APPENDIX A

Lake Eden Watershed Data Library

(8½”x11”)

Fitzgerald Environmental Associates, LLC.

Applied Watershed Science & Ecology

MEMORANDUM

To: Lamoille County Conservation District
From: Rodrigue Spinette, PhD and Evelyn Boardman
Re: Lake Elmore Watershed Data Library
Date: January 9, 2020

As a first step in the development of a Watershed Action Plan for Lake Elmore, 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 lake'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

Lake Elmore is a 222-acre lake located in the Town of Elmore, VT (Figure 1). 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 (Homer et al., 2015) 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.

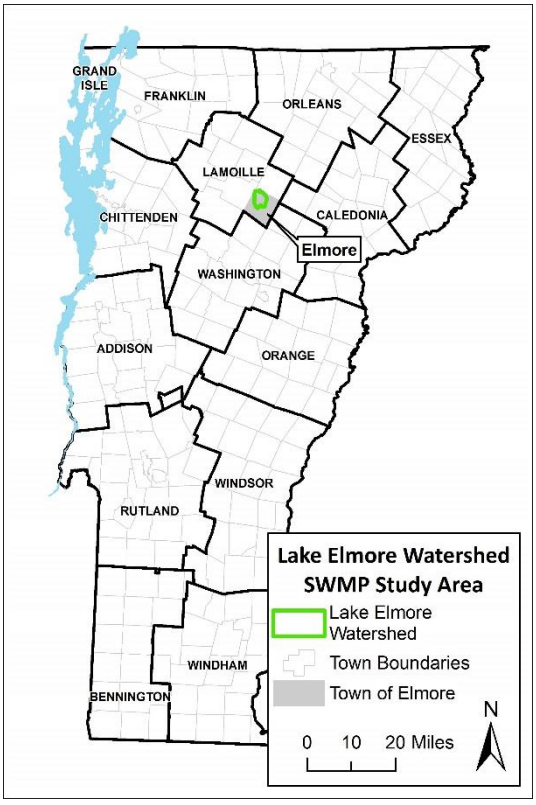

Figure 1: Lake Elmore watershed location map.

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

Mapping Data

VTDEC Municipal Roads Program

A Road Erosion Inventory (REI) for the Town of Elmore was conducted by the Lamoille County Planning Commission (LCPC) 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 in terms of erosion and given a road erosion 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 214 hydrologically connected segments inventoried, 174 (81%) did not meet MRGP standards and 27 (13%) partially met MRGP standards (link). Roads in the immediate vicinity of Lake Elmore with segments that did not meet or partially met MRGP standards included Beach Road, Camp Road, and Elmore Pond Road (link). Non-compliant segments in the headwaters of the Lake Elmore Watershed included Lacasse Road and Symonds Mill Road. 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 Lamoille County were collected in a series of flights conducted between November 2014 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 Lamoille County Planning Commission (LCPC) for town roads in Elmore are available online (https://vtculverts.org/). There are no bridge records in the area covered by the Lake Elmore watershed. However, approximately 35 culvert records dating back to October 2013 exist for Beach Road, Camp Road and Elmore Pond Road. The data set includes the structure dimensions and overall conditions but does not include the presence/absence of erosion. While most culverts were rated as good or excellent, a few were rated as poor or fair. 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 Elmore Highway Department to understand which culverts have been upgraded or replaced since the 2013 data was posted.

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). Since Lake Elmore is part of the Lake Champlain watershed (Elmore Pond Brook discharges into the Lamoille River) , it is covered by the Clean Water Roadmap tool and the tool can be used to explore contributions of TP to surface waters around Lake Elmore. In the model, loads of TP are related to land cover classifications. The three NHDPlus catchment areas mapped over the Lake Elmore watershed area are predominantly forested. However, forests contribute lower phosphorus loads on an aerial basis compared to other types of land cover such as roads, developed land, cropland and hay/pasture. In general, the tool shows that yields of phosphorus (in units of kg/ha/y) increase significantly as cover types other than forests increase. In the area immediately east and west of Lake Elmore, roads make up 5.4% of the total catchment area but contribute 55% of the annual TP load. In the catchment located to the south of the Lake, cropland and hay/pasture are important contributors to TP in addition to roads and developed land.

Natural Resources Conservation Service (NRCS) Soils Survey

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

Phase 1 Elmore Brook Stream Geomorphic Assessment (SGA)

Phase 1 SGA was conducted on the Lake Elmore watershed by Bear Creek Environmental in 2008 (link). Minimal encroachment, development and straightening were cataloged in the Phase 1 SGA for the assessed tributaries to Lake Elmore.

Watershed Planning

Lamoille Tactical Basin Plan

The basin plan discusses the current condition of surface waters in the Lamoille River watershed, recommends actions to preserve and restore water quality, and relevant permit requirements (VTDEC, 2016).

In the context of the Lake Elmore watershed, a top objective listed in the report is to improve lakeshore zone habitat along Lake Elmore. The plan recommends outreach, watershed planning, VT LakeWise Program participation, and BMP implementation. Lake Elmore is given a shoreland habitat score of red in the Lamoille Tactical Basin Plan, meaning that is has less than 50% shoreland vegetative cover. The basin plan noted that although the shoreland habitat condition is on a degrading trend, TP annual means are decreasing.

The Lamoille Tactical Basin Plan qualifies Lake Elmore and Elmore Pond Brook situated downstream as being altered due to the dam on Route 12. The alteration consists of flow regulation due to the dam.

Lake Elmore is also affected by locally abundant Eurasian watermilfoil, an aquatic invasive species. The basin plan noted that the Lake Elmore Lake Association (LELA) is actively involved in invasive species removal efforts.

The final recommendations made by the Lamoille Tactical Basin Plan in regards to the Lake Elmore watershed include: (1) developing a stormwater management project for the town garage sand storage area (off Beach Road) to address stormwater issues, (2) adopt river corridor protection or strengthen by-laws and add approved regional planning commission flood resiliency section to town plans to encourage stream equilibrium and wetland, floodplain and river corridor protection, (3) Continue to monitor and manage AIS, and (4) initiate LakeWise Program to determine projects to improve shoreland and lake habitat to protect lake water quality.

Lake Elmore Score Card

Lake Elmore is listed as altered based on water quality standards but exhibits some good water quality trends. Summer annual total phosphorus mean concentration has significantly decreased during the monitoring period of 1995 - 2018 (VT DEC, 2017). Over the monitoring period of 1979 - 2019, summer Secchi depth annual means have not changed appreciably, but summer chlorophyll *a* annual means have significantly decreased. Lake Elmore is affected by Eurasian watermilfoil, conferring a rating of poor for Aquatic Invasive Species. Shoreland and lake habitat are rated as fair. As noted previously in the Lamoille Tactical Basin Plan, the shoreland vegetative cover is relatively low which results in a higher Lakeshore Disturbance Index. Mercury pollution is likewise rated fair, indicating contamination in fish tissue is likely.

Town Planning and Permitting

Town of Elmore Town Plan (2018)

The Town of Elmore 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 land and soil conditions while reducing potential impacts on local streams and surface waters (Town of Elmore Town Plan, 2018). The report discusses the action that will be taken to come into compliance with the Municipal Roads General Permit (MRGP) and mentions the budgeting

that will be necessary to upgrade the Town's roads. The transportation planning section of the report includes a goal to "provide a transportation network that does not adversely affect water quality" and recommends applying for grant aid to offset the cost to taxpayers of upgrading road segments. Protecting sensitive ecosystems such as wetlands and floodplains, and preserving shoreland habitats, are also discussed in relation to wildlife habitat, water quality, and flood mitigation.

Lamoille County Road Erosion Assessment

LCPC and Watershed Consulting Associates conducted erosion assessments of Class 3 and 4 roads in 2014. Problem areas within the Lake Elmore Watershed were identified on Beach Road and Cross Road. Other roads in the Town were flagged as having erosion issues in this assessment but fall outside of the Lake Elmore Watershed boundary. These sites will be revisited in the problem area identification process.

Data Gaps

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

Although a Phase 1 SGA was conducted in the Lake Elmore watershed, it is now 10 years old and some of its data may no longer be current. A Phase 2 SGA, which involves a more detailed field investigation, would better characterize the condition of the watershed lake and river system, especially in reaches where channel stability issues are suspected.

As an alternative/complement to a full phase 2 SGA, a more narrowly focused "stream walk" approach can be employed to identify and evaluate areas of channel instability that may be contributing to sediment and phosphorus loading to the lake. Three smaller tributaries to Lake Elmore and one section of stream covered by the Phase 1 SGA study were selected for a "stream walk" assessment. The extent of the walk is shown in the attached map. The stream walk can be thought of as a pared down version of the stream geomorphic assessment focusing on:

- 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)

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 Beach Road, Camp Road and Route 12 in proximity to Lake Elmore. Further away, it appears that a few locations on Symonds Mill Road and Cross Road may need to be investigated. Areas where land use includes more farming along Route 12, Lacasse Road, Symonds Mill Road, and Hardwood Flats Road, may also provide opportunities for localized erosion and nutrient control.

Literature Cited

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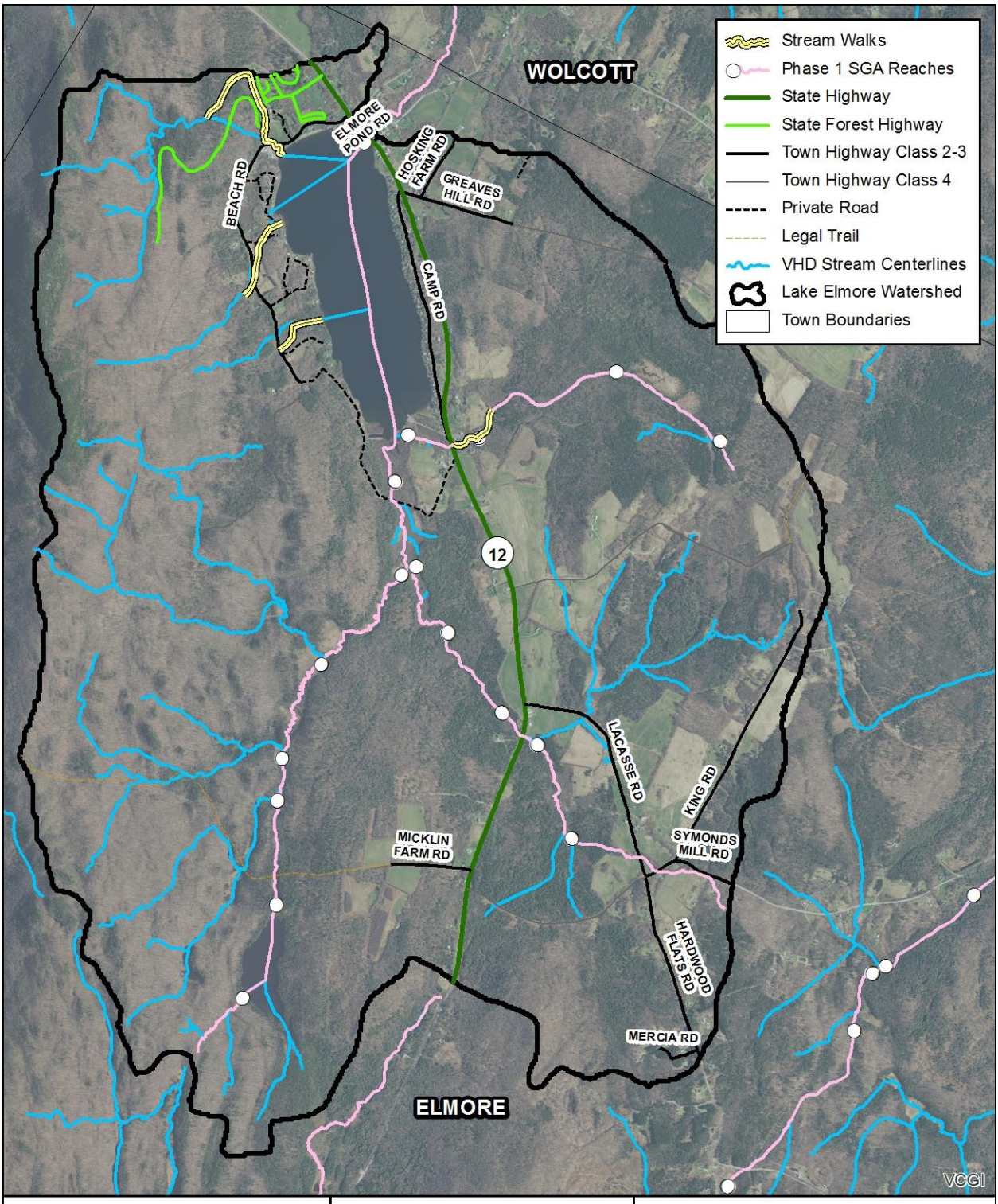

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Lake Elmore Watershed

Notes: VCGI imagery from 2018.
Map By: EHB
Date: January 9, 2020

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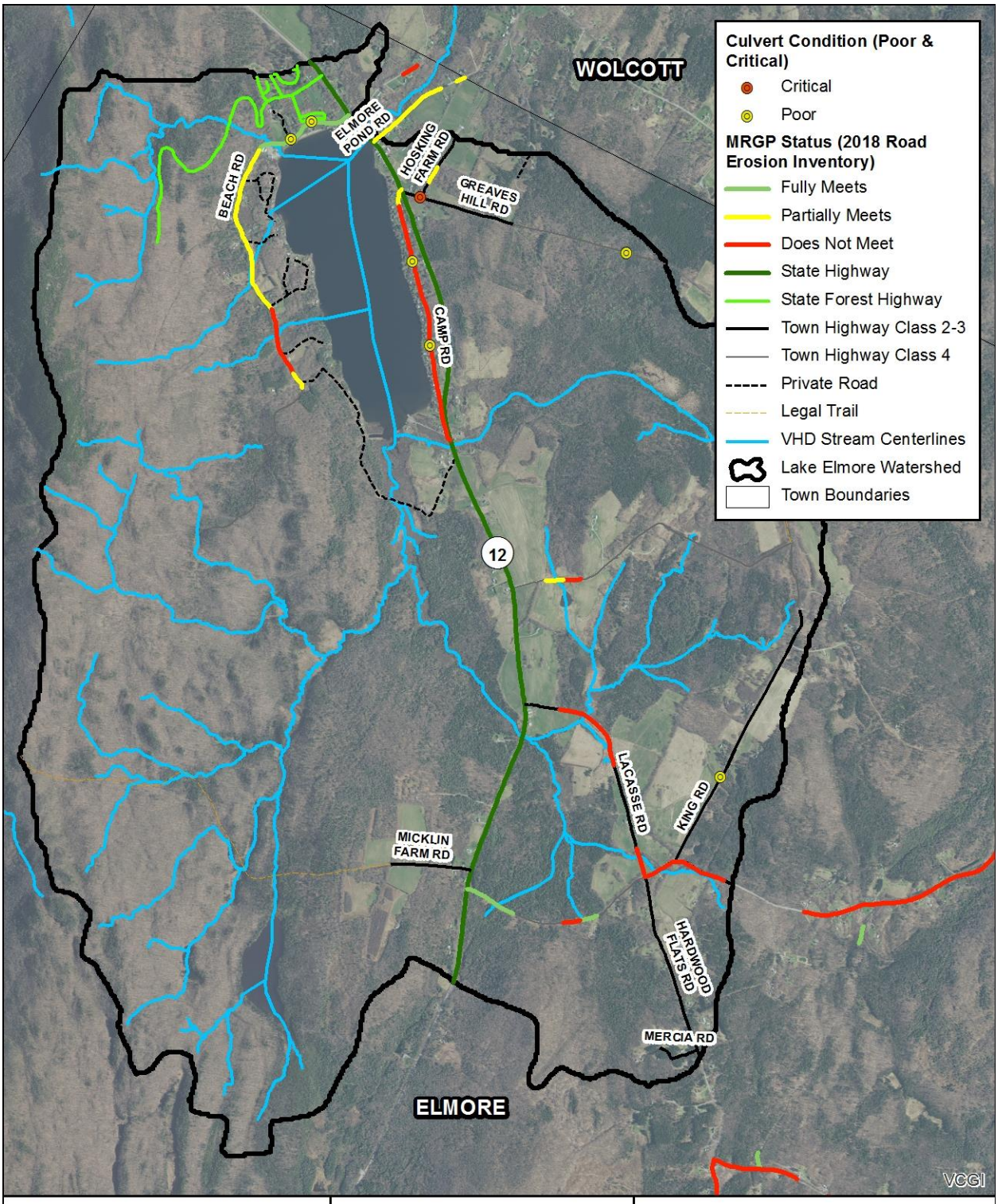

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Road Erosion Inventory Results Lake Elmore Watershed

Notes: VCGI imagery from 2018.
Map By: EHB
Date: January 9, 2020

0 0.25 0.5 Miles

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