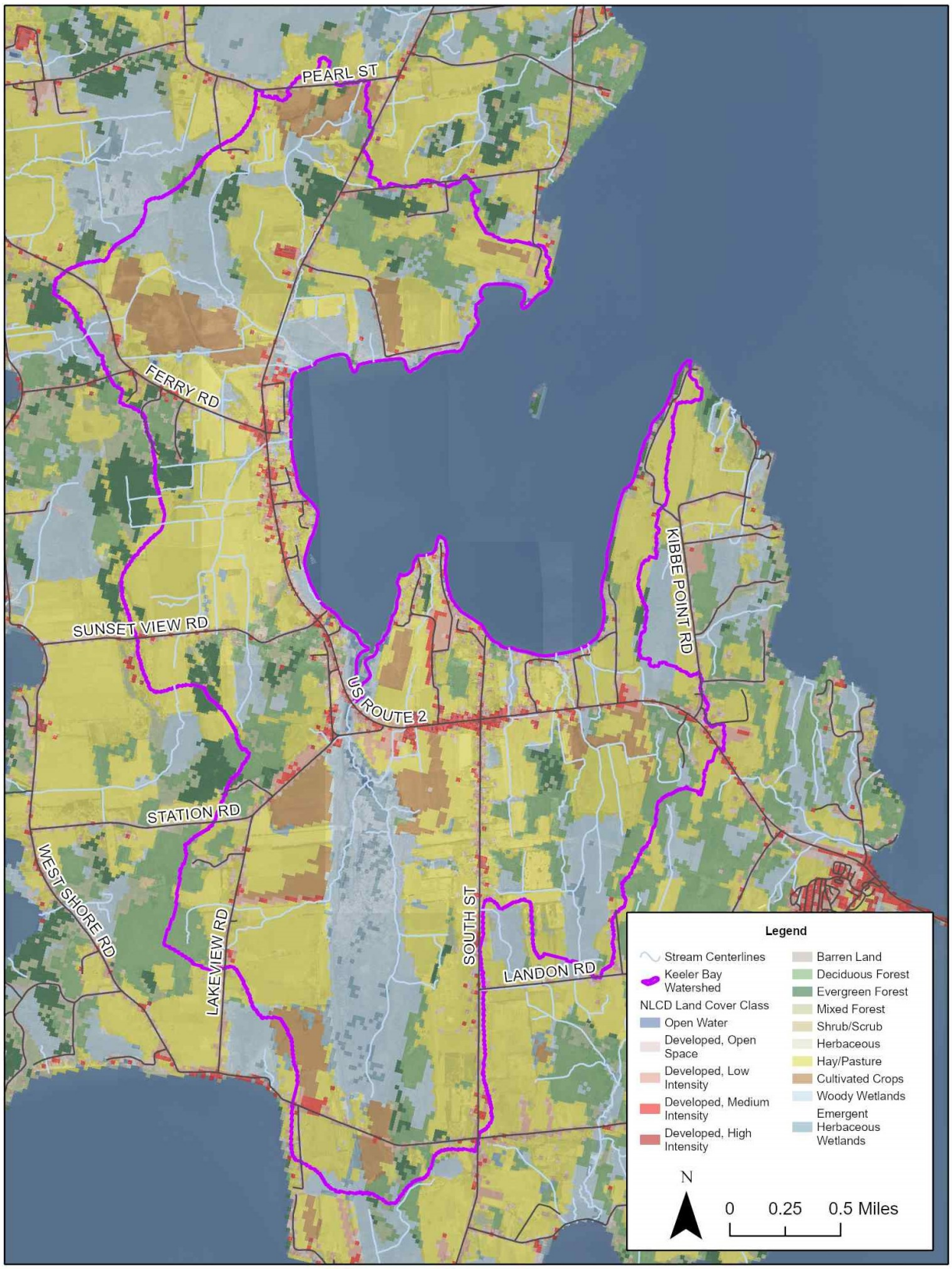


Keeler Bay Overview Map



Keeler Bay Watershed Overview Map

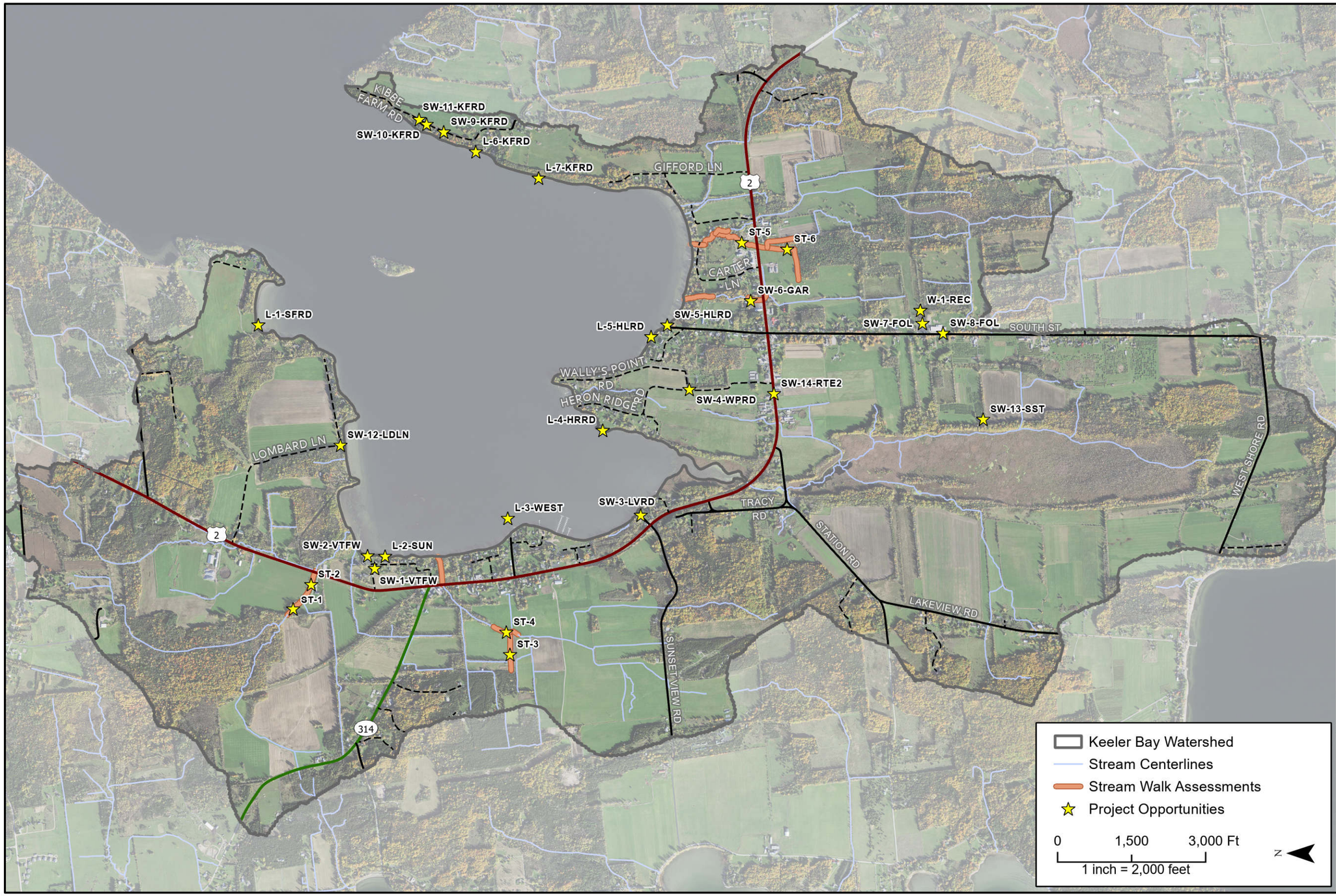


Keeler Bay Watershed Land Cover Map

APPENDIX B

Problem Area Location Map

(11”x17”)



Fitzgerald Environmental Associates, LLC
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Colchester, VT 05446
Telephone: 802.876.7778
www.fitzgeraldenvironmental.com

Notes:
- Project identification field tours were conducted between Aug. 2022 and Feb. 2023

KEELER BAY LWAP
PROJECT IDENTIFICATION MAP

MAP BY	CHECKED
EHB	EPF/JHB

SCALE: 1 inch = 2,000 feet

DATE: April 18, 2023

SHEET NO.: SHEET 1

APPENDIX C

Problem Area Summary Table and Prioritization Matrix (11”x17”)

Keeler Bay Watershed Action Plan
Project Prioritization
December 6, 2023

Additional Benefits Codes	CPA	SF	E	HV	AC	BMP	L
	Chronic Problem Area	Seasonal Flooding	Educational	High Visibility or Potential Influence to Community	Agricultural Land Use Compatibility	Improves BMP Performance	Enhance Lakeshore Natural Communities

										Water Quality Benefits									
Project ID	Landowner Contact	Project Type	Town	Location	Description	Preliminary Recommendations	P Reduction from Calc Tools (kg/yr)	P Reduction from Calc Tools (lb/yr)	Phosphorus Reduction	Drainage Area	Impervious Drainage	Connectivity to Surface Waters	O&M Requirements	Cost and Constructability	Additional Benefits	Additional Benefits Score	Total Score	Priority
									8	1	3	3	2	6		7	30	
L-1-SFRD	N	Lakeshore	South Hero	Sweeny Farm Common Land	There is lakeshore erosion present. To the north, there is an extensive lawn area.	Bioengineered shoreline stabilization, plantings to reestablish native lakeshore vegetation	2.74	6.04	8	1	1	3	1	3	HV, AC, L	3	20	High
L-2-SUN	Y	Lakeshore	South Hero	32 Sunrise Drive	There is lakeshore erosion present. The owner has sought a LakeWise assessment and additional guidance on bioengineered shoreline stabilization techniques.	Bioengineered shoreline stabilization, plantings to reestablish native lakeshore vegetation	0.45	0.99	6	0	0	3	1	1	E, HV, L	3	14	Moderate
L-3-WEST	N	Lakeshore	South Hero	Western Shore of Keeler Bay	Hard armor and lawns common with along the lakeshore.	Plantings to reestablish native lakeshore vegetation. Consider bioengineered shoreline stabilization if hardscaping to be replaced.	0.39	0.86	6	0	1	3	1	6	E, HV, L	3	20	High
L-4-HRRD	N	Lakeshore	South Hero	Heron Ridge Road	Areas of extensive lawn along the lakeshore.	Plantings to reestablish native lakeshore vegetation	0.7	1.54	8	1	1	3	1	6	E, HV, L	3	23	High
L-5-HLRD	N	Lakeshore	South Hero	Hill Road	Areas of extensive lawn along the lakeshore.	Plantings to reestablish native lakeshore vegetation	0.3	0.66	6	0	1	3	1	6	E, HV, L	3	20	High
L-6-KFRD	N	Lakeshore	South Hero	35 Kibbe Farm Road	Area of cedar cliff shoreline and potential educational opportunity with Dunkley's Gymnastics.	Conduct a LakeWise assessment of the property	0	0.00	0	0	0	3	2	6	E, HV, L	3	14	Moderate
L-7-KFRD	N	Lakeshore	South Hero	9 Kibbe Farm Road	Area of exemplary undeveloped cedar cliff shoreline at the Lalumiere farm.	Recognize and protect shoreline	0	0.00	0	0	0	3	2	5	E, HV, L	3	13	Low
ST-1	Y	Stream	South Hero	Tributary at 567 Route 2	Banks of the tributary are steep and eroded. Erosion potentially a threat to wastewater mound.	Monitor erosion and consider armoring bank.	0	0.00	0	0	0	3	1	5	CPA	1	10	Low
ST-2	Y	Stream	South Hero	Tributary at 567 Route 2	Channel is wide, shallow, and grassed.	Plant water-tolerant native species in no-mow area around the channel. Consider berries for birds or species to attract pollinators.	1.08	2.38	8	1	1	3	1	6	HV, AC	2	22	High
ST-3	Y	Stream	South Hero	Tributary at 17A Ferry Road	Bank erosion in incised ditched channel in agricultural setting.	Potential to add grade controls, bank shaping, and plantings. Improve forested buffers (landowner interested in windrow for horse area to the north)	1.21	2.67	8	1	0	3	1	3	AC	1	17	Moderate
ST-4	Y	Stream	South Hero	Tributary at 17A Ferry Road	Bank erosion in incised ditched stream in agricultural setting.	Potential to add grade controls, bank shaping, and plantings. Improve forested buffers	0.58	1.28	8	1	0	3	1	3	AC	1	17	Moderate
ST-5	Y	Stream	South Hero	Tributary at 260 Route 2	The channel is eroded for approximately 90 feet. The erosion is expected to continue up from the headcut. The headcut is threatening a sewer forcemain and has disconnected the adjacent floodplain	Stabilize erosion with grade controls, bank shaping, and planting.	0.97	2.14	8	1	2	3	2	3	E, HV	2	21	High
ST-6	Y	Stream/ Wetland	South Hero	Tributary at 269 Route 2	Opportunity to improve the stream buffer within a historically cleared wetland in an agricultural setting.	Plant water-tolerant native species in within 50-feet of the stream top-of-bank.	0.48	1.06	8	1	0	3	1	6	HV	1	20	High
SW-1-VTFW	Y	Stormwater	South Hero	38 Sunrise Drive	Large recently constructed gravel parking lot on VT F&W property southeast of Sunrise Drive drains to a ditch then to the bay untreated.	Add check dams to ditch to slow runoff and trap sediment. Consider installing a treatment basin east of the parking lot to treat runoff.	0.15	0.33	4	0	3	3	0	5	E, HV	2	17	Moderate
SW-2-VTFW	Y	Stormwater/ Lakeshore	South Hero	38 Sunrise Drive	VT F&W boat launch is shallow with weeds, making access difficult. The large gravel parking lot and launch area has erosion directly into the lake. The ditch is filled in with sediment.	Divert runoff from the parking lot to treatment basins on either side of the ramp. Consider diverting upslope runoff if needed with a cross culvert into existing ditch. Narrow the ramp and decomission part of parking if possible and establish native lakeshore vegetation in the reclaimed areas.	0.85	1.87	8	0	2	3	0	3	CPA, E, HV, L	4	20	High
SW-3-LVRD	Y	Stormwater/ Road	South Hero	Lavigne Road Ramp	Pavement ends after last two driveways and erosion starts down the gravel ramp to the lake. Plow has pushed a pile of loose material right to the shoreline. MRGP REI: Partially Meets Gravel Road with 4.8% Slope (Reclassify to Does Not Meet)	Recommend paving the ramp and installing a small ditch along the side. Could angle to the right at the end for plow stockpile.	0.29	0.64	6	0	3	3	1	6	CPA, HV, BMP	3	22	High
SW-4-WPRD	Y	Stormwater/ Road	South Hero	Wally's Point Road	The road surface is eroding near the intersection with Heron Ridge Road. There are no existing ditches. Chronic problem area for erosion.	Install ditches and crown road to encourage sheet flow off of the road	0.29	0.64	6	0	3	1	1	6	CPA	1	18	Moderate
SW-5-HLRD	Y	Stormwater/ Road	South Hero	Hill Road Ramp	Concentrated runoff comes out next to water intake. There is minor gully erosion present from the end of the ditch to the lake. MRGP REI: Partially Meets Gravel Road with 8.0% Slope (Reclassify to Does Not Meet).	Extend the ditch to the lake and stabilize with stone. Could install a sediment trap near the terminus, or a few check dams in the lower part of the ditch.	0.19	0.60	6	0	3	3	1	6	CPA,, BMP	2	21	High
SW-6-GAR	Y	Stormwater	South Hero	286 Route 2	Runoff conveys sand and salt from the pile at the Town Garage into the adjacent stream.	Relocate sand pile and install treatment basin in the vicinity of the northeastern corner of the property.	1.02	2.25	8	0	3	3	0	2	CPA, HV	2	18	High
SW-7-FOL	Y	Stormwater	South Hero	65 South Street	The large gravel parking lot runs off to the wetland to the east with minimal treatment. Snow is plowed toward the eastern edge of the parking lot.	Install a treatment basin in the grass between the parking lot and wetland.	0.37	0.82	6	0	3	1	0	3	E, HV	2	15	Moderate

Keeler Bay Watershed Action Plan
Project Prioritization
December 6, 2023

Additional Benefits Codes	CPA	SF	E	HV	AC	BMP	L
	Chronic Problem Area	Seasonal Flooding	Educational	High Visibility or Potential Influence to Community	Agricultural Land Use Compatibility	Improves BMP Performance	Enhance Lakeshore Natural Communities

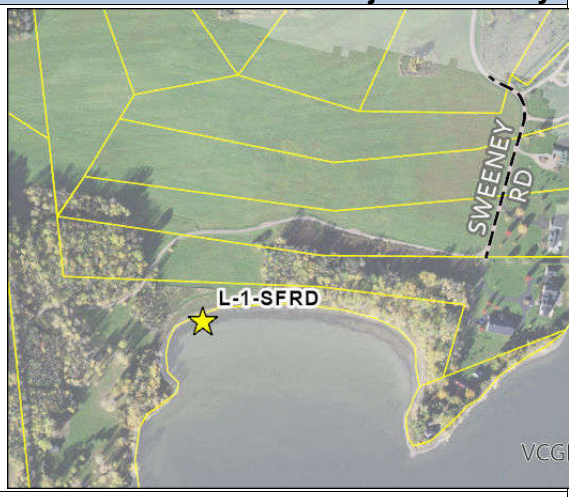
									Water Quality Benefits									
Project ID	Landowner Contact	Project Type	Town	Location	Description	Preliminary Recommendations	P Reduction from Calc Tools (kg/yr)	P Reduction from Calc Tools (lb/yr)	Phosphorus Reduction	Drainage Area	Impervious Drainage	Connectivity to Surface Waters	O&M Requirements	Cost and Constructability	Additional Benefits	Additional Benefits Score	Total Score	Priority
									8	1	3	3	2	6		7	30	
SW-8-FOL	Y	Stormwater	South Hero	75 South Street	Water is ponded in the handicap parking spaces at the Folsom School and there is an accumulation of sediment. The nearby catch basin is completely full of sediment. Space is limited.	Install a narrow basin along the edge of pavement to trap sediment.	0.2	0.44	4	0	2	1	0	3	CPA	1	11	Low
SW-9-KFRD	N	Stormwater/ Driveway	South Hero	51 Kibbe Farm Road	Rill erosion caused by runoff down driveway. Road cross culvert drains to stone lined area, but ditch shaping is minimal.	Install a cross culvert with level spreader to direct runoff to the forested area south of the driveway and send runoff south of the existing shed.	0.125	0.28	4	0	3	1	0	6	CPA	1	15	Moderate
SW-10-KFRD	N	Stormwater	South Hero	61 & 63 Kibbe Farm Road	Runoff from road and lawns transports runoff and some gravel down steps toward camps 61 and 63.	Install infiltration steps	0.04	0.09	2	0	2	1	0	5		0	10	Low
SW-11-KFRD	N	Stormwater/ Driveway	South Hero	69 & 71 Kibbe Farm Road	Rill erosion caused by runoff down driveway.	Install a water bar or open top culvert to a level spreader to divert water off of the driveway and dissipate flow in forested area to the south of the driveway.	0.05	0.11	2	0	3	1	0	6	CPA	1	13	Low
SW-12-LDLN	N	Stormwater	South Hero	70 & 86 Lombard Lane	Runoff from agricultural field and road concentrates to culvert.	Install constructed shallow surface wetland at the bend in the road to treat runoff. Consider regenerative stormwater conveyance basins in the channel.	3.73	8.22	8	1	1	3	0	2	CPA, SF, HV, AC	4	19	High
SW-13-SST	Y	Stormwater	South Hero	86 South Street	Swale receives stormwater runoff from the Folsom School (mainly rooftop) and from orchard. Potential stormwater retrofit opportunity.	Install a flood bench or flow through wetland. Could install a forebay closer to the road to trap sediment.	1.25	2.76	8	1	1	2	0	4	AC	1	17	Moderate
SW-14-RTE2-WEST	Y	Stormwater	South Hero	Route 2	Stormwater from Route 2 and the village is collected in the storm drain network.	Add swirl separator(s) to trap sediment. Could be creditable under the VTrans TS4 PCP.	1.44	3.17	8	1	2	2	0	1		0	14	Moderate
SW-14-RTE2-CENTRAL	Y	Stormwater	South Hero	Route 2	Stormwater from Route 2 and the village is collected in the storm drain network.	Add swirl separator(s) to trap sediment. Could be creditable under the VTrans TS4 PCP.	0.25	0.55	4	1	2	2	0	1		0	10	Low
SW-14-RTE2-EAST	Y	Stormwater	South Hero	Route 2	Stormwater from Route 2 and the village is collected in the storm drain network.	Add swirl separator(s) to trap sediment. Could be creditable under the VTrans TS4 PCP.	0.11	0.24	2	0	2	2	0	1		0	7	Low
W-1-REC	Y	Wetland	South Hero	65 South Street	Town-owned parcel with trails. Parts of the wetland are dominated by Phragmites, especially around the manmade fire pond.	Explore wetland restoration opportunities. This may include vegetation management to reduce invasives or restoring the wetland within the pond if it is no longer used.	0	0.00	0	0	0	2	0	5	E, HV	2	9	Low

APPENDIX D

Problem Area Summary Sheets (8½”x11”)

L-1-SFRD

Project: L-1-SFRD	**Project Summary**
Location	Sweeny Farm Road
Land Ownership	Private Residential Common Land
Landowner Support/ Communication	None
BMP Type	Lakeshore
Calculated P Reduction	*6.04 lb/yr*
Estimated Project Cost	*$20,000-50,000*
P Efficiency ($/lb removed)	*$ 3,000-8,000*
Project Priority	*High*



Site Description: There is a long area of active lakeshore erosion present. To the north, there is an extensive lawn area with no woody buffer vegetation.

Photo 1: Area of erosion and lawn along the lakeshore

BMP Description: Bioengineered shoreline stabilization, plantings to reestablish native lakeshore vegetation

WQ Benefits	O&M Requirements	Cost and Constructability	Additional Benefits	Total Score
13	*2*	*3*	*3*	*20*

Additional Project Benefits Description: The project presents an opportunity to enhance lakeshore natural communities by establishing native vegetation and by providing shade along the lakeshore in a high visibility area. The project could be complementary to agricultural best practices on the upslope hayfield by improving filtration and soil loss.

Project Comments: The project is assigned a high priority due to the water quality and habitat benefits of enhancing lakeshore natural communities and stabilizing shoreline erosion.

L-2-SUN

Project: L-2-SUN	**Project Summary**
Location	32 Sunrise Drive
Land Ownership	Private Residential
Landowner Support/ Communication	Yes
BMP Type	Lakeshore
Calculated P Reduction	*0.99 lb/yr*
Estimated Project Cost	*$50,000-100,000*
P Efficiency ($/lb removed)	*$50,000-100,000*
Project Priority	*Medium*

Site Description: There is lakeshore erosion present. The owner has sought a Lake Wise assessment and additional guidance on bioengineered shoreline stabilization techniques.

Photo 1: Area of erosion along the lakeshore

BMP Description: Bioengineered shoreline stabilization, plantings to reestablish native lakeshore vegetation

WQ Benefits	O&M Requirements	Cost and Constructability	Additional Benefits	Total Score
9	*1*	*1*	*3*	*14*

Additional Project Benefits Description: The project presents an opportunity to enhance lakeshore natural communities by establishing native vegetation and by providing shade along the lakeshore in a high visibility area due to its location near the State Access. The project could provide an educational opportunity for neighbors and the broader community to learn about alternatives to hard armor.

Project Comments: The project is assigned a moderate priority due to the water quality and habitat benefits of enhancing lakeshore natural communities and stabilizing shoreline erosion.

L-5-HLRD

Project: L-5-HLRD	**Project Summary**
Location	Hill Road
Land Ownership	Private Residential
Landowner Support/ Communication	Yes
BMP Type	Lakeshore
Calculated P Reduction	0.66 lb/yr
Estimated Project Cost	<$5,000
P Efficiency ($/lb removed)	$ 5,000 – 7,600
Project Priority	High

Site Description: Multiple opportunities for shoreline assessment and improvements including mowed lawns and hard armor along the lakeshore.

Photo 1: Example of a shoreline along Heron Ridge Road

BMP Description: Potential opportunity for shoreline assessment and Lake Wise practice implementation. Suggested practices include implementing no-mow areas, planting native trees and shrubs along the lakeshore, and improving lake access points to minimize erosion.

Water Quality Benefits	O&M Requirements	Cost and Constructability	Additional Benefits	Total Score
10	*1*	*6*	*3*	*20*

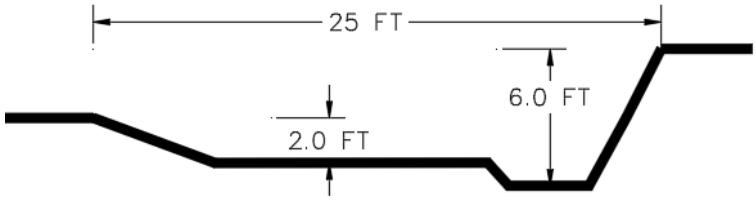
Additional Project Benefits Description: The project presents an opportunity to enhance lakeshore natural communities by establishing native vegetation and by providing shade along the lakeshore in a high visibility area. The project could provide an educational opportunity for neighbors and the broader community to learn about lakeshore vegetation and buffers.

Project Comments: Preliminary P removal and efficiency calculations assume 0.3 acres of lakeshore buffer reestablished. The project is assigned a high priority due to the water quality and habitat benefits of enhancing lakeshore natural communities and the low cost of implementation.

ST-1

Project: ST-1	**Project Summary**
Location	567 Route 2
Land Ownership	Private Residential
Landowner Support/ Communication	Yes
BMP Type	Stream
Calculated P Reduction	*0 lb/yr*
Estimated Project Cost	*$ 10,000-20,000*
P Efficiency ($/lb removed)	*N/A*
Project Priority	*Low*

Site Description: Banks of the tributary are steep and eroded. Erosion potentially a threat to wastewater mound.



Erosion (30'L x 1.7'H; 70'L x 5'H)

Photo 1: Steep eroded stream bank

Photo 2: Steep eroded stream bank; wastewater mound in the background (upper right)

BMP Description: Monitor erosion and consider armoring bank.

WQ Benefits	O&M Requirements	Cost and Constructability	Additional Benefits	Total Score
3	*1*	*5*	*1*	*10*

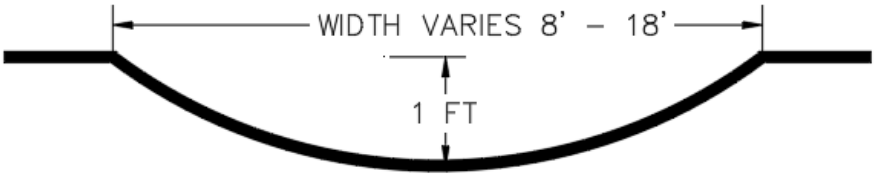
Additional Project Benefits Description: The bank erosion is likely an ongoing problem.

Project Comments: The project is assigned a low priority due to the as the water quality benefits of streambank hard armor are considered minimal.

ST-2

Project: ST-2		**Project Summary**
Location	567 Route 2	
Land Ownership	Private Residential	
Landowner Support/ Communication	Yes	
BMP Type	Stream	
Calculated P Reduction	*2.38lb/yr*	
Estimated Project Cost	*$ <5,000*	
P Efficiency ($/lb removed)	*$ 2,000*	
Project Priority	*High*	

Site Description: Channel is wide, shallow, and grassed.



Tile Inputs (2)

Photo 1: Wide shallow grassed channel

Photo 2: Wide shallow grassed channel

BMP Description: Implement a no-mow buffer (35-feet on either side of channel, 70-feet total) and plant water-tolerant native species in and around the channel. Consider planting berries for birds and/or species to attract pollinators..

WQ Benefits	O&M Requirements	Cost and Constructability	Additional Benefits	Total Score
13	*1*	*6*	*2*	*22*

Additional Project Benefits Description: The project presents an opportunity to implement a stream buffer high visibility area along Route 2. The project could be complementary to agricultural best practices on the neighboring field by improving filtration.

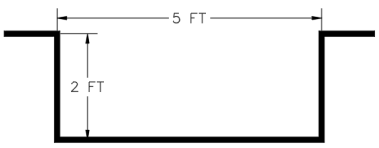
Project Comments: High priority for water quality and habitat benefits with a low cost.

ST-3

Project: ST-3	**Project Summary**
Location	17A Ferry Road
Land Ownership	Private/ Agricultural
Landowner Support/ Communication	Yes
BMP Type	Stream
Calculated P Reduction	*2.67lb/yr*
Estimated Project Cost	*$ 40,000-60,000*
P Efficiency ($/lb removed)	*$ 15,000-25,000*
Project Priority	*Medium*

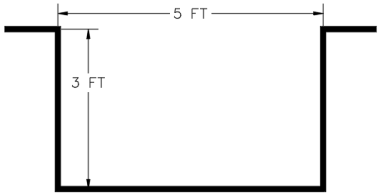
Site Description: Bank erosion present along the entire extent (800') of the incised ditched channel in an agricultural setting. There is undercutting of the vertical banks. The channel was widened and deepened in approximately 2019. Fine grained substrate (sand and silt).

Upper Channel



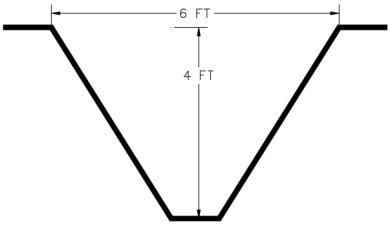
Tile Inputs (2); 18" Culvert (1)

Mid Channel



Tile Inputs (2); Widening

Lower Channel



Tile Input (1)

Photo 1: Incised ditched channel

Photo 2: Incised ditched channel

BMP Description: Potential to add grade controls, bank shaping, and plantings. Improve forested buffers (landowner interested in windrow for horse area to the north).

WQ Benefits	O&M Requirements	Cost and Constructability	Additional Benefits	Total Score
12	*1*	*3*	*1*	*17*

Additional Project Benefits Description: The project could be complementary to agricultural best practices on the surrounding field by improving filtration and minimizing soil loss.

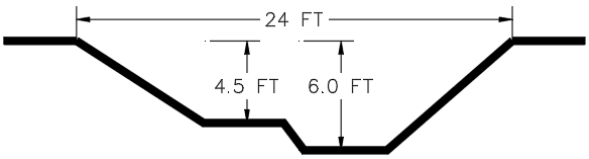
Project Comments: Moderate priority from water quality benefits associated with stream buffer.

ST-4

Project: ST-4	**Project Summary**
Location	17A Ferry Road
Land Ownership	Private Residential and Agricultural
Landowner Support/ Communication	Yes
BMP Type	Stream
Calculated P Reduction	*1.28 lb/yr*
Estimated Project Cost	*$ 20,000-40,000*
P Efficiency ($/lb removed)	*$ 15,000-30,000*
Project Priority	*Medium*

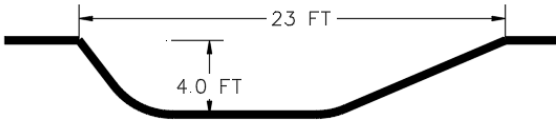
Site Description: Bank erosion in incised ditched stream in agricultural setting. The area near the tributary junction has a small inset floodplain. Further downstream the channel is more U-shaped and widening. Both fine grained (sand, silt) and gravel substrate. Beaver activity present upstream.

Upper Channel



Rip-rap (40'); Erosion (50'L x 4'H)

Lower Channel



Tile Inputs (1, Clay); Erosion (60'L x 3'H); Widening

Photo 1: Incised ditched channel

Photo 2: Incised ditched channel

BMP Description: Potential to add grade controls, bank shaping, and plantings. Improve forested buffers.

WQ Benefits	O&M Requirements	Cost and Constructability	Additional Benefits	Total Score
12	*1*	*3*	*1*	*17*

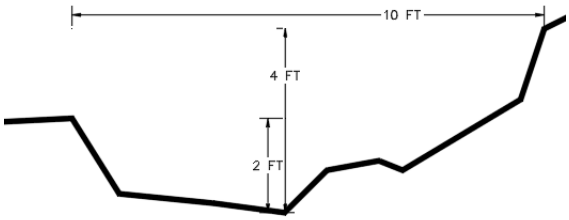
Additional Project Benefits Description: Ditch stabilization and buffer improvements could be compatible with existing agricultural land use.

Project Comments: The project is assigned a moderate priority due to the water quality benefits of implementing a stream buffer.

ST-5

Project: ST-5	**Project Summary**
Location	260 Route 2
Land Ownership	Commercial
Landowner Support/ Communication	Yes
BMP Type	Stream
Calculated P Reduction	*2.14 lb/yr*
Estimated Project Cost	*$ 40,000-50,000*
P Efficiency ($/lb removed)	*$ 20,000-25,000*
Project Priority	*High*

Site Description: A 2-3 foot tall headcut is present in the channel. Channel erosion extends approximately 90 feet downstream from the headcut. The erosion is expected to continue from the headcut upstream if it is left unchecked. The channel substrate is fine grained (silt). The headcut is threatening a sewer forcemain and has disconnected the channel from the wetland floodplain.



Erosion (90'L x 4'H)

Photo 1: Headcut in channel

Photo 2: Erosion in channel

BMP Description: Stabilize erosion with grade controls, bank shaping, and planting. Stabilize tile drain output.

WQ Benefits	O&M Requirements	Cost and Constructability	Additional Benefits	Total Score
14	*2*	*3*	*2*	*21*

Additional Project Benefits Description: Wetland/floodplain restoration would be highly visible and be an excellent education opportunity.

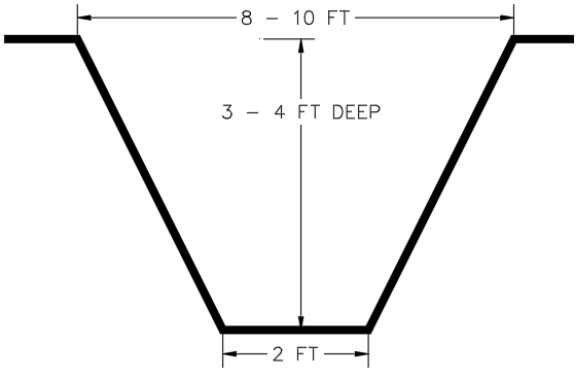
Project Comments: Landowers are very supportive of the project and hoping for quick implementation to protect the forcemain.

ST-6

Project: ST-6	**Project Summary**
Location	269 Route 2
Land Ownership	Commercial
Landowner Support/ Communication	Yes
BMP Type	Stream/ Wetland
Calculated P Reduction	*1.06 lb/yr*
Estimated Project Cost	*$ 5,000-10,000*
P Efficiency ($/lb removed)	*$ 5,000-10,000*
Project Priority	*High*

Site Description: Opportunity to improve the stream buffer within a historically cleared wetland in an agricultural setting.

Photo 1: Opportunity to plant a wider stream buffer, improve wetland vegetation, and manage invasive buckthorn and honeysuckle



Typical Channel Cross-Section

BMP Description: Plant water-tolerant native species in within 50-feet of the stream top-of-bank. Manage to reduce invasive buckthorn and honeysuckle along the stream channel.

WQ Benefits	O&M Requirements	Cost and Constructability	Additional Benefits	Total Score
12	*1*	*6*	*1*	*20*

Additional Project Benefits Description: The project presents an opportunity to restore a stream in a high visibility area along Route 2. The project could provide an educational opportunity for neighbors and the broader community to learn about stream restoration.

Project Comments: The project is assigned a high priority due to the water quality benefits of implementing a stream buffer and the relatively low cost of the project.

SW-1-VTFW

Project: SW-1-VTFW	**Project Summary**
Location	38 Sunrise Drive
Land Ownership	Public Recreational
Landowner Support/ Communication	Yes
BMP Type	Stormwater
Calculated P Reduction	*0.33 lb/yr*
Estimated Project Cost	*$2,500-5,000*
P Efficiency ($/lb removed)	*$ 7,500-15,000*
Project Priority	*Medium*

Site Description: Large recently constructed gravel parking lot on VT F&W property southeast of Sunrise Drive drains to a ditch then to the bay untreated. The ditch begins along the parking lot and does not extend up to Route 2. The ditch crosses Sunrise Drive and continues along the boat launch.

Photo 1: Large recently constructed lot (left) and ditch (right)

Photo 2: Driveway culvert in the ditch at the parking lot entrance

BMP Description: Add check dams to ditch to slow runoff and trap sediment. Consider adding a basin along the eastern side of the parking lot to treat runoff.

WQ Benefits	O&M Requirements	Cost and Constructability	Additional Benefits	Total Score
10	*0*	*5*	*2*	*17*

Additional Project Benefits Description: The project presents an opportunity to implement a stormwater best management practice in a high visibility area. The project could provide an educational opportunity for neighbors and the broader community to learn about stormwater treatment.

Project Comments: The project is assigned a moderate priority due to the water quality benefits of enhancing treating stormwater from impervious surfaces and the relatively low cost of the project.

SW-2-VTFW

Project: SW-2-VTFW	**Project Summary**
Location	38 Sunrise Drive
Land Ownership	Public Recreational
Landowner Support/ Communication	Yes
BMP Type	Stormwater/ Lakeshore
Calculated P Reduction	*1.87 lb/yr*
Estimated Project Cost	*$ 20,000-40,000*
P Efficiency ($/lb removed)	*$ 10,000-20,000*
Project Priority	*High*

Site Description: VT F&W boat launch is shallow with weeds, making access difficult. The large gravel parking lot and launch area has erosion directly into the lake. The ditch is filled in with sediment.

Photo 1: Boat launch with swale along the right side

Photo 2: Erosion on the boat ramp

BMP Description: Divert runoff from the parking lot to treatment basins on either side of the ramp. Consider diverting upslope runoff if needed with a cross culvert into existing ditch Narrow the ramp if possible and establish native lakeshore vegetation in the reclaimed areas.

WQ Benefits	O&M Requirements	Cost and Constructability	Additional Benefits	Total Score
13	*0*	*3*	*4*	*20*

Additional Project Benefits Description: The project presents an opportunity to enhance lakeshore natural communities by establishing native vegetation and by providing shade along the lakeshore in a high visibility location that is a chronic problem area for erosion. The project could provide an educational opportunity to learn about stormwater, lakeshore vegetation, and buffers.

Project Comments: The project is assigned a high priority due to the water quality and habitat benefits of enhancing lakeshore natural communities and reducing or treating runoff from impervious surfaces.

SW-3-LVRD

Project: SW-3-LVRD		**Project Summary**
Location	Keelers Bay Road Ramp	
Land Ownership	Town Road ROW	
Landowner Support/ Communication	Yes	
BMP Type	Stormwater/ Road	
Calculated P Reduction	*0.64 lb/yr*	
Estimated Project Cost	*$ 10,000-20000*	
P Efficiency ($/lb removed)	*$ 15,000-30,000*	
Project Priority	*High*	

Site Description: Pavement ends after last two driveways and erosion starts down the gravel ramp to the lake. Plow has pushed a pile of loose material right to the shoreline. Road Erosion Inventory from 2018: Partially Meets Gravel Road with 4.8% Slope (Reclassify to Does Not Meet)

Photo 1: Ramp on Lavigne Road with erosion down to lake

BMP Description: Recommend paving the ramp and installing a small ditch along the side. Could angle end of road to the right for plowing.

WQ Benefits	O&M Requirements	Cost and Constructability	Additional Benefits	Total Score
12	*1*	*6*	*3*	*22*

Additional Project Benefits Description: The project presents an opportunity to improve efficacy of upslope Municipal Roads General Permit Best Management Practices in a high visibility area. The project would reduce erosion of a chronic problem area.

Project Comments: The project is assigned a high priority due to the water quality of reducing road erosion and the relatively low cost of the project.

SW-4-WPRD

Project: SW-4-WPRD	**Project Summary**
Location	Wally's Point Road
Land Ownership	Private Road
Landowner Support/ Communication	Yes
BMP Type	Stormwater/ Road
Calculated P Reduction	*0.64 lb/yr*
Estimated Project Cost	*$ 10,000-20000*
P Efficiency ($/lb removed)	*$ 15,000-30,000*
Project Priority	*High*

Site Description: The private road surface is eroding near the intersection with Heron Ridge Road. There are no existing ditches. Chronic problem area for erosion and standing water.

Photo 1: Wally's Point Road at the intersection with Heron Ridge Road.

BMP Description: Install ditches and crown road to encourage sheet flow off of the road.

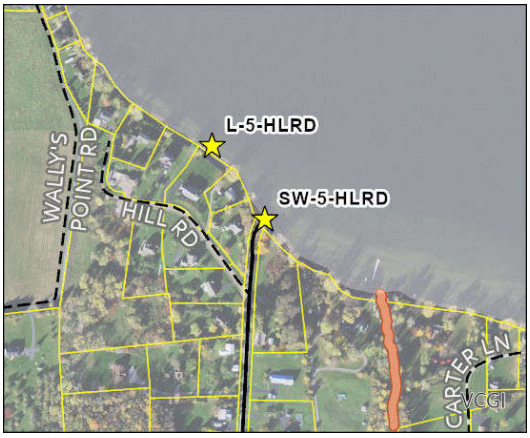
WQ Benefits	O&M Requirements	Cost and Constructability	Additional Benefits	Total Score
10	*1*	*6*	*1*	*18*

Additional Project Benefits Description: Alleviate an area with chronic ponding issues.

Project Comments: The project is assigned a moderate priority due to the water quality of reducing road erosion and the relatively low cost of the project.

SW-5-HLRD

Project: SW-5-HLRD	**Project Summary**
Location	Hill Road Ramp
Land Ownership	Town Road ROW
Landowner Support/ Communication	Yes
BMP Type	Stormwater/ Road
Calculated P Reduction	*0.6 lb/yr*
Estimated Project Cost	*$ 10,000-20,000*
P Efficiency ($/lb removed)	*$ 15,000-30,000*
Project Priority	*High*



Site Description: Ditch ends below culvert for access to water intake. Runoff flows across gravel ramp with gully erosion continuing into the lake. Road Erosion Inventory from 2018: Partially Meets Gravel Road with 8.0% Slope (Reclassify to Does Not Meet)

Photo 1: Gully erosion on ramp down to the lake

Photo 2: Stable ditch above ramp

BMP Description: Extend the ditch to the lake and stabilize with stone. Could install a sediment trap near the terminus, or a few check dams in the lower part of the ditch.

WQ Benefits	O&M Requirements	Cost and Constructability	Additional Benefits	Total Score
12	*1*	*6*	*2*	*21*

Additional Project Benefits Description: The project presents an opportunity to improve efficacy of upslope Municipal Roads General Permit Best Management Practices in a high visibility area. The project would reduce gully erosion directly into the lake.

Project Comments: The project is assigned a high priority due to the water quality of reducing road erosion and the relatively low cost of the project.

SW-6-GAR

Project: SW-6-GAR	**Project Summary**
Location	286 Route 2
Land Ownership	Town Garage
Landowner Support/ Communication	Yes
BMP Type	Stormwater
Calculated P Reduction	*2.25 lb/yr*
Estimated Project Cost	*$50,000 - $100,000** ** Cost specific to stormwater treatment. Does not include storage shed or pile relocation.*
P Efficiency ($/lb removed)	*$ 20,000-40,000*
Project Priority	*High*

Site Description: Grading around the large municipal sand pile directs runoff into the adjacent stream with additional erosion along the flow path.

Photo 1: Conveyance from sand pile to the stream

Photo 2: Runoff from parking lot around sand pile

BMP Description: Relocate sand pile to storage shed as planned by the Town. Install a forebay and basin to treat stormwater runoff in the vicinity of the northeastern corner of the property. Restore wetland floodplain area along stream.

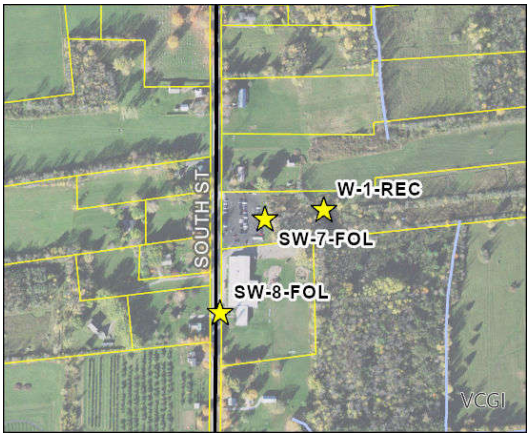
WQ Benefits	O&M Requirements	Cost and Constructability	Additional Benefits	Total Score
14	*0*	*2*	*2*	*18*

Additional Project Benefits Description: Erosion and excess sediment/salt loading from the pile is a chronic water quality issue for the adjacent stream.

Project Comments: The project is assigned a high priority due to the water quality benefits of enhancing treating stormwater from impervious surfaces with a direct surface water connection.

SW-7-FOL

Project: SW-7-FOL	**Project Summary**
Location	65 South Street
Land Ownership	Town Land
Landowner Support/ Communication	Yes
BMP Type	Stormwater
Calculated P Reduction	*0.82 lb/yr*
Estimated Project Cost	*$ 30,000-50,000*
P Efficiency ($/lb removed)	*$ 35,000-60,000*
Project Priority	*Medium*



Site Description: The large gravel parking lot runs off to the wetland to the east with minimal treatment. Snow is plowed toward the eastern edge of the parking lot. The parking lot is used by the school but is on Town land. Grassed area between parking lot and wetland is currently used for snow stockpiling.

Photo 1: Large gravel parking area on Town land associated with school.

Photo 2: Grass between parking lot and wetland with accumulated sediment.

BMP Description: Install a treatment basin or a filter strip in the grass between the parking lot and wetland.

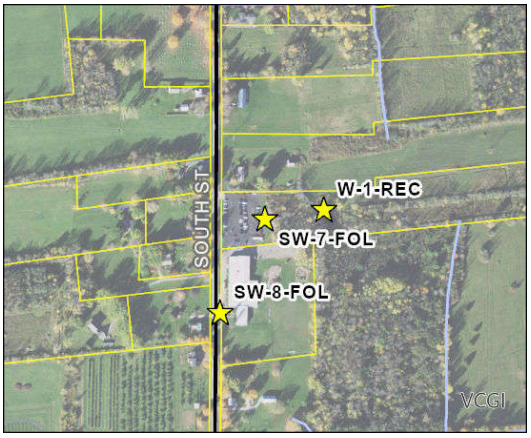
WQ Benefits	O&M Requirements	Cost and Constructability	Additional Benefits	Total Score
10	*0*	*3*	*2*	*15*

Additional Project Benefits Description: The project presents an opportunity to implement a stormwater best management practice in a high visibility area. The project could provide an educational opportunity for school children and the broader community to learn about stormwater treatment.

Project Comments: The project is assigned a moderate priority due to the water quality benefits of enhancing treating stormwater from impervious surfaces and the moderate cost of the project.

SW-8-FOL

Project: SW-8-FOL	**Project Summary**
Location	75 South Street
Land Ownership	Educational
Landowner Support/ Communication	Yes
BMP Type	Stormwater
Calculated P Reduction	*0.44 lb/yr*
Estimated Project Cost	*$ 20,000-30,000*
P Efficiency ($/lb removed)	*$ 40,000-50,000*
Project Priority	*Low*



Site Description: Water is ponded in the handicap parking spaces at the Folsom School and there is an accumulation of sediment. The nearby catch basins are completely full of sediment. Space is limited.

Photo 1: Accumulated sediment suggests water pools and evaporates in the handicap parking area.

Photo 2: The catch basin is completely full of sediment and higher than the handicap parking area.

BMP Description: Install a narrow basin along the edge of pavement to trap sediment. Likely requires a culvert under South Street discharging to the lawn across from the school.

WQ Benefits	O&M Requirements	Cost and Constructability	Additional Benefits	Total Score
7	*0*	*3*	*1*	*11*

Additional Project Benefits Description: The existing catch basins are not functional and do not appear to be connected to anything, we expect that prolonged ponding is a chronic problem here.

Project Comments: Project has a relatively high cost due to the required culvert crossing South Street.

SW-9-KFRD

Project: SW-9-KFRD	**Project Summary**
Location	51 Kibbe Farm Road
Land Ownership	Private Road/ Driveway
Landowner Support/ Communication	None
BMP Type	Stormwater/ Driveway
Calculated P Reduction	*0.28 lb/yr*
Estimated Project Cost	*$ 5,000-10,000*
P Efficiency ($/lb removed)	*$15,000-30,000*
Project Priority	*Medium*

Site Description: Rill erosion caused by runoff down driveway. Road cross culvert drains to stone lined area, but ditch shaping is minimal.

Photo 1: Erosion down driveway (left). Cross culvert outlet with stone stabilization (right).

Photo 2: Forested area south of the driveway.

BMP Description: Install a cross culvert with level spreader to direct runoff to the forested area south of the driveway and send runoff south of the existing shed.

WQ Benefits	O&M Requirements	Cost and Constructability	Additional Benefits	Total Score
8	*0*	*6*	*1*	*15*

Additional Project Benefits Description: The project would reduce erosion of a chronic problem area.

Project Comments: The project is assigned a moderate priority due to the water quality of reducing road erosion and the relatively low cost of the project.

SW-10-KFRD

Project: SW-10-KFRD		**Project Summary**
Location	61 & 63 Kibbe Farm Road	
Land Ownership	Private Land	
Landowner Support/ Communication	None	
BMP Type	Stormwater	
Calculated P Reduction	*0.09 lb/yr*	
Estimated Project Cost	*$ 2,500-5,000*	
P Efficiency ($/lb removed)	*$ 25,000-50,000*	
Project Priority	*Low*	

Site Description: Runoff from road and lawns transports runoff and some gravel down steps toward camps 61 and 63.

Photo 1: Runoff from road and lawn conveys sediment down existing steps.

BMP Description: Install infiltration steps.

WQ Benefits	O&M Requirements	Cost and Constructability	Additional Benefits	Total Score
5	*0*	*5*	*0*	*10*

Additional Project Benefits Description:

Project Comments: The project is assigned a low priority due to the limited water quality benefits of reducing the erosion.

SW-11-KFRD

Project: SW-11-KFRD	**Project Summary**
Location	69 & 71 Kibbe Farm Road
Land Ownership	Private Road/ Driveway
Landowner Support/ Communication	None
BMP Type	Stormwater/ Driveway
Calculated P Reduction	*0.11 lb/yr*
Estimated Project Cost	*$ 2,500-5,000*
P Efficiency ($/lb removed)	*$ 20,000-40,000*
Project Priority	*Low*

Site Description: Rill erosion caused by runoff down driveway

Photo 1: Rill erosion caused by runoff down driveway.

Photo 2: Forested area south of the driveway with existing culvert outlet.

BMP Description: Install a water bar or open top culvert to a level spreader to divert water off the driveway and dissipate flow in forested area to the south of the driveway.

WQ Benefits	O&M Requirements	Cost and Constructability	Additional Benefits	Total Score
6	*0*	*6*	*1*	*13*

Additional Project Benefits Description: The project would reduce erosion of a chronic problem area.

Project Comments: The project is assigned a low priority due to the limited water quality benefits of reducing the erosion.

SW-12-LDLN

Project: SW-12-LDLN	**Project Summary**
Location	70 & 86 Lombard Lane
Land Ownership	Private Road/ Agricultural
Landowner Support/ Communication	None
BMP Type	Stormwater
Calculated P Reduction	*8.22 lb/yr*
Estimated Project Cost	*$ 50,000-100,000*
P Efficiency ($/lb removed)	*$ 6,000-12,000*
Project Priority	*High*

Site Description: Runoff with high sediment and nutrient loads from a large agricultural field and road concentrates to a cross-culvert at the bend on Lombard Lane.

Photo 1: Agricultural runoff concentrates to a cross-culvert on Lombard Lane.

Photo 2: Ponded water on Lombard Lane. The Cross-culvert is located at the bend in the road.

BMP Description: Install a constructed wetland at the bend in the road to treat runoff. Consider regenerative stormwater conveyance basins in the channel. Crop planting parallel to contours is recommended. Practices will require some area of the field to be taken out of agricultural production.

WQ Benefits	O&M Requirements	Cost and Constructability	Additional Benefits	Total Score
13	*0*	*2*	*4*	*19*

Additional Project Benefits Description: The project presents an opportunity to treat runoff from a large agricultural field that is highly visible from the water. The area is a chronic problem area, prone to seasonal flooding. The project could be complementary to agricultural best practices that might be implemented on the surrounding field to reduce runoff and soil loss, such as contour plowing.

Project Comments: Project requires significant support/sacrifice from the landowner. High priority due to the large amount of phosphorus.

SW-13-SST

Project: SW-13-SST	**Project Summary**
Location	86 South Street
Land Ownership	Private Road/ Agricultural
Landowner Support/ Communication	Yes
BMP Type	Stormwater
Calculated P Reduction	*2.76 lb/yr*
Estimated Project Cost	*$ 20,000-50,000*
P Efficiency ($/lb removed)	*$ 7,500-15,000*
Project Priority	*Medium*

Site Description: Swale receives stormwater runoff from the Folsom School (mainly rooftop) and from orchard. Drains to large wetland complex to the east where stormwater likely receives more treatment.

Photo 1: Near where ditch enters the tree line, there is space for treatment that would minimize impacts to the orchard's operations.

BMP Description: Install a floodplain bench or flow through wetland. Could install a forebay closer to the road to trap sediment for easier cleanout.

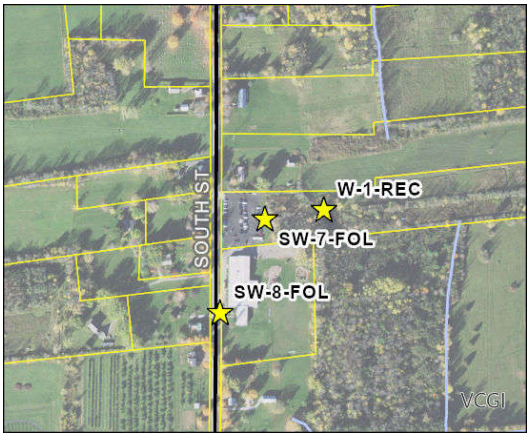
WQ Benefits	O&M Requirements	Cost and Constructability	Additional Benefits	Total Score
12	*0*	*4*	*1*	*17*

Additional Project Benefits Description: Project is compatible with existing agricultural practices.

Project Comments: Orchard owners are supportive of the project, would not interfere with operations. Extensive downstream wetland complex likely minimizes actual water quality benefit for the Lake.

W-1-REC

Project: W-1-REC	**Project Summary**
Location	65 South Street
Land Ownership	Town Land
Landowner Support/ Communication	Yes
BMP Type	Wetland
Calculated P Reduction	*0 lb/yr*
Estimated Project Cost	*$ 5,000-10,000*
P Efficiency ($/lb removed)	*N/A*
Project Priority	*Low*



Site Description: Town-owned parcel with trails. Parts of the wetland are dominated by Phragmites, especially around the manmade fire pond.

Photo 1: Fire pond surrounded by wetland. Invasive phragmites is visible in the background.

BMP Description: Explore wetland restoration opportunities. This may include vegetation management to reduce invasives or restoring the wetland within the pond if it is no longer used.

WQ Benefits	O&M Requirements	Cost and Constructability	Additional Benefits	Total Score
2	*0*	*5*	*2*	*9*

Additional Project Benefits Description: The project presents an opportunity to implement a wetland restoration practices in a high visibility area. The project could provide an educational opportunity for school children and the broader community to learn about wetlands and wetland restoration.

Project Comments: The project is assigned a low priority due to the limited calculable water quality benefits of enhancing wetland vegetation and the potential infrastructure conflict with the area's use as a fire pond (e.g., may require periodic dredging).

APPENDIX E

30% Conceptual Designs (11”x17”)

Fitzgerald Environmental Associates, LLC
164 Main Street, Suite 2
Colchester, VT 05446
Telephone: 802.876.7778
www.fitzgeraldenvironmental.com

30% CONCEPTUAL DESIGN
PROJECT SW-2-VTFW
VT FISH & WILDLIFE ACCESS
SOUTH HERO, VT
KEELER BAY LAKE WATERSHED ACTION PLAN

AEM DRAWN	JHB CHECKED
1" = 20' SCALE	
2023-12-12 DATE	
22016 PROJECT NO.	
1 OF 12 SHEET NO.	
SW-2-PR SHEET NAME	

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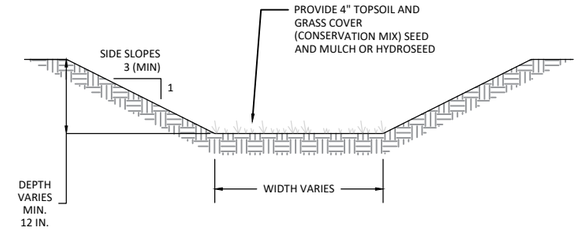
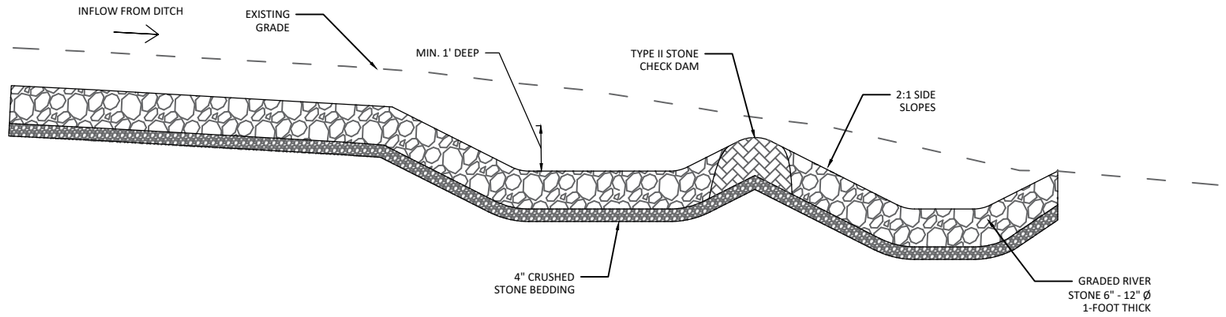
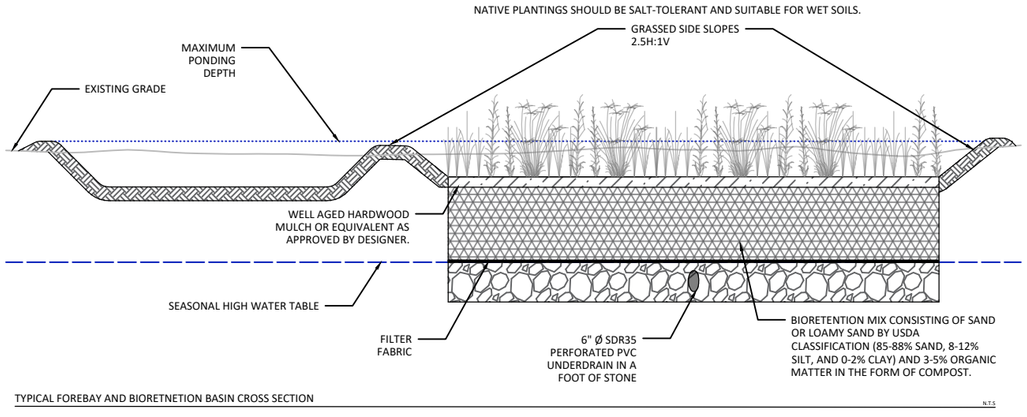


VEGETATED SWALE N.T.S



TIERED TREATMENT BASIN N.T.S



TYPICAL FOREBAY AND BIORETNETION BASIN CROSS SECTION N.T.S

Preliminary Cost Opinion

VT F&W Boat Launch

Item	Quantity	Unit	Unit Price	Cost
Mobilization/Demobilization	1	LS	$ 2,000	$ 2,000
Clean Ditch	100	LF	$ 15	$ 1,500
Common Excavation and Trucking	75	CY	$ 50	$ 3,750
Stone for Tiered Treatment Basin, Placed	20	CY	$ 50	$ 1,000
Topsoil/Compost	10	CY	$ 60	$ 600
Mulch	2	CY	$ 60	$ 120
Plantings	50	EA	$ 25	$ 1,250
Laborer	40	HR	$ 45	$ 1,800
Basin Outlet Structure	1	LS	$ 500	$ 500
Driveway Culvert	1	LS	$ 3,000	$ 3,000
Misc. Erosion Control/Restoration	1	LS	$ 2,000	$ 2,000
Final Design & Permitting				$ 10,000
Construction Oversight				$ 2,500
			Subtotal	$ 30,020
			Contingency (20%)	$ 6,000
			Total	**$ 36,020**

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30% CONCEPTUAL DESIGN
PROJECT SW-2-VTFW
VT FISH & WILDLIFE ACCESS
SOUTH HERO, VT
KEELER BAY LAKE WATERSHED ACTION PLAN

DRAWN	CHECKED
AEM	JHB

SCALE: AS SHOWN
DATE: 2023-12-12
PROJECT NO.: 22016
SHEET NO.: 2 OF 12
SHEET NAME: SW-2-D

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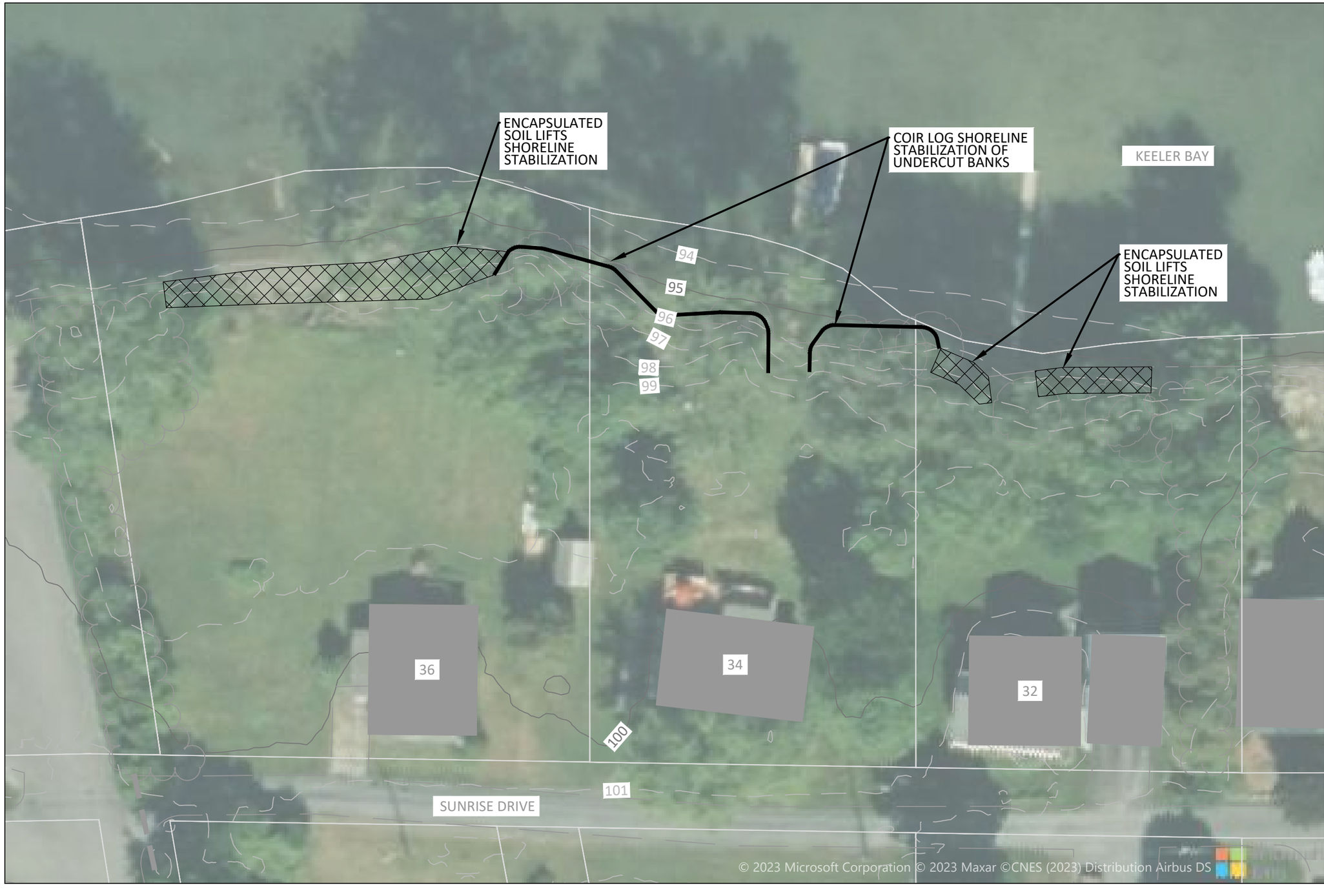

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30% CONCEPTUAL DESIGN
PROJECT L-2-SUN
SUNRISE DRIVE (32, 34, 36)
SOUTH HERO, VT
KEELER BAY LAKE WATERSHED ACTION PLAN

DRAWN	CHECKED
AEM	JHB

SCALE	1" = 30'
DATE	2023-12-12
PROJECT NO.	22016
SHEET NO.	3 OF 12
SHEET NAME	L-2-PR

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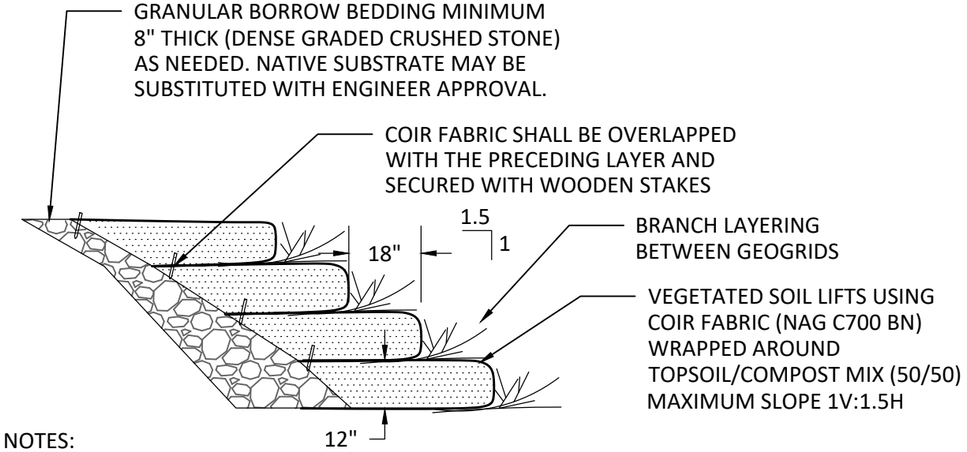
Preliminary Cost Opinion

Sunrise Drive Shoreline Stabilization

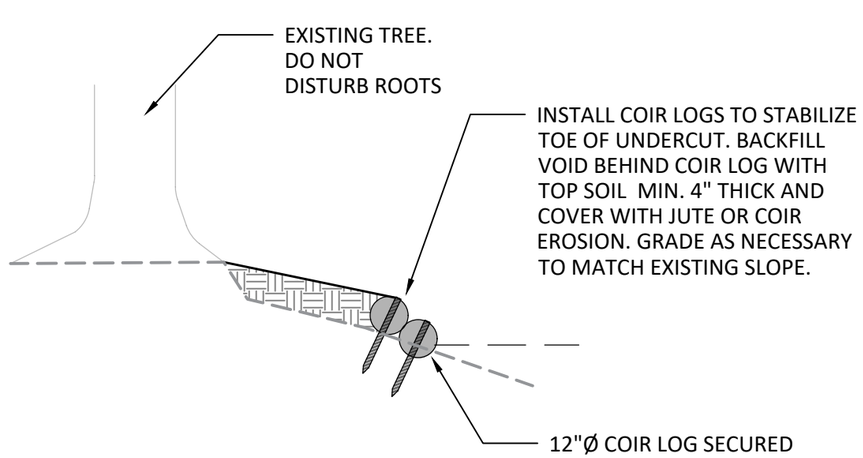
Item	Quantity	Unit	Unit Price	Cost
Mobilization/Demobilization	1	LS	$ 1,000	$ 1,000
Coir Log	1000	LF	$ 15	$ 15,000
Rebar / Stakes	1	LS	$ 2,500	$ 2,500
Topsoil	35	CY	$ 60	$ 2,100
Plantings	1	LS	$ 4,000	$ 4,000
Excavation and Trucking (Slope Grading)	60	CY	$ 50	$ 3,000
Vegetated Soil Lifts	170	LF	$ 50	$ 8,500
Laborer	96	HR	$ 45	$ 4,320
Seed Mixes	1	LS	$ 500	$ 500
Turbidity Curtain	1	LS	$ 1,000	$ 1,000
Stabilized Shoreline Steps	3	LS	$ 1,000	$ 3,000
Misc. Erosion Control/Restoration	1	LS	$ 3,000	$ 3,000
Final Design & Permitting				$ 10,000
Construction Oversight				$ 2,500
			Subtotal	$ 60,420
			Contingency (20%)	$ 12,080
			Total	**$ 72,500**



NOTES:

1. COIR MATTING SHALL BE BIODEGRADABLE AND MADE OF 100% WOVEN COIR FABRIC.
2. MATTING SHALL HAVE A MINIMUM WIDTH OF 2 METERS (6.5 FEET) TO FACILITATE BUILDING OF STACKED GEOGRID LAYERS ON STREAM BANKS.
3. MATTING FOR GEOGRID LAYERS SHALL BE SECURED WITH WOODEN STAKES ON LOWER AND UPPER LAYERS. STAKE SPACING SHALL NOT EXCEED 3 FEET IN THE WIDTH DIMENSION OR 8 FEET IN THE LENGTH DIMENSION.
4. COIR MATTING SHALL BE NORTH AMERICAN GREEN BIONET C700BN (HTTPS://NAGREEN.COM/EROSION-CONTROL-PRODUCTS/ROLLMAX/ERONET) OR EQUAL.
5. STEMS USED FOR BRANCH LAYERING SHALL HAVE A MINIMUM BASE DIAMETER OF ½ INCH, MINIMUM LENGTH OF 4 FEET, AND SHALL BE INSTALLED AT A MINIMUM DENSITY OF 3 STEMS PER LINEAR FOOT ALONG THE BANK.

SHORELINE STABILIZATION WITH COIR MATTING N.T.S



SHORELINE STABILIZATION WITH COIR LOGS N.T.S

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30% CONCEPTUAL DESIGN
PROJECT L-2-SUN
SUNRISE DRIVE (32, 34, 36)
SOUTH HERO, VT
KEELER BAY LAKE WATERSHED ACTION PLAN

AEM DRAWN	JHB CHECKED
AS SHOWN SCALE	
2023-12-12 DATE	
22016 PROJECT NO.	
4 OF 12 SHEET NO.	
L-2-D SHEET NAME	

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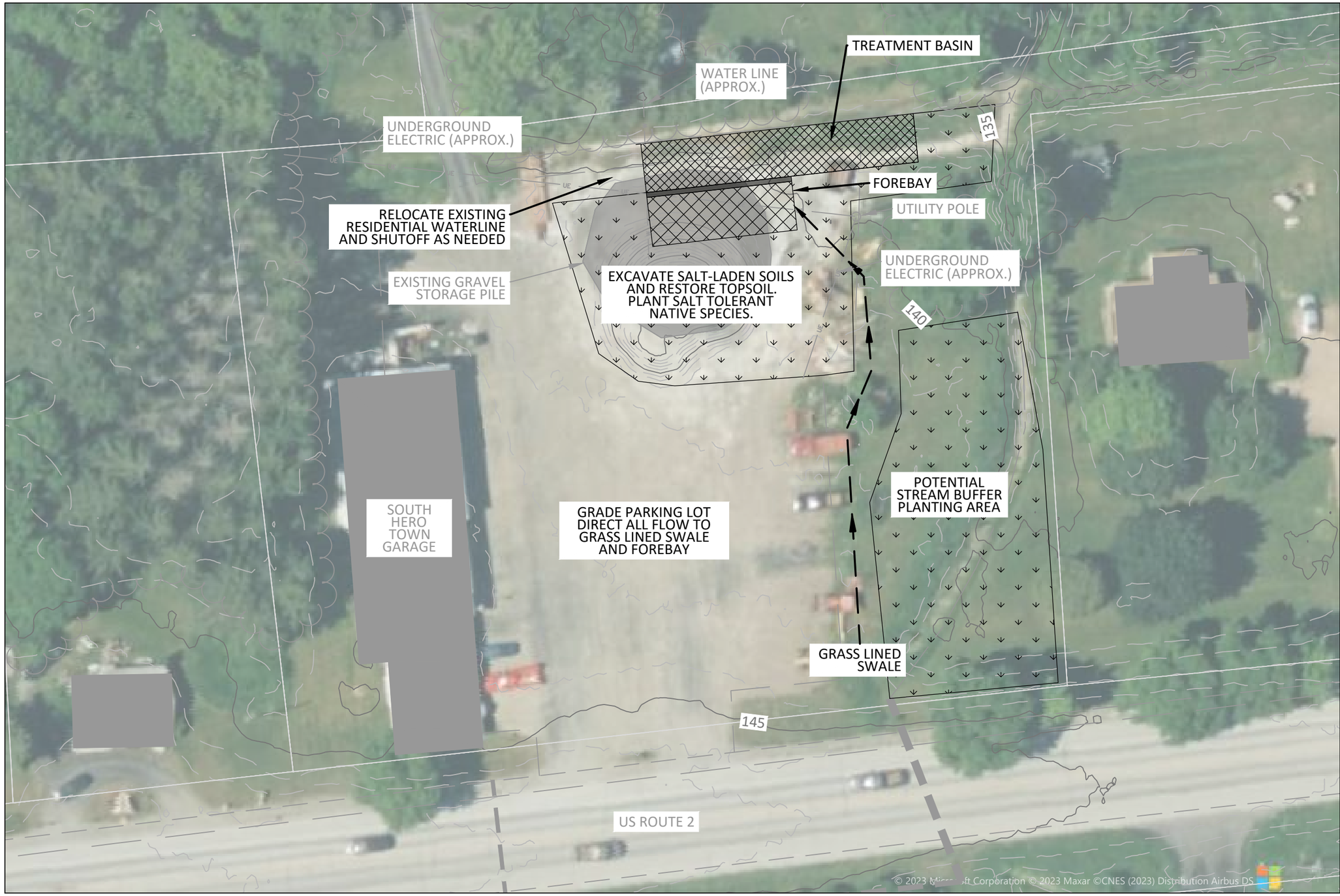

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30% CONCEPTUAL DESIGN

PROJECT SW-6-GAR
TOWN GARAGE - 286 ROUTE 2
SOUTH HERO, VT

KEELER BAY LAKE WATERSHED ACTION PLAN

AEM (DRAWN)	JHB (CHECKED)
SCALE	1" = 40'
DATE	2023-12-12
PROJECT NO.	22016
SHEET NO.	5 OF 12
SHEET NAME	SW-6-PR

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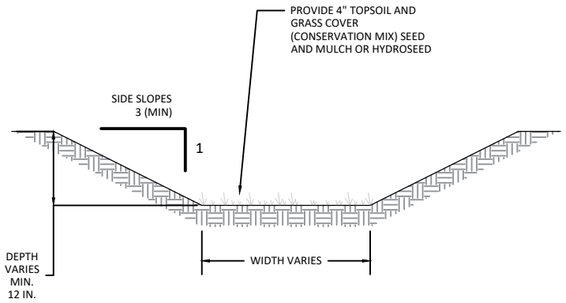
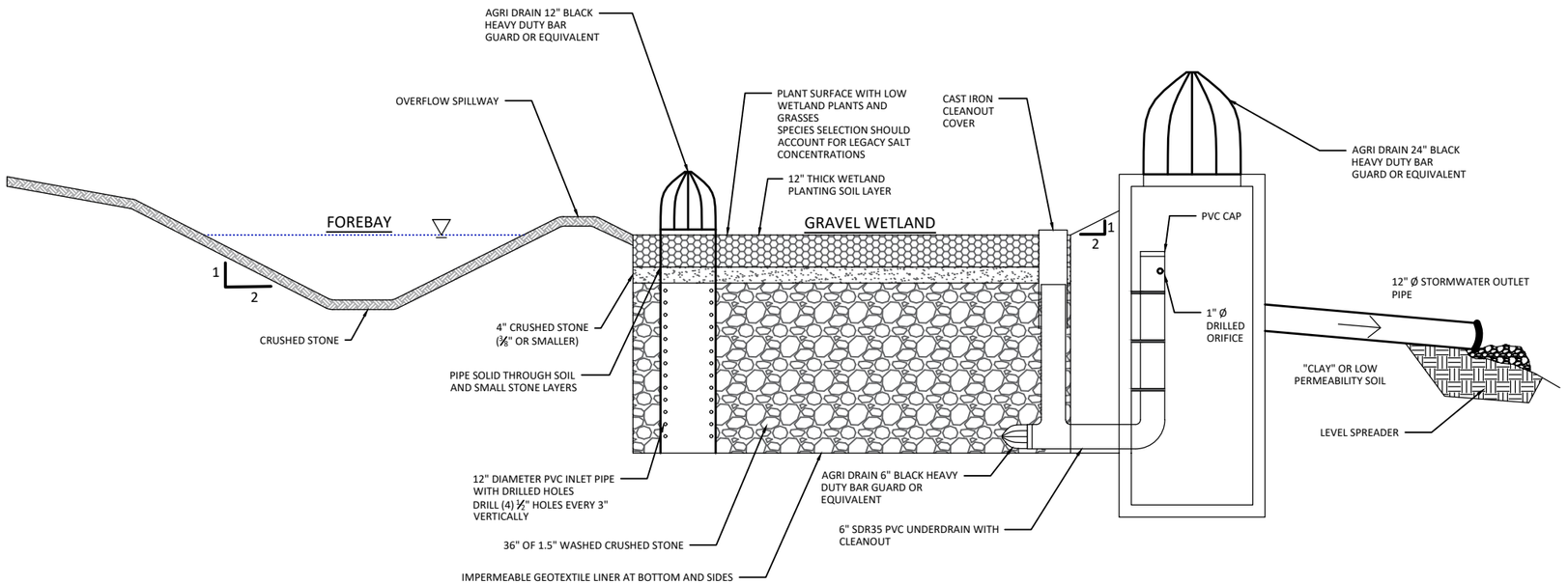


VEGETATED SWALE N.T.S

Preliminary Cost Opinion

Town Garage - Gravel Wetland

Item	Quantity	Unit	Unit Price	Cost
Mobilization/Demobilization	1	LS	$ 1,000	$ 1,000
Common Excavation and Soil Amendment	800	CY	$ 20	$ 16,000
Trucking	800	CY	$ 15	$ 12,000
Pipe and Outlet Structure	1	LS	$ 5,000	$ 5,000
1-1/2" Crushed Stone	350	CY	$ 50	$ 17,500
3/8" Crushed Stone	40	CY	$ 50	$ 2,000
Topsoil/Compost	120	CY	$ 50	$ 6,000
Plantings	300	EA	$ 15	$ 4,500
Misc. Erosion Control	1	LS	$ 2,000	$ 2,000
Final Design				$ 10,000
Construction Oversight				$ 2,500
			Subtotal	$ 78,500
			Contingency (20%)	$ 15,700
			Total	**$ 94,200**



GRAVEL WETLAND TYPICAL DETAIL N.T.S

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30% CONCEPTUAL DESIGN
PROJECT SW-6-GAR
TOWN GARAGE - 286 ROUTE 2
SOUTH HERO, VT
KEELER BAY LAKE WATERSHED ACTION PLAN

AEM DRAWN	JHB CHECKED
AS SHOWN SCALE	
2023-12-12 DATE	
22016 PROJECT NO.	
6 OF 12 SHEET NO.	
SW-6-D SHEET NAME	

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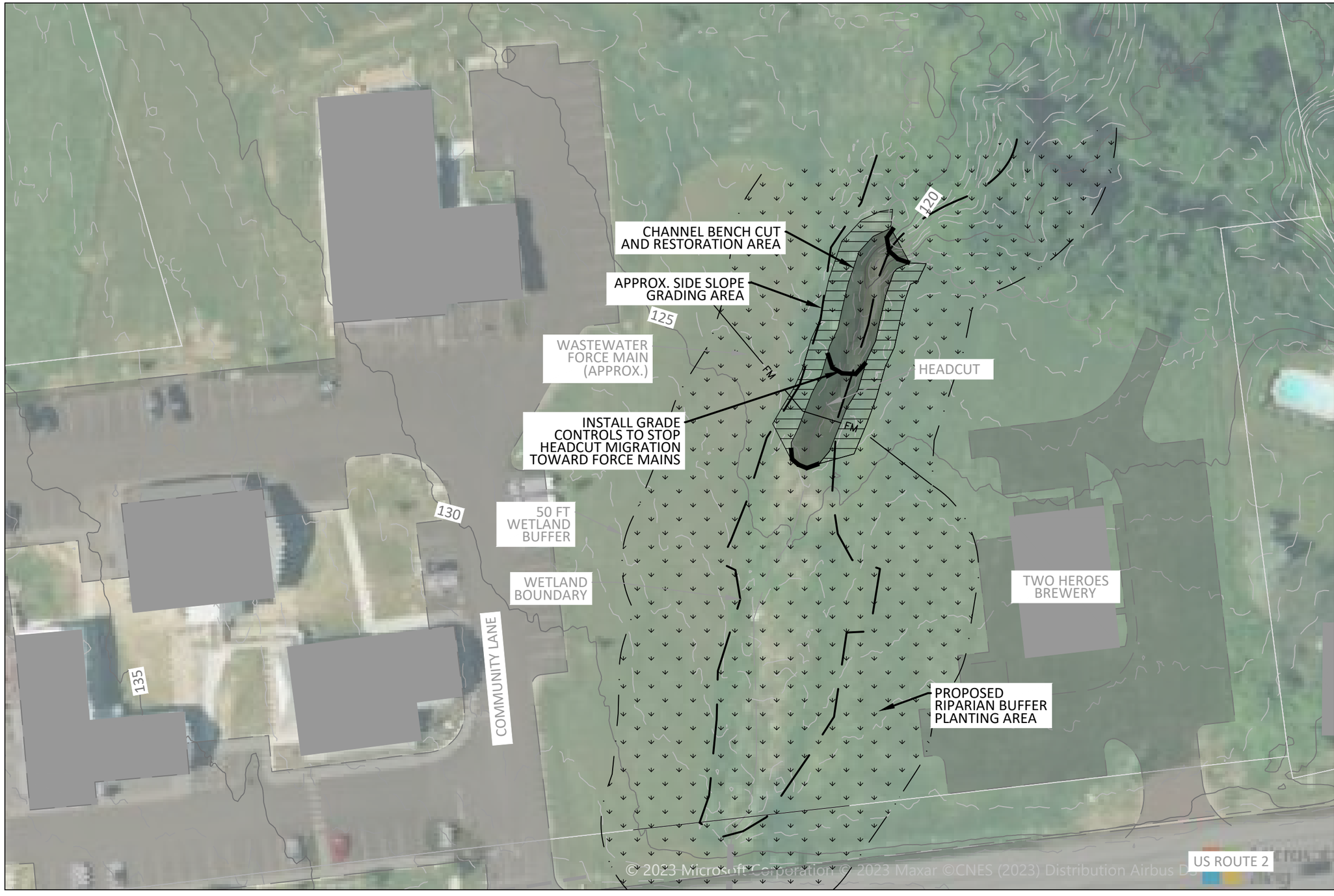

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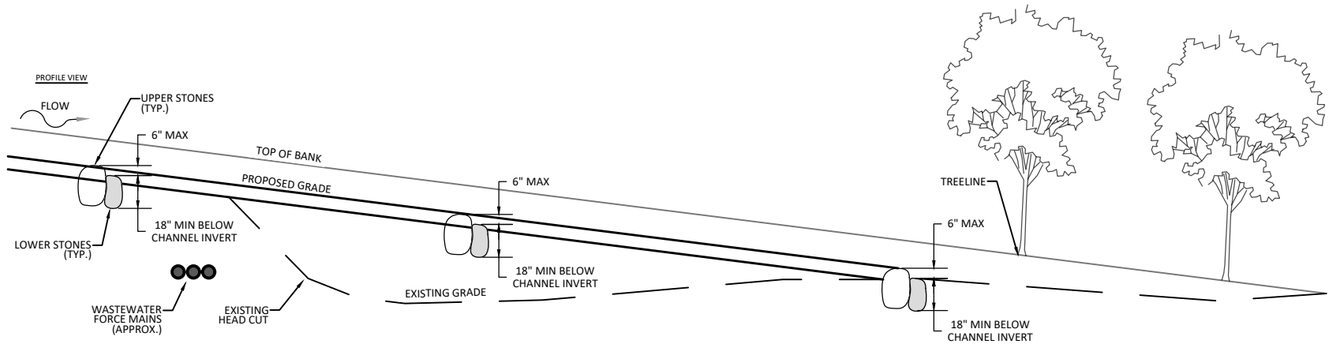
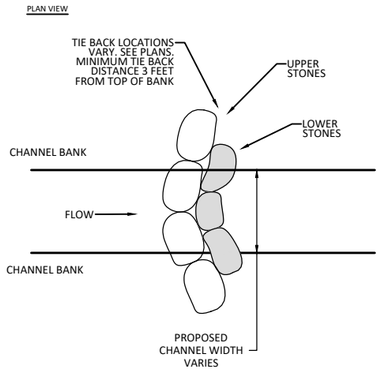
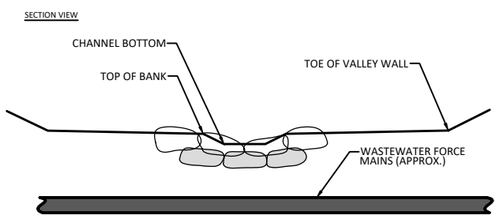
30% CONCEPTUAL DESIGN
PROJECT ST-5
COMMUNITY LANE COMPLEX
SOUTH HERO, VT

KEELER BAY LAKE WATERSHED ACTION PLAN

AEM DRAWN	JHB CHECKED
1" = 50' SCALE	
2023-12-12 DATE	
22016 PROJECT NO.	
7 OF 12 SHEET NO.	
ST-5-PR SHEET NAME	



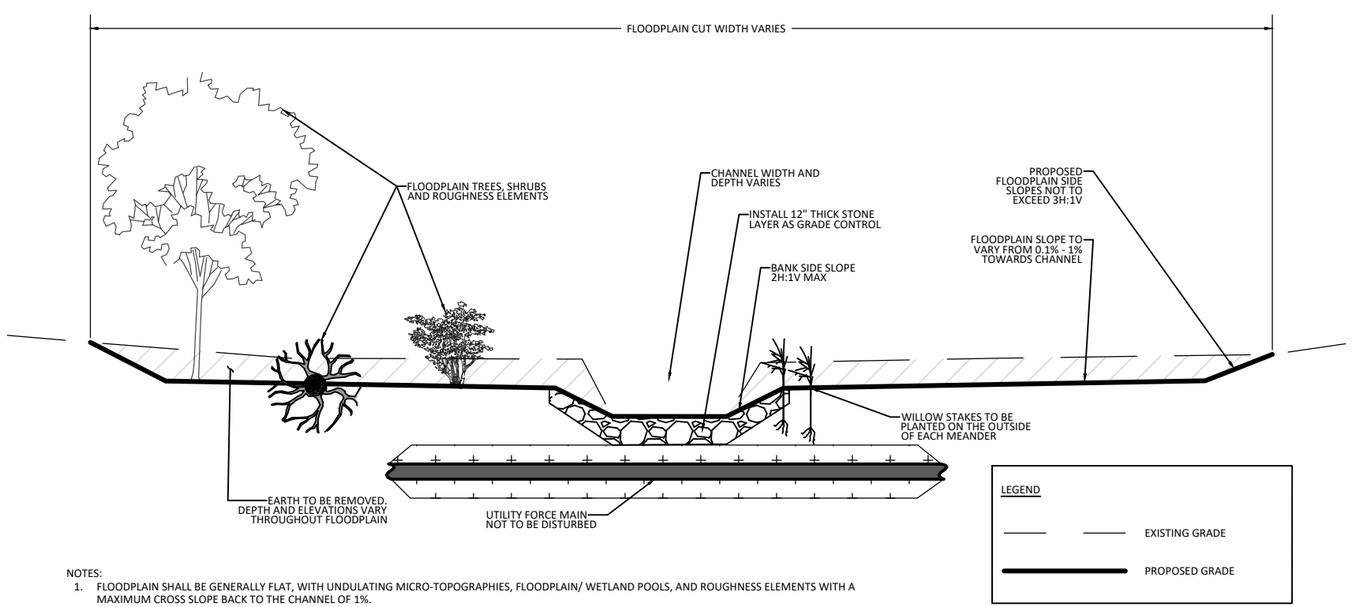




NOTES:
1. STONE SHALL BE A MINIMUM DIAMETER OF 24 INCHES AND LENGTH OF 36 INCHES.
2. UPPER STONES SHALL BE ELEVATED NO MORE THAT 6" ABOVE THE EXISTING CHANNEL BOTTOM.
3. STONES SHALL BE TIED BACK INTO CHANNEL BANKS AT LEAST 3 FEET EMBEDDED ON BOTH BANKS.
4. UPPER STONES SHALL BE LOWER IN CHANNEL CENTER TO CENTER THE FLOW OF WATER.

ROCK WEIR GRADE CONTROL

N.T.S



NOTES:
1. FLOODPLAIN SHALL BE GENERALLY FLAT, WITH UNDULATING MICRO-TOPOGRAPHIES, FLOODPLAIN/ WETLAND POOLS, AND ROUGHNESS ELEMENTS WITH A MAXIMUM CROSS SLOPE BACK TO THE CHANNEL OF 1%.

TYPICAL CHANNEL AND FLOODPLAIN CROSS SECTION

N.T.S

Preliminary Cost Opinion

Community Lane Complex Channel Restoration

Item	Quantity	Unit	Unit Price	Cost
Mobilization/Demobilization	1	LS	$ 1,000	$ 1,000
Common Excavation and Soil Amendment	400	CY	$ 25	$ 10,000
Trucking	400	CY	$ 20	$ 8,000
Grade Control Structure	3	LS	$ 1,500	$ 4,500
Plantings	60	EA	$ 15	$ 900
Misc. Erosion Control	1	LS	$ 3,000	$ 3,000
Final Design/Permitting				$ 15,000
Construction Oversight				$ 4,000
			Subtotal	$ 46,400
			Contingency (20%)	$ 9,280
			Total	**$ 55,680**

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30% CONCEPTUAL DESIGN
PROJECT ST-5
COMMUNITY LANE COMPLEX
SOUTH HERO, VT
KEELER BAY LAKE WATERSHED ACTION PLAN

AEM DRAWN	JHB CHECKED
AS SHOWN SCALE	
2023-12-12 DATE	
22016 PROJECT NO.	
8 OF 12 SHEET NO.	
ST-5-D SHEET NAME	

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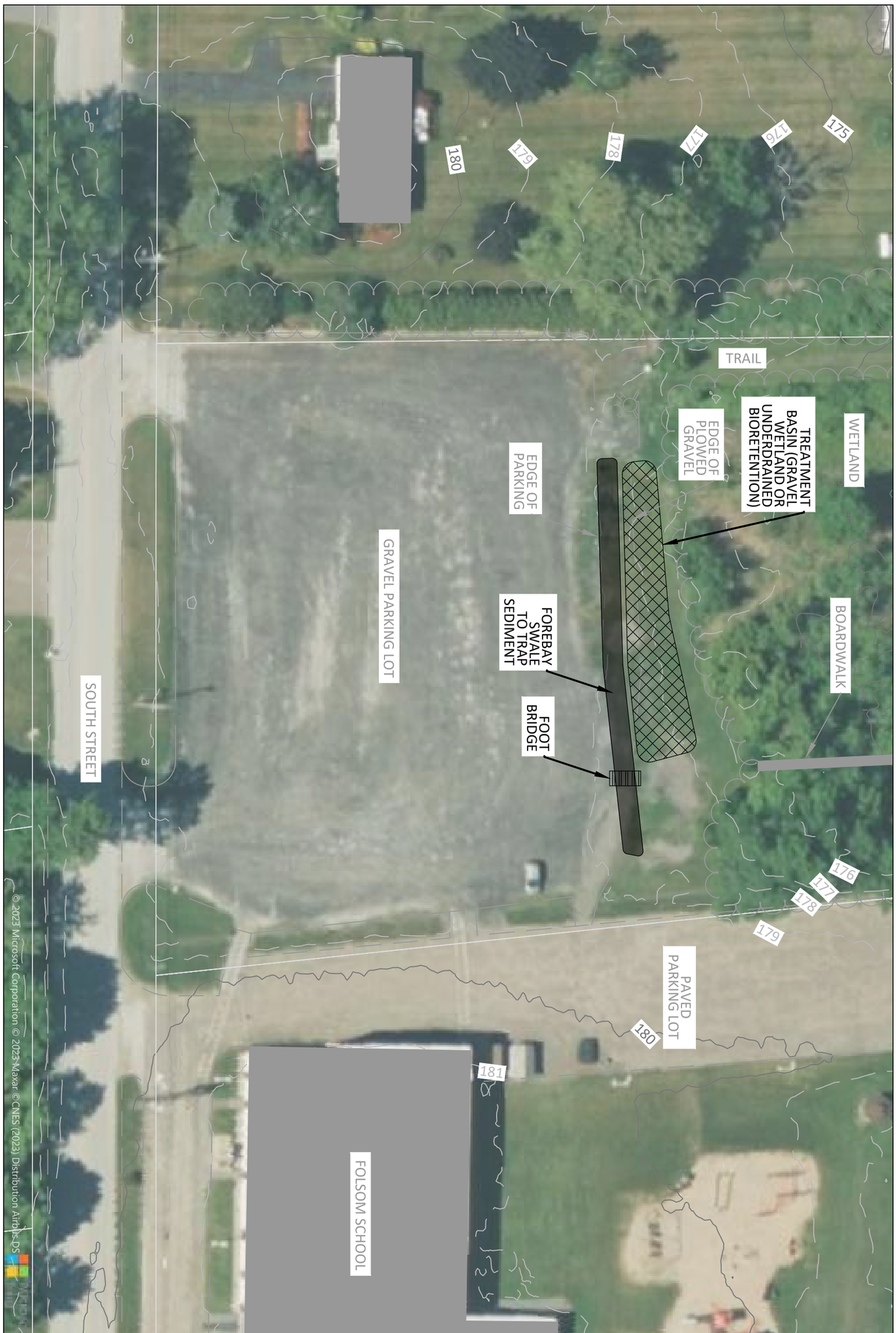

30% CONCEPTUAL DESIGN

PROJECT SW-7-FOL
65 SOUTH STREET
SOUTH HERO, VT

KEELER BAY LAKE WATERSHED ACTION PLAN

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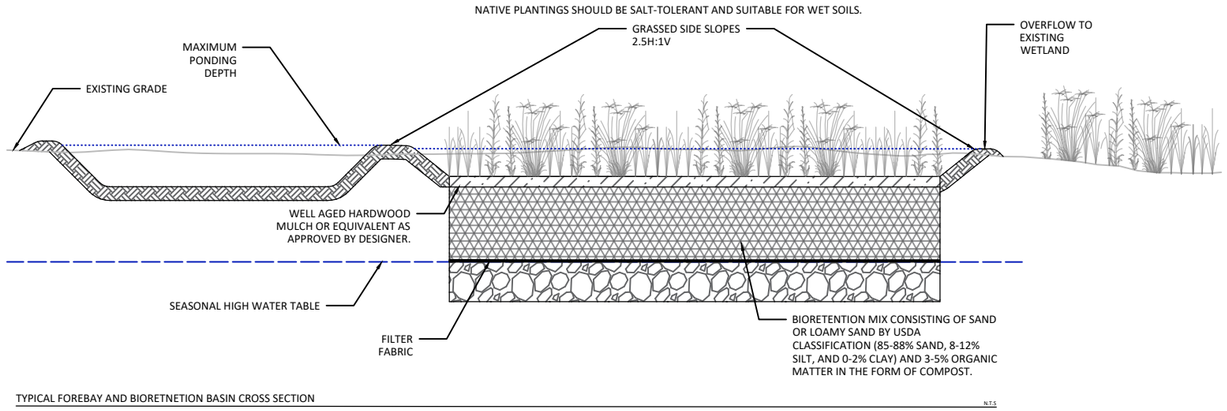
DRAWN	AEM
CHECKED	JHB
SCALE	1" = 40'
DATE	2023-12-12
PROJECT NO.	22016
SHEET NO.	9 OF 12
SHEET NAME	SW-7-PR

Preliminary Cost Opinion

Folsom School Rain Garden / Bioretention

Item	Quantity	Unit	Unit Price	Cost
Mobilization/Demobilization	1	LS	$ 1,000	$ 1,000
Common Excavation and Soil Amendment	300	CY	$ 25	$ 7,500
Trucking	300	CY	$ 20	$ 6,000
Perforated Pipe	150	LF	$ 5	$ 750
3-4" Clean Stone	50	CY	$ 50	$ 2,500
Topsoil/Compost	30	CY	$ 50	$ 1,500
Mulch	20	CY	$ 60	$ 1,200
Plantings	30	EA	$ 15	$ 450
Foot Bridge	1	LS	$ 1,000	$ 1,000
Misc. Erosion Control	1	LS	$ 1,000	$ 1,000
Final Design				$ 10,000
Construction Oversight				$ 2,500
			Subtotal	$ 35,400
			Contingency (20%)	$ 7,080
			Total	**$ 42,480**



TYPICAL FOREBAY AND BIORETNETION BASIN CROSS SECTION N.T.S

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30% CONCEPTUAL DESIGN

PROJECT SW-7-FOL
65 SOUTH STREET
SOUTH HERO, VT

KEELER BAY LAKE WATERSHED ACTION PLAN

AEM DRAWN	JHB CHECKED
AS SHOWN SCALE	
2023-12-12 DATE	
22016 PROJECT NO.	
10 OF 12 SHEET NO.	
SW-7-D SHEET NAME	

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30% CONCEPTUAL DESIGN
PROJECT SW-12-LDLN
LOMBARD LANE
SOUTH HERO, VT
KEELER BAY LAKE WATERSHED ACTION PLAN

AEM (DRAWN)	JHB (CHECKED)
1" = 50' (SCALE)	
2023-12-12 (DATE)	
22016 (PROJECT NO.)	
11 OF 12 (SHEET NO.)	
SW-12-PR (SHEET NAME)	

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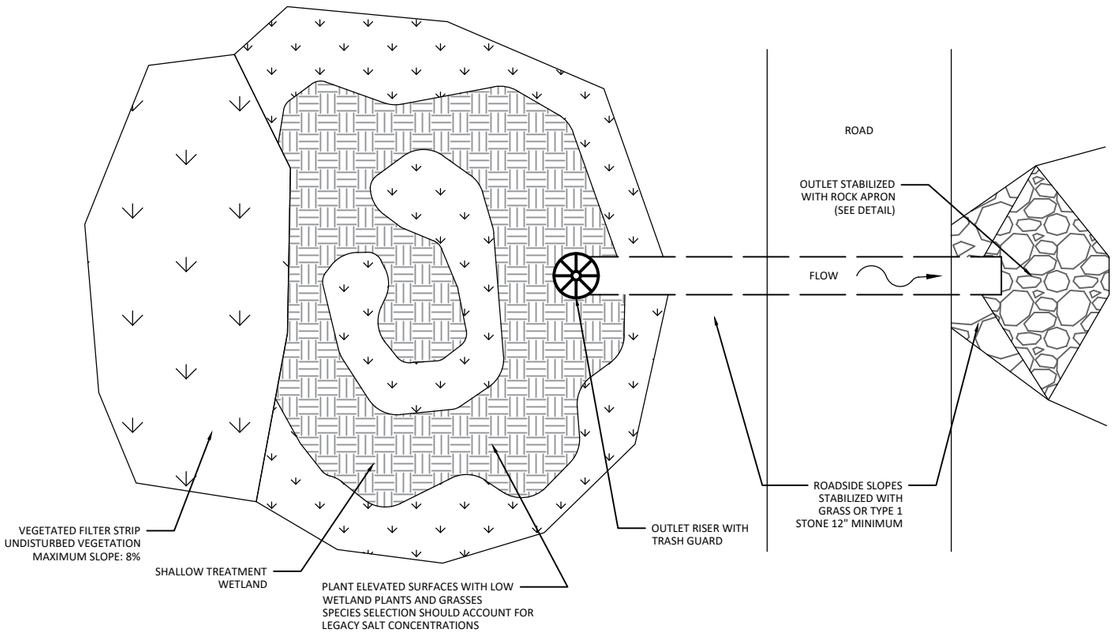
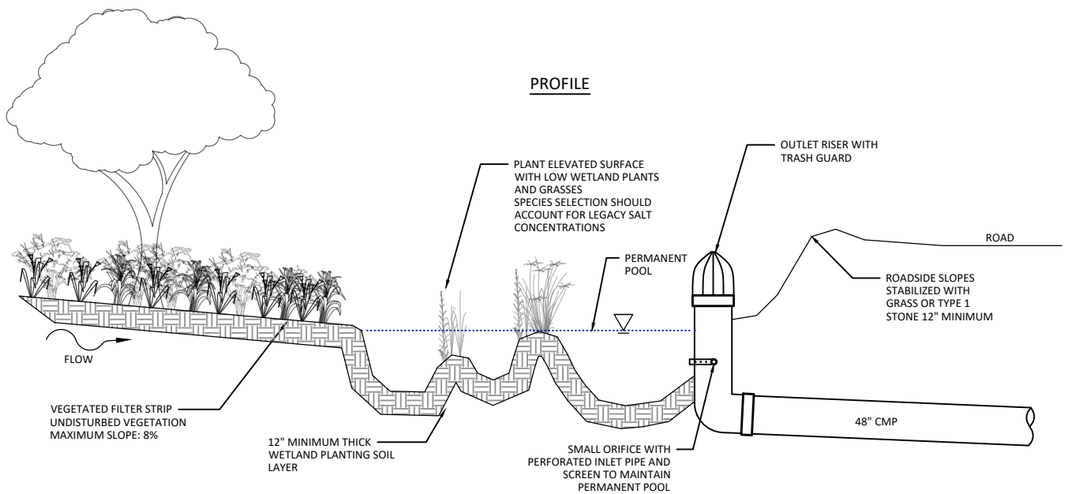
PLAN



PROFILE



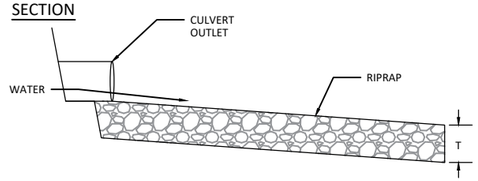
VEGETATED FILTER STRIP TO SHALLOW TREATMENT WETLAND WITH ROAD CULVERT RISER N.T.S

Preliminary Cost Opinion

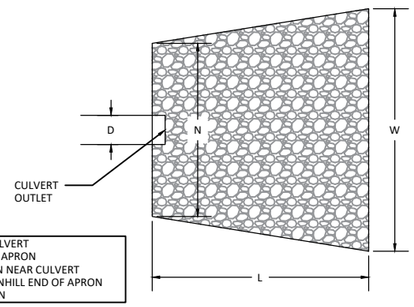
Lombard Lane Treatment Basin

Item	Quantity	Unit	Unit Price	Cost
Mobilization/Demobilization	1	LS	$ 1,000	$ 1,000
Common Excavation and Soil Amendment	300	CY	$ 25	$ 7,500
Trucking	300	CY	$ 20	$ 6,000
Perforated Pipe	5	LF	$ 5	$ 25
3-4" Clean Stone	20	CY	$ 50	$ 1,000
Topsoil/Compost	200	CY	$ 50	$ 10,000
Plantings	400	EA	$ 15	$ 6,000
Wetland Seed Mix	1	LS	$ 500	$ 500
Outlet Structure	1	LS	$ 3,000	$ 3,000
48" Cross Culvert	1	LS	$ 4,000	$ 4,000
Coarse Stone	40	CY	$ 50	$ 2,000
Misc. Erosion Control	1	LS	$ 3,000	$ 3,000
Final Design				$ 15,000
Construction Oversight				$ 5,000
			Subtotal	$ 64,025
			Contingency (20%)	$ 12,805
			Total	**$ 76,830**

SECTION



PLAN



D = DIAMETER OF CULVERT
T = DEPTH OF STONE APRON
N = WIDTH OF APRON NEAR CULVERT
W = WIDTH AT DOWNHILL END OF APRON
L = LENGTH OF APRON

ROCK APRON SPECIFICATIONS					
CULVERT DIAMETER (D)	RIPRAP SIZE	T (in.)	N (ft.)	W (ft.)	L (ft.)
18 INCHES	3-12 INCH	18	4.5	14.5	10
24 INCHES	3-12 INCH	18	6	20	14

ROCK APRON N.T.S

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30% CONCEPTUAL DESIGN
PROJECT SW-12-LDLN
LOMBARD LANE
SOUTH HERO, VT

KEELER BAY LAKE WATERSHED ACTION PLAN

AEM DRAWN	JHB CHECKED
AS SHOWN SCALE	
2023-12-12 DATE	
22016 PROJECT NO.	
12 OF 12 SHEET NO.	
SW-12-D SHEET NAME	