Watershed Action Plan
Lake Elmore Watershed
Elmore, Vermont

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DRAFT FOR REVIEW

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1.0 Introduction

The Lake Elmore watershed is located in Lamoille County, Vermont, and drains a portion of the Town of Elmore. In the summer of 2018, stakeholders representing the Town of Elmore, the Lake Elmore Association (LEA), the Vermont Agency of Natural Resources (VTANR), and the Lamoille County Conservation District (LCCD) began discussing concerns over water quality in Lake Elmore and initiated the process of securing funding for a Watershed Action Plan. In 2019 LCCD received grant funding from the VTANR Clean Water Fund (2019-CWF-S-3-13) to conduct shoreline and stormwater assessments and develop a water quality restoration plan for the Lake Elmore watershed.

LCCD hired Fitzgerald Environmental Associates (FEA) in 2019 to assist with the development of the watershed assessment and accompanying project prioritization and concept designs. The Lake Elmore Watershed Action Plan generally follows the VT ANR Stormwater Master Planning (SWMP) guidelines 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). In addition, given the need to evaluate water quality impacts from the shoreland zone, shoreline assessments were completed by LCCD and VTANR in conjunction with LEA volunteers. The Watershed Action Plan was developed over the course of 2019 and 2020 through extensive field work, interaction with multiple stakeholders from the Town of Elmore, LEA, VT ANR, and LCCD to identify and prioritize projects, and follow-up analysis and design work.

1.1 Watershed and Planning Background

The goal of the Lake Elmore Watershed Action Plan was to identify and evaluate water quality stressors to Lake Elmore, and to identify projects to mitigate inputs of sediments and nutrients. Environmental concerns and stressors identified by the group of stakeholders included channel erosion, road/ditch erosion, lakeshore encroachment, invasive species, soil erosion, nutrient loading, and thermal stress. 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.

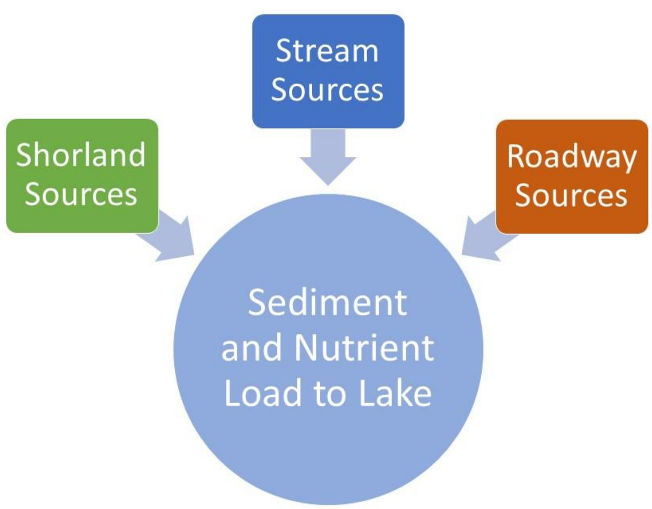

Figure 1: Conceptual diagram of primary water quality stressors on Lake Elmore.

1.2 Lake Elmore Project Goals

The goal of this project was to evaluate the Lake Elmore 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.

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 at least 30 projects and to create conceptual designs (roughly 30% design) for at least five projects.

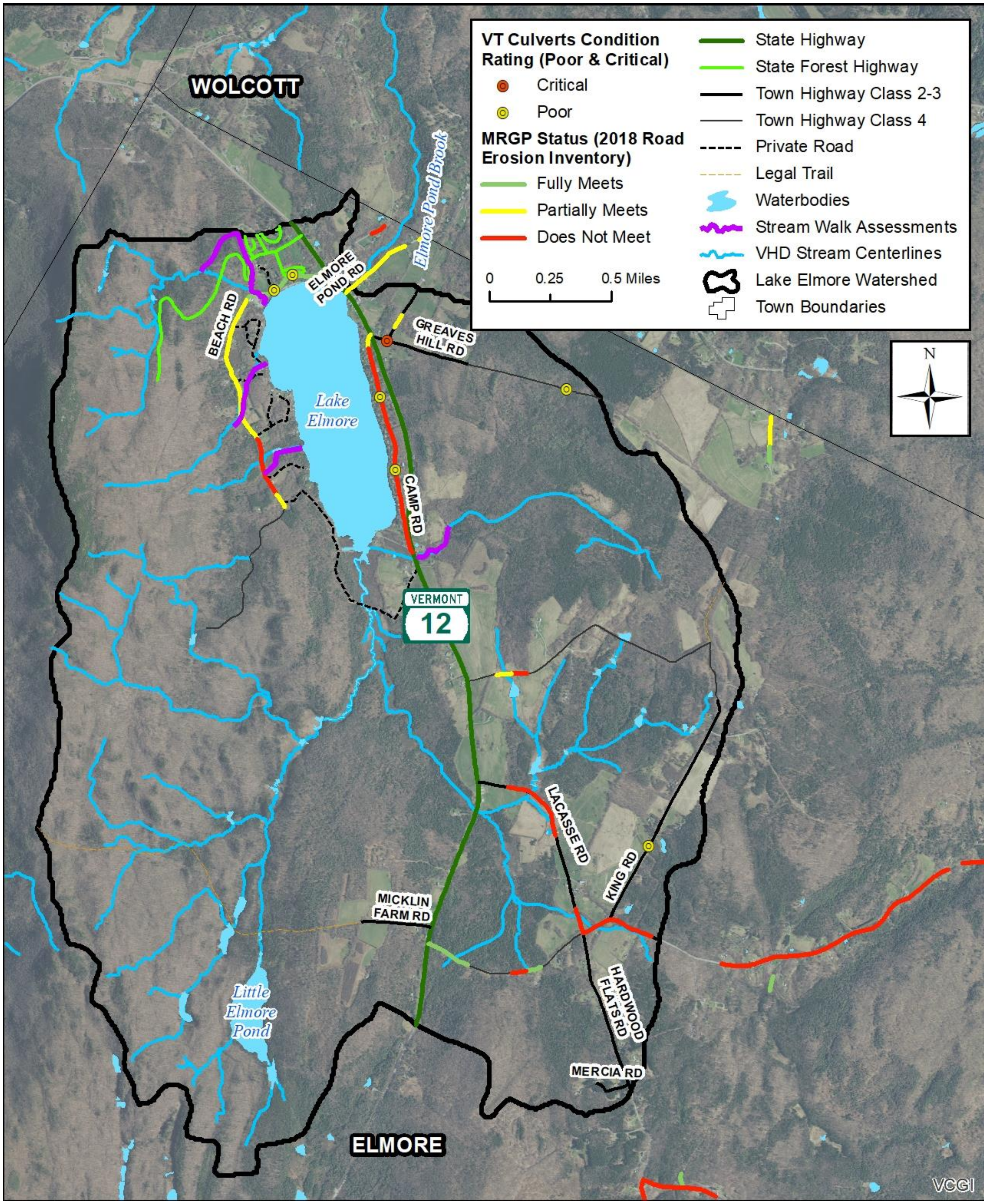

Figure 2: Lake Elmore watershed study area

2.0 Study Area Description

Lake Elmore is a 222-acre lake located in the Town of Elmore, VT (Figure 3). The contributing watershed area is approximately 8.4 square miles located in the Town of Elmore. Elmore is a small town, with a population of 855 according to the 2010 census (U.S. Census Bureau, 2011). The Lake Elmore watershed is part of the headwaters of the Lamoille River.

There are 19.5 miles of roads in the Lake Elmore Watershed (Table 1), made up of state forest highways (10%), legal trails (10%), private roads (12%), town highways (49%), and state highways (28%). Road distances are based on road centerline data from VTrans (2017). Land cover data based on imagery from 2016 National Land Cover Database (Yang et al., 2018) are summarized in Table 2. The Lake Elmore watershed is predominantly forested. Development is concentrated along Route 12 and Beach and Camp Road around the lake.

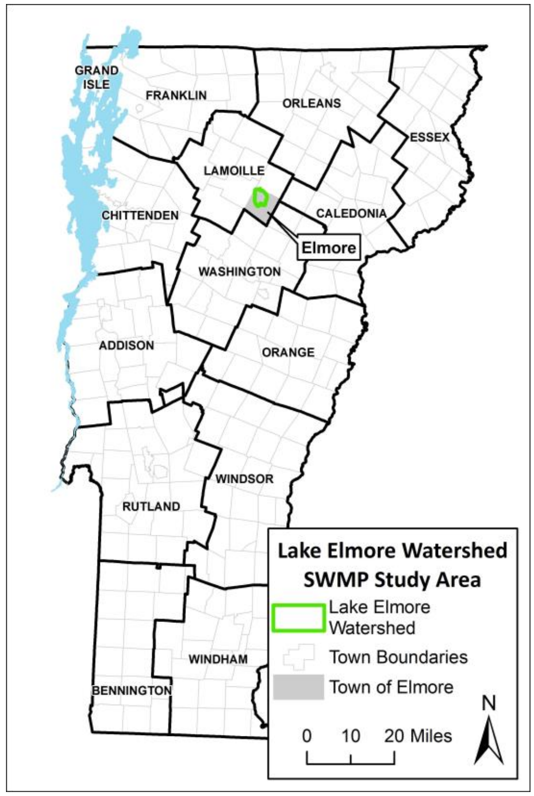

Figure 3: Lake Elmore watershed study area location map.

Table 1: Road length by AOT class in the Lake Elmore Watershed (VTrans, 2017)

AOT Class	Description	Length (miles)	% of Watershed Road Length
2	Class 2 Town Highway	1.2	6
3	Class 3 Town Highway	5.0	26
4	Class 4 Town Highway	3.4	17
5	State Forest Highway	2.0	10
7	Legal Trail	1.9	10
8	Private Road	2.4	12
30	Vermont State Highway	3.5	18

Table 2: Land cover in the Lake Elmore Watershed.

Land Cover/Land Use Type	% of Watershed
Open water	4.6
Developed	4.7
Barren land	< 0.1
Forest	72.9
Shrub/scrub	0.8
Grasslands/herbaceous	0.5
Pasture Hay	8.5
Cultivated crops	< 0.1
Wetlands	8.0

The Protected Shoreland Area defined by the VT DEC applies to land within 250' feet of the mean water level of a lake greater than 10 acres in size (Figure 4). The shoreland zone around Lake Elmore has a relatively high level of development in the form of impervious surfaces (i.e., buildings, roads, and driveways) and developed pervious areas (i.e., lawns). Compared to other lakes where we have used the Watershed Action Plan/Stormwater Master Plan approach, Lake Elmore has the highest percentage of impervious surfaces and grass/shrubland based on the high resolution land cover and impervious mapping from UVM (2016). The grass/shrubland category includes wetland areas that may be naturalized, but even after accounting for these areas Lake Elmore still has the highest shoreland percent cover of grass of the lakes listed below (Table 3).

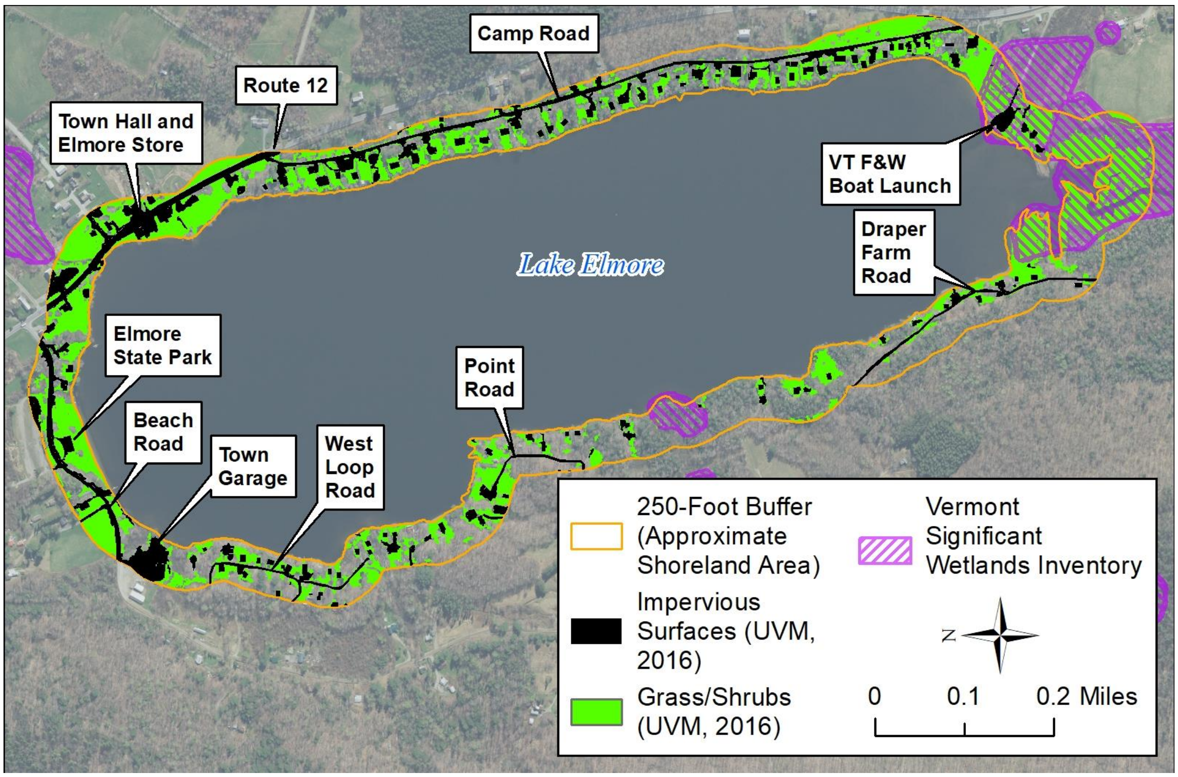

Figure 4: Shoreland land cover around Lake Elmore (UVM, 2016).

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.)	Lake Area (acres)	Lake Perimeter (miles)	UVM Land Cover in 250-Foot Buffer (Approximate Shoreland Area)		
				Tree Canopy	Grass/ Shrubs	Impervious
Lake Elmore	**8.4**	**222**	**3.3**	**50%**	**34%**	**16%**
Fern Lake	0.8	67	2.3	84%	8%	8%
Lake Eden	7.2	198	6.1	65%	22%	13%
Little Lake/Lake St. Catherine	14	1085	16.0	58%	30%	12%
Lake Dunmore	20.8	1040	11.5	74%	14%	12%
Lake Bomoseen	37.5	2415	22.9	61%	26%	13%

3.0 Watershed Data Library

We began our assessment efforts by gathering and reviewing information and documentation related to information and documentation related to lake and shoreland conditions, stormwater runoff, and watershed management within the Lake Elmore 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**
  - Town of Elmore Town Plan - 2018
  - Lamoille County Road Erosion Assessment – 2014
  - LCPC Road Erosion Inventory - 2018
  - LCPC Bridge and Culvert Assessments - 2013
    - Summer 2019 culvert assessment data, which became available during the course of the study, was incorporated into project identification.
- **State Data and Plans**
  - Lamoille Tactical Basin Plan - 2015
  - Lake Elmore Score Card - 2017
  - Light Detection and Ranging (LiDAR) Topography Data - 2015
  - VT ANR Clean Water Roadmap
  - NRCS Soils Survey
  - Phase 1 Stream Geomorphic Assessments

4.0 Water Quality Problem Areas

One of the primary objectives of the Lake Elmore watershed assessment is to identify and assess priority areas for stormwater, erosion, and flood hazards. FEA conducted a total of five (5) field tours of the project area including a lakeshore assessment, stream walks on selected tributaries to the lake, and assessments of public and private roads and other impervious surfaces. Lake and stream assessments were conducted with representatives from VTANR and Lamoille County Conservation District (LCCD).

4.1 Identification of Problem Areas

The initial round of problem area identification began by identifying stormwater related projects using a desktop exercise scanning the watershed with aerial imagery, NRCS soils data, LiDAR contour data, and road erosion risk in a GIS. Potential project areas were identified and mapped for review during site visits.

Field tours of the priority areas identified and assessed 67 problem areas. The problem areas are shown on the map included in Appendix B. We grouped the problem areas into three (3) project categories described below. **However, many projects have benefits and components that could be attributed to the other categories listed.**

- **Stormwater (36 Projects), Including:**

  - **Green Stormwater Infrastructure (GSI) BMP Installation/Retrofit**– Opportunity to reduce sediment and nutrient 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 Drainage Improvement/Stabilization –** Areas of high sediment and nutrient loading due to road, embankment, and/or ditch erosion.
- **Stream (15 Projects), Including:**
  - **Stream Culvert –** Locations of undersized culverts and culverts with active erosion.
  - **Stream or Wetland Restoration** – Problem 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.
- **Lakeshore (16 Projects) –** Problem 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.

The stream walk assessment focused on four (4) blue-line tributaries to the lake. The stream walks were a pared down version of the VTDEC's Stream Geomorphic Assessment Protocols focusing on evaluating:

- Erosion of channel and embankments (bank erosion, mass failures, and headcuts)
- Additional linear features of interest (buffers < 25')
- Point features of interest (stormwater inputs, beaver impoundments, debris jams)
- Stream crossings
- Channel characteristics (dominant bed and bank material, basic cross-section, bar features)

Stressors identified in the stream walks included undersized and perched culverts, bank and gully erosion, a berm, and a small derelict dam. The majority of these stressors were concentrated in the lower portions of the tributaries near the lake rather than the headwaters.

A boat tour of the lake 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 Lake Elmore are variable and depending on the degree of shoreline development and the steepness of the landscape. Generally speaking, erosion and invasive vegetation were low. Lakeshore areas of lawn and hardscaping tended to be concentrated in the neighborhoods along Camp Road, suggesting a cultural component to lakeshore landscaping practices. There is potential for significant water quality improvement to the shoreline zone in this neighborhood, which should be a focal area for future LakeWise 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 table (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 problem area was mapped based on field observations and 2-foot contours derived from the 0.7 2014/2015 LiDAR elevation surface.
- **Aerial Photography** – We used the 0.3 m imagery collected for Northern Vermont in 2018 to review the site land cover characteristics (i.e., forest, grass, impervious).
- **Impervious Surfaces Data** – We manually measured total impervious area in acres for GSI projects from the aerial photography. For non-GSI projects, we estimated impervious area using the aerial imagery.
- **NRCS Soils** – We used the Lamoille 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.
- **LCPC Road Erosion Inventory –** We used the 2018 inventory of road erosion and hydrologic connectivity of road segments to prioritize areas of potential sediment loading to visit for field surveys.

4.2.2 Unified Matrix Evaluation and Prioritization of Problem Areas

The 37 projects that could be assessed for a GSI treatment volume or erosion volume described in the master project table (Appendix C) were prioritized based on the potential for each project to improve water quality, reduce environmental impact, project feasibility, and co-benefits. Estimated project cost and the phosphorus removal efficiency ($/lb of P) were included. We followed the Unified Scoring Prioritization for Stormwater Master Plans document developed by VTDEC, with an adjustment to the phosphorus loading and phosphorus reduction criteria (VTDEC, 2018). This method includes a total of 19 criteria divided into 3 categories. The final score is expressed as a percent of the total score, with slightly different criteria applied to road drainage projects.

<u>Phosphorus Loads from Sediment</u>

Land cover-based phosphorus loading estimates account for generalized assumptions of sediment mobilization; however, we believe that phosphorus loading from active erosion areas may be underestimated for some of the stormwater problem areas. Other project types such as stream bank restoration or gully stabilization do not fit into the VTDEC Unified Scoring framework. We followed the VTDEC Standard Operating Procedure (SOP) for tracking and accounting of phosphorus associated with the Municipal Roads General Permit (MRGP) to estimate phosphorus loading and reduction associated with road improvements and erosion stabilization (VTDEC 2020).

For grader berm removal, crown improvement, and drainage (ditch) improvement projects, we used the linear loading rates from the VTDEC SOP to estimate phosphorus loading. Phosphorus reduction is estimated as a 40% reduction for upgrading a segment from partially meeting the MRGP standards to fully meeting the MRGP standards. Phosphorus reduction is estimated as an 80% reduction for upgrading a segment from not meeting the MRGP standards to fully meeting the MRGP standards.

For estimating the overall phosphorus loading and phosphorus reduction associated with excess sediment mobilization and stabilization, we used methods and loading rates established for the stabilization of roadside gully erosion in the VTDEC SOP. We estimate annual soil loss (in cubic feet) based on our best professional estimate of the age and volume of erosion features. We apply a 43.38 kg/ft^3 sediment bulk density to volume of erosion and 0.000396 kg (P)/ kg sediment (TSS), the equivalent of an annual loading rate of 0.017 kg (P)/ft^3 and 0.037 kg (P)/ft^3 (VTDEC 2020).

BMP Unit Costs and Adjustment Factors

BMP unit costs (2016 $) and adjustment factors were derived from recent stormwater master plans completed by Watershed Consulting Associates (2018). These numbers were primarily based on research completed by the Charles River Watershed Association and the Center for Watershed Protection (EPA, 2016), as well as updates based on actual construction costs in Vermont (Table 4). The unit cost estimates include an 8% total inflation adjustment for 2017-2020 based on the Consumer Price Indicator Inflation Calculator. Unit construction costs for road drainage projects were based on the estimates provided in the Road Erosion Site Prioritization and Remediation Project Summary (Fitzgerald Environmental Associates and Milone and MacBroom, Inc., 2017). Additional multipliers for site type (Table 5) and level of permitting and engineering required (Table 6) are also shown below.

Table 4: BMP Unit Costs

BMP Type	Cost/ft^3 Treatment Volume
Surface infiltration basin	6.61
Surface infiltration basin	6.75
Subsurface infiltration	6.77
Rain garden/bioretention	16.73

Table 5: Site Type Cost Adjustment

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

Table 6: Permitting and Engineer (P&E) Cost Adjustment

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

4.2.3 Non-Unified Evaluation and Prioritization of Problem Areas

Areas identified during field tours of the study area where the primary project recommendation was not erosion stabilization or stormwater treatment infrastructure (e.g., lakeshore improvements and undersized culvert replacements) 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 any additional benefits. The maximum possible score is 30 and the individual site scores ranged from 6 to 19. Each category is described below and includes a description of the scoring for each criterion. Final evaluation criteria summarized in the table in Appendix C included the overall prioritization and the following components of the score:

- **Water Quality Benefits (15 points total)**
  - **Nutrient Reduction Effectiveness (4 points)** – Degree of nutrient removal potential with project implementation, this accounts for both the existing nutrient loads and the removal efficiency and capacity of the proposed treatment. Nutrient loading was quantified based on the watershed size, the land cover types, and percent impervious surfaces, and the effectiveness was based on the treatment efficacy of the potential mitigation options appropriate for the space and location of the treatment area.
    - 0 points – No nutrient source and/or no increased treatment
    - 1 point – Minor nutrient source and/or minor increase in treatment
    - 2 points – Moderate nutrient source with some increase in treatment
    - 3 points – Moderate nutrient source with significant increase in treatment

        - 4 points – Major nutrient source with significant increase in treatment
    - **Sediment Reduction Effectiveness (4 points)** – Degree of sediment removal potential with project implementation, this accounts for both the existing sediment loads and the removal efficiency and capacity of the proposed treatment. Sediment loading was quantified based on the watershed size, the land cover types, and percent impervious surfaces, and the effectiveness was based on the treatment efficacy of the potential mitigation options appropriate for the space and location of the treatment area.
        - 0 points – No sediment source and/or no increased treatment
        - 1 point – Minor sediment source and/or minor increase in treatment
        - 2 points – Moderate sediment source with some increase in treatment
        - 3 points – Moderate sediment source with significant increase in treatment
        - 4 points – Major sediment source with significant increase in treatment
    - **Drainage Area (1 point)** – Approximate drainage area to site is greater than 2 acres
    - **Impervious Drainage (3 points)**– Approximate area of impervious surfaces draining to the site.
        - 0 points – Area of impervious surfaces is less than 0.25 acres
        - 1 point – Area of impervious surfaces is 0.25-0.5 acres
        - 2 points – Area of impervious surfaces is 0.5-1.0 acres
        - 3 points – Area of impervious surfaces is >1.0 acres

    - **Connectivity to Surface Waters (3 points)**
        - 0 points – All stormwater infiltrates on site
        - 1 point – Stormwater receives some treatment before reaching receiving waters
        - 2 points – Stormwater drains into drainage infrastructure that directly outlets to receiving waters (assumes no erosion or additional pollutant loading to discharge point)
        - 3 points – Stormwater drains directly into receiving waters (typically stormwater draining directly into a large wetland is assigned 2 points)
- **Landowner Support (2 points)**
    - 0 points – Project is located on private property, no contact with landowner
    - 1 point – Project is on Town or State property with no contact
    - 2 points – Project has been discussed and is supported by landowner
- **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 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.

- **Additional Benefits (5 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 stormwater treatment practices
    - **(4) High Visibility** – The site is highly visible and will benefit from aesthetically designed treatment practices
    - **(5) Infrastructure Conflicts** – The stormwater problem area is increasing erosion or inundation vulnerability of adjacent infrastructure (i.e. roads, buildings, etc.)
    - **(6) Drains to Connected Stormwater Infrastructure** – The site drains into a larger stormwater conveyance system that is less likely to receive downstream treatment
    - **(7) Reduces Thermal Pollution** – Project implementation will reduce the risk of thermal loading from runoff to receiving surface waters
    - **(8) Improves BMP Performance** – Project implementation will improve the performance of existing stormwater treatment practices that receive runoff from the site
    - **(9) Peak Flow Reduction** – Project implementation will significantly reduce stormwater peak flows leaving the site
    - **(10) Enhances Lakeshore Natural Communities** – Project implementation will promote a native vegetated lakeshore buffer and/or provide wildlife habitat along the lakeshore

Figure 5: A culvert on private property with reduced capacity compared to the road cross culvert received the lowest problem area score (left photo, Project SW-11). Erosion and transport of sediment Lacasse Road directly to a stream received the highest problem area score (right photo, Project SW-28).

4.2.4 Problem Area Summary Sheets

Problem area summary sheets were developed for 29 of the high- and moderate- priority project sites, and are provided in Appendix E. These sites were selected based on the prioritization categories shown in the Problem Area Table in Appendix C, and from input from project stakeholders during several meetings and field tours. Problem areas and prioritization strategies were discussed and refined with input from representatives of the Town of Elmore, LCCD, and VTANR during various meetings. The one-page summary sheets found in Appendix E include a site map and description, site photographs, and prioritization categories.

4.3 Sediment and Nutrient Loads to Lake Elmore

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 load from each of the primary "sectors" of the Lake Elmore watershed. Given the high degree of development along much the lake's shoreline, as well as the extensive network of private gravel roads and driveways near the lakeshore, it is our opinion that the lakeshore represents the largest contribution of sediment and nutrients to the Lake. Municipal roadways and associated drainage from roadways likely represent around one third of the load, while stream bed and bank erosion appears to represent less than one quarter of the load (Figure 6).

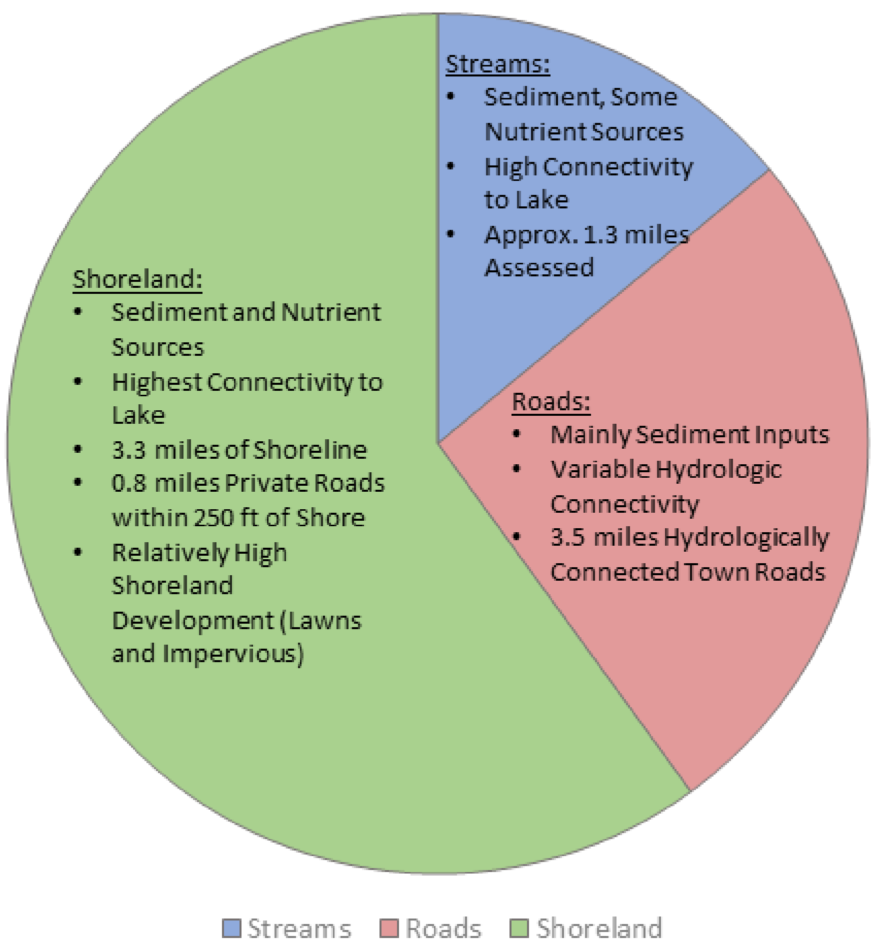

Figure 6: Relative contribution of sediment/nutrients to Lake Elmore from various sources.

4.4 Project Prioritization and Conceptual Designs

The Lake Elmore Watershed Action Plan partners reviewed and commented on the list of preliminary projects during various meetings and email correspondences. From the list of 67 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, five (5) projects were chosen for conceptual design development (30% design). The projects focus on the priorities outlined in Figure 6, with 3 of the 5 designs addressing lakeshore runoff from impervious surfaces including private and municipal roads.

Figure 7: Gravel parking area at the VT Fish & Wildlife Boat Launch.

30% Conceptual Designs

Five (5) of the highest priority projects were selected for the development of 30% concept designs (Appendix F). 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-5: Camp Road Swale –** There is erosion at the 15” culvert outlet and in the swale near the lake confluence. The swale emerging from an 18” HDPE culvert upslope of the road is steep, contributing to erosive flow velocities downstream.
2. **Projects SW-13 & L-3: Vermont Fish and Wildlife Boat Launch** – Runoff from the gravel parking lot pools in low spots on either side of the boat launch. The low areas are vegetated with mowed

grass along the margins of the parking lot and overflow directly into the lake. Along the shoreline, wave action is eroding an area vegetated with mowed grass.

3. **Project SW-28: Lacasse Road –** Erosion along the road shoulder due to the lack of ditches to convey flow has caused a significant pile of sediment to accumulate next to the stream with gully erosion through the pile to the stream. Sediment deposition and a flowpath to the stream is visible on the downstream side of the culvert as well.
4. **Project SW-30: Beach Road and West Loop Road** – The high shoulder along Beach Road collects runoff, which turns out and erodes West Loop Road. The elevation of West Loop Road is low relative to its shoulders, causing water to flow down the road from Beach Road to the wetland crossing. The ditch on the west side of Beach Road, across from West Loop Road, lacks a cross culvert and holds water until it infiltrates or spills onto the road.
5. **Projects SW-10 & SW-21: Elmore Town Hall and Elmore Store** – Runoff from the roadway and rooftops is concentrated along Route 12 and turns out between the Elmore Store and Town Hall and at an eroded turnout north of the Town Hall parking area. The gravel parking area between the Town Hall and Elmore Store slopes toward the lake. The concentrated flow north of the Town Hall parking area appears to be eroding the shoreline.

Figure 8: Erosion in the swale downstream of Camp Road. The concept design for this area (SW-5) describes BMPs that would stabilize erosion and treat runoff.

5.0 Next Steps

This watershed action plan represents an extensive effort to identify, describe, and evaluate water quality problem areas affecting the Lake Elmore watershed. For each project recommendation, we provided a preliminary cost estimate and a site rating to aid the LCCD, LEA, and Town representatives 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 LCCD continues to work with the Town, LEA, 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.

- **Project SW-5: Camp Road Swale** (30% design already complete)
- **Project SW-13: Vermont Fish and Wildlife Boat Launch** (30% design already complete)
- **Project SW-28: Lacasse Road** (30% design already complete)
- **Project SW-30: Beach Road and West Loop Road** (30% design already complete)
- **Projects SW-10 & SW-21: Elmore Town Hall and Elmore Store** (30% design already complete)

Additionally, we recommend that VT DEC and LCCD reach out to a selection of landowners with properties appearing likely to receive a LakeWise 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.

In addition to addressing the problem areas identified in this document, the Town can take steps to reduce future stormwater problems through planning and zoning regulations. Stormwater best management strategies and other planning and zoning regulations may be applied to existing and future growth to reduce the risk of stormwater runoff conflicts and nutrient and sediment loading to receiving waters.

6.0 References

EPA, 2016. Methodology for Developing Cost Estimates for Opti-Tool. Memorandum to Opti-Tool TAC prepared by Karen Mateleska, EPA Region 1.

Fitzgerald Environmental Associates and Milone and MacBroom. 2017. Road Erosion Site Prioritization and Remediation Project Summary. Memo prepared for the Chittenden County Regional Planning Commission. Dated December 27, 2017.

Ishee, E. R., D. S. Ross, K. M. Garvey, R. R. Bourgault, and C. R. Ford. 2015. Phosphorus Characterization and Contribution from Eroding Streambank Soils of Vermont's Lake Champlain Basin. Journal of Environmental Quality. 44: 1745-1753.

U.S. Census Bureau, 2011. U.S. Census Bureau American FactFinder web page. Accessed in March, 2017 at: http://factfinder.census.gov

VTANR (Vermont Agency of Natural Resources), 2016, Lamoille Tactical Basin Plan. Watershed Management Division, Montpelier, Vermont. Accessed in October 2018 at: https://dec.vermont.gov/sites/dec/files/wsm/mapp/docs/2016-12-30_Lamoille_Tactical_Plan_FINAL.pdf

VTDEC (Vermont Department of Environmental Conservation). 2018. Unified Scoring Prioritization for Stormwater Master Plans

VTDEC (Vermont Department of Environmental Conservation), 2020, Standard Operating Procedures for Tracking & Accounting of Stormwater Permit Programs: Municipal Roads General Permit (MRGP). June 1, 2020.

Watershed Consulting Associates, LLC. 2018. Stormwater Master Plan for the Town of Berlin, Vermont. Prepared for the Central Vermont Regional Planning Commission. Final Report, January 17, 2018.

Yang, L., Jin, S., Danielson, P., Homer, C.G., Gass, L., Bender, S.M., Case, A., Costello, C., Dewitz, J.A., Fry, J.A., Funk, M., Granneman, B.J., Liknes, G.C., Rigge, M.B., Xian, G., 2018, A new generation of the United States National Land Cover Database—Requirements, research priorities, design, and implementation strategies. *ISPRS Journal of Photogrammetry and Remote Sensing*, v. 146, p. 108 – 123, at: https://doi.org/10.1016/j.isprsjprs.2018.09.006