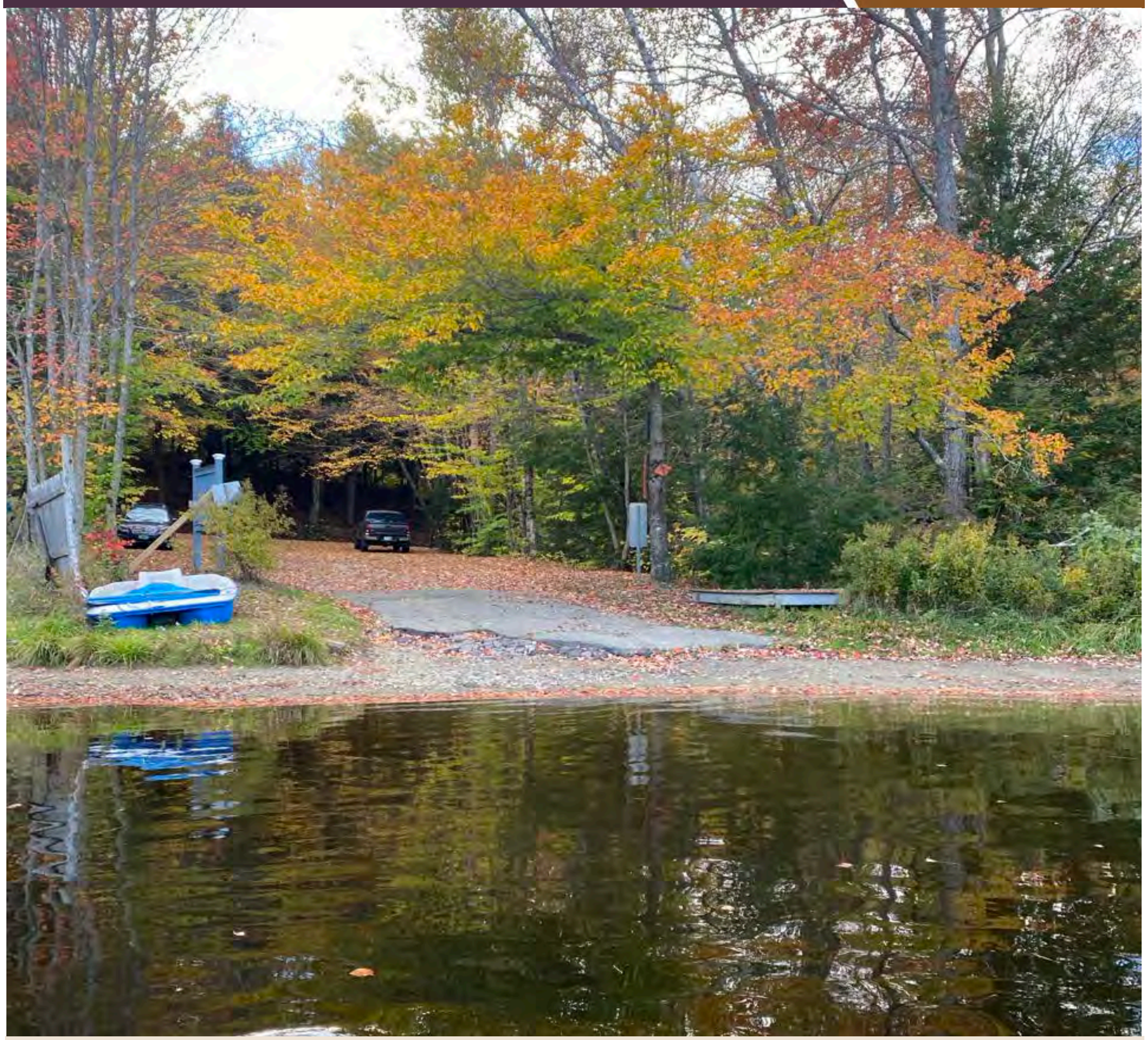
Crescent Lake Watershed Based Management Plan



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A special thanks to the Crescent Lake Association Water Quality Group, who provided extensive local knowledge and accompanied field work efforts to provide a local presence.

Executive Summary

Crescent Lake is a 128-acre lake with a 3,900-acre watershed in the headwaters of the Cold River, located in the towns of Acworth and Unity, New Hampshire. Development in the watershed is residential, with a mix of seasonal use, short-term rentals, and year-round homes. In the past twenty years, there has been a general trend in converting seasonal camps to larger residences and building out properties with accessory dwellings.

Crescent Lake's water quality has tested well during 35 years of regular monitoring through the New Hampshire Department of Environmental Services (NHDES) Volunteer Lake Assessment Program (VLAP). There have been no identified or measurable cyanobacteria blooms. However, there are zones with consistently low dissolved oxygen levels in deeper water. Other signs of deterioration have been recorded in recent years, as well, with in-lake phosphorus and chlorophyll-*a* concentrations fluctuating within a higher range since 2021. There have also been increases in turbidity, darker water color, and diminished water clarity. Extreme, high intensity storms in 2021 and 2023 overwhelmed existing road drainage infrastructure, washed out roads, and contributed large amounts of sediment to the lake. Data collected in 2023 and 2024 do not suggest any major changes to the lake water quality since the 2023 floods. However, we recommend the lake be carefully monitored, and water quality goals be reassessed if testing criteria show signs of rapid deterioration.

Cyanobacteria blooms are becoming more common in New Hampshire and New England due to warming waters and increasing nutrient loads to surface waters. Harmful cyanobacteria blooms have been shown to cause illness and death and reduce property values due to loss of recreation opportunities. Excess nutrient loads come to watersheds from sources such as shoreline erosion, stormwater runoff from urban development, erosion from construction activities and roadways, fertilizer use, failed or poorly maintained septic systems, and pet and wildlife feces. Twenty-four (24) locations were identified as sources of phosphorus during the watershed field survey carried out by Stone Environmental, Inc. (Stone) in the Crescent Lake watershed. The main problems identified were eroding gravel road surfaces and roadside ditches, and undersized or eroding culverts. During the shoreline survey, 55 shorefront properties were found to be in poor condition with water quality impacted by active shoreline erosion or lack of a vegetated buffer.

Modeling results suggest degrading water quality in Crescent Lake due to changes in watershed phosphorus loading from pre-development to future conditions. The effects of increased frequency and intensity of rainfall could not be modeled appropriately with the chosen methodology, however, intense storms in recent years provide a glimpse of the impact it might have on the lake. Storm frequency and intensity models predict higher intensity rain events likely to increase soil erosion and transport of phosphorus-laden sediment to surface waters.

The Crescent Lake Association (CLA) acknowledges that now is the time to act to protect the quality of their lake, avoid the worst impacts, and maintain this precious resource through changing conditions and increased use. To that end, the Crescent Lake Association and the Crescent Lake Environmental Action Response Trust (CLEAR) directed funds and raised money to hire Stone to complete a Watershed-Based Management Plan.

The WBMP includes an assessment of past and present land use changes, a land-use and water quality model, water quality and assimilative capacity analysis, septic system assessment, shoreline survey, and watershed survey to quantify sources of phosphorus to the lake. The results of the field work and analyses led to recommendations for management strategies to address phosphorus loading to the lake and an Implementation Plan to establish measurable actions to improve water quality. The plan established two primary objectives to accomplish this goal:

Objective 1: Reduce phosphorus loading from existing development.

Objective 2: Mitigate phosphorus loading from future development through prevention or offsets.

The following actions are recommended:

Installation of Structural Stormwater Control Measures
Sources of phosphorus in the watershed should be mitigated through Stormwater Control Measures (SCMs), shoreline stabilization, and buffer plantings. The watershed and shoreline projects identified in this plan, as well as any new or redevelopment projects in the watershed with the potential for soil erosion, should be considered for remediation. Water quality is the primary purpose of this WBMP, not flood prevention. While some of the projects—stormwater drainage improvements and culvert replacements—will help with flooding, extreme storm events will continue to overwhelm infrastructure under the right conditions.

Monitoring
Long-term monitoring is required to track and evaluate the effectiveness of the Implementation Plan. The CLA should continue annual monitoring with the NHDES VLAP and consider including the additional monitoring efforts recommended in this plan.

Education and Outreach
The CLA should continue to educate and develop outreach strategies to reach its members and watershed residents. Materials should be posted at public locations and distributed through news and social media to reach as many people as possible. Educational campaigns could include topics such as water quality, septic system operation and maintenance, fertilizer use, pet waste disposal, waterfowl, invasive species, boat pollution, shoreline stabilization and improvements, gravel road maintenance, and SCMs.

Local Zoning and Regulations
Local zoning and regulations are another method to facilitate the reduction of phosphorus loading to the lake. Requiring Low Impact Development (LID) strategies on new construction, replacing failing septic systems, conserving land, and the use of SCMs for road maintenance and other municipal activities are all areas to focus on.

The CLA is the primary driver behind this plan, with support from the Towns of Acworth and Unity, conservation commissions, state and federal agencies, nonprofits, land trusts, schools and community groups, local businesses, and private landowners. The CLA is responsible for administering and reassessing the plan to ensure it is effective. The Implementation Plan is estimated to cost between $660,000 and $1.03 million over 10 or more years. These costs are high-level estimates and should be updated as more detailed information and price quotes are made available. Funding may come in many forms, including state and federal grants, Town commitments, and donations from private residents. This plan meets the nine key elements required by the United States Environmental Protection Agency (EPA) for watershed-based plans, which makes Crescent Lake eligible for partial federal funding under Watershed Assistance Grants administered by the NHDES Watershed Assistance Section.

Crescent Lake Watershed-Based Management Plan

***Cover Photo**: Crescent Lake boat launch prior to replacement of boat launch pad, November 2024.*

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1. Introduction

1.1. Waterbody Description

Crescent Lake is a 128-acre lake with a 3,900-acre watershed in the headwaters of the Cold River, which discharges to the Connecticut River. The lake and watershed are situated in the Towns of Acworth and Unity, New Hampshire. The lake has two main tributaries, Sleeper Brook at the western end of the lake, and an unnamed stream running from Potato Hill to the northeastern end of the lake. Both tributaries are impacted by beaver activity. There are also several small intermittent streams and drainages along the hillside to the south of Crescent Lake. Lake water levels are managed for recreation purposes by a dam at the eastern end of the lake.

The highest elevation in the watershed is the Gove Hill peak to the south of the lake, which sits at approximately 1,932 feet above sea level. The lake and direct shoreline sit at approximately 1,210 feet above sea level. The watershed is primarily forested in mixed northern hardwood-conifer and hemlock-hardwood-pine stands, with lesser areas of grassland, marsh and shrub wetland, and northern swamp. The marsh and shrub wetlands have been affected by beaver activity, creating a series of impoundments above the western inlet on Sleeper Brook and one large impoundment above the northeastern inlet.

Crescent Lake is relatively shallow with an average depth of 10 feet, a maximum depth of 25 feet, and a permanent storage volume of 1,287 acre-feet. There is one public boat launch at the southwest corner of the lake on Crescent Lake Road. The dam at the eastern end is privately owned and managed by the Crescent Lake Association with input from the State of New Hampshire Department of Environmental Services (NHDES). Its primary use is to raise water levels in the lake for recreation. The dam is 40 feet wide and 4 feet tall and it has wooden stoplogs for controlling the lake level (*NHDES 2024a*).

The climate at Crescent Lake is consistent with the temperate zone of the northeastern United States. The warmest month of the year is July, with an average maximum temperature of 79 degrees Fahrenheit (°F), while the coldest month of the year is January with an average minimum temperature of 6°F (Figure 1). The average precipitation is 41.5 inches, which includes an average snowfall amount of 61 inches.

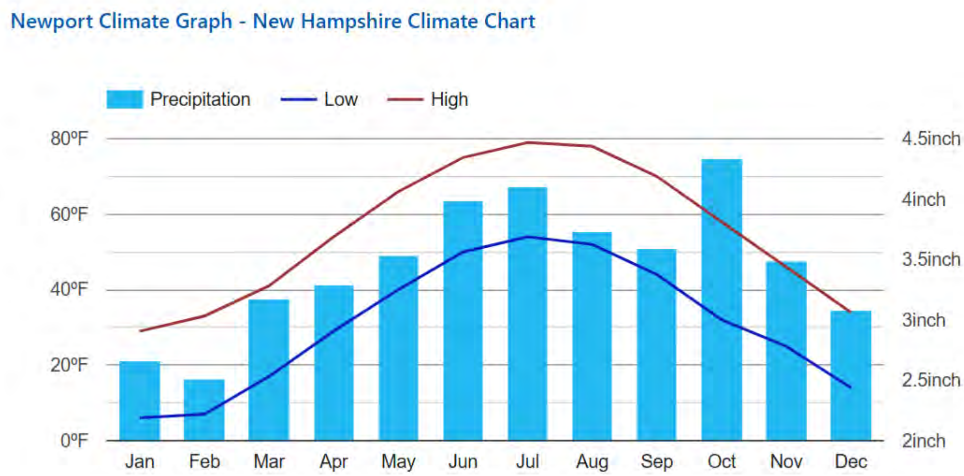

Figure 1. Temperature and precipitation for Newport, NH (1981 – 2010) (US Climate Data 2025)

Hydrologic changes are occurring at Crescent Lake and throughout the northeastern United States. Warmer winter temperatures have increased the amount of precipitation that falls as rain and extreme precipitation events have increased by about 60% (*Whitehead et al. 2023*). These trends are shown in Figure 2, Figure 3, and Figure 4. Average annual temperatures are increasing 0.3°F per decade; average annual precipitation is increasing by 1.16 inches per decade; and the duration of ice cover is decreasing. Warmer temperatures, more rainfall, and more intense storms paired with a longer growing season are expected to increase phosphorus loading and the potential for lake eutrophication and cyanobacteria blooms. Therefore, when developing strategies to improve water quality in a lake it is important to plan for the impacts of future changes by reducing phosphorus loads and accommodating increased runoff.

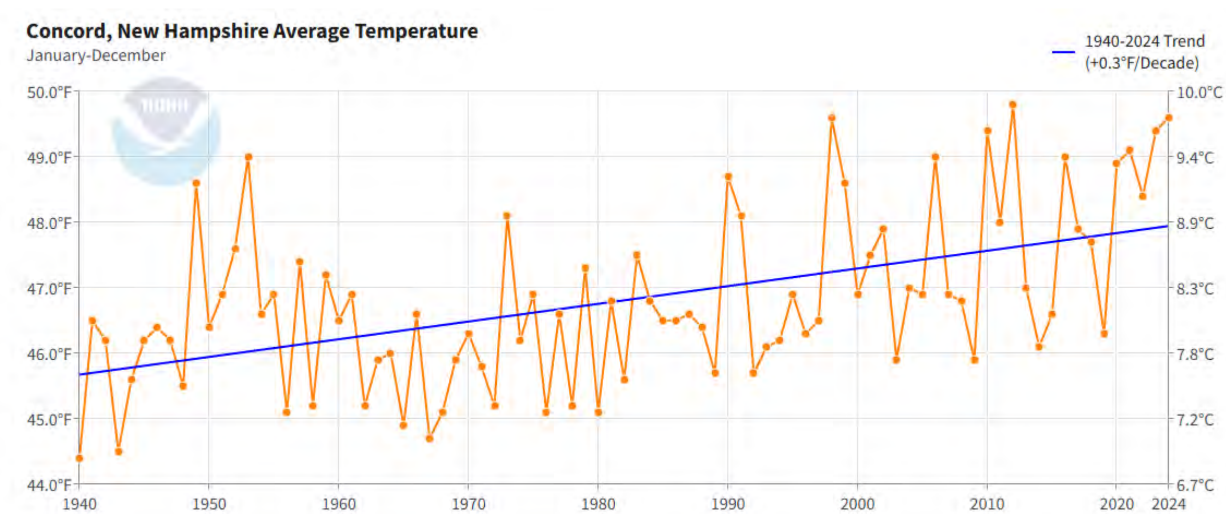

Figure 2. Average annual temperature at Concord, NH (NOAA 2025)

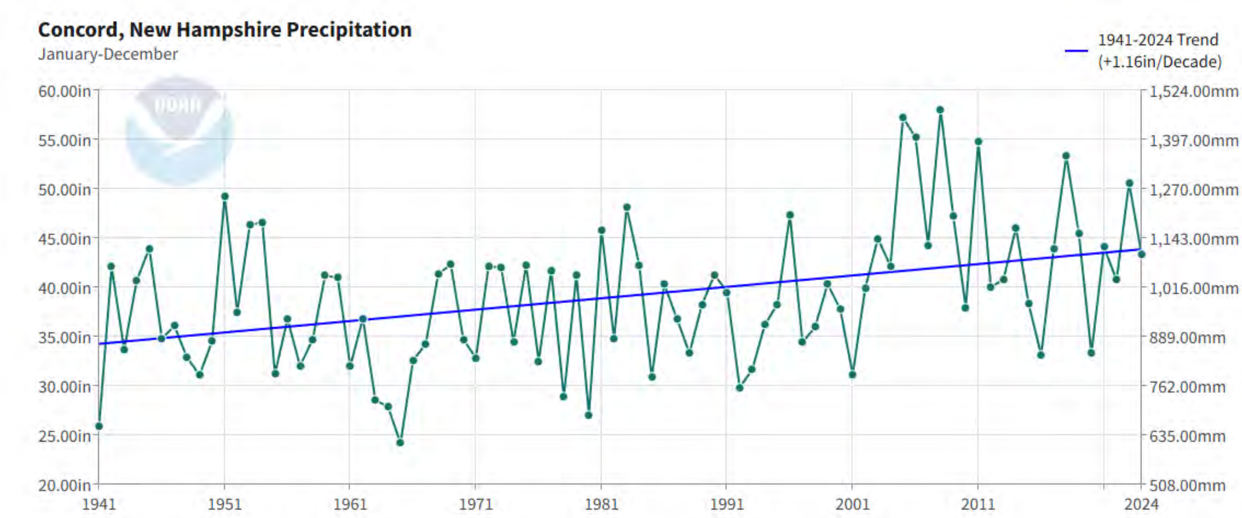

Figure 3. Average annual precipitation at Concord, NH (NOAA 2025)

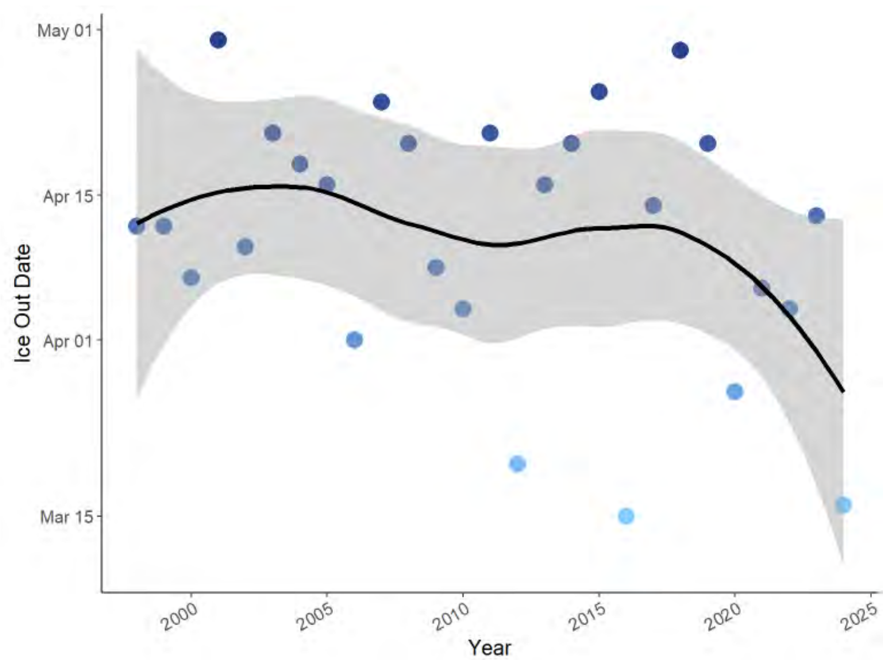

Figure 4. Ice out dates at Crescent Lake from 1998 to 2024 (NHDES 2025)

1.2. Purpose and Scope

Water quality in Crescent Lake has been consistent since monitoring began in 1990 and representative of a mesotrophic system. However, the lake is showing signs of deterioration, with in-lake phosphorus and chlorophyll concentrations fluctuating within a higher range since 2021. There have also been recent increases in turbidity, darker water color, and diminished water clarity. While there have been minimal changes in land use in the watershed in recent years, more frequent high-intensity storms have overwhelmed existing road drainage infrastructure, washed out roads, and contributed large amounts of sediment to the lake. These events will become more frequent and intense. Increased nutrients in the lake along with warming temperatures may increase the likelihood of harmful cyanobacteria blooms which are a health hazard to humans and pets, diminish the aesthetic and recreational quality of a waterbody, and potentially cause decreases in property values and loss of tax revenue (*Dodds et al 2009, Wolf and Klaiber 2017, Zhang et al 2022*). Ideally, steps should be taken now to reduce sediment and phosphorus loads in an attempt to avoid these impacts.

The purpose of the Crescent Lake Watershed-Based Management Plan (WBMP) is to guide implementation efforts over the next 10 years to improve water quality in the lake. The goal is to meet state water quality standards for the protection of Aquatic Life Integrity (ALI) and reduce the likelihood of harmful cyanobacteria blooms. To develop this plan the watershed was assessed through in-person shoreline and watershed surveys to identify sources of phosphorus to the lake and through the development of a land-use model to compare current and future phosphorus loads. Results from this work were used to establish water quality goals, determine recommended management strategies, and develop an implementation plan to reduce phosphorus loads and estimate costs needed for remediation. The completion of this plan and the incorporation of the Environmental Protection Agency's (EPA) nine elements mean the community is eligible to compete for partial federal funding under Watershed Assistance Grants administered by the NHDES Watershed Assistance Section.

1.3. Community Involvement

This plan was developed through a collaborative effort by Stone Environmental, Inc. (Stone), the Crescent Lake Association (CLA), NHDES, representatives from the Towns of Acworth and Unity, and private landowners. Several meetings of the CLA and the CLA Water Quality Group were held during the development of this plan:

- June 29,2024: Crescent Lake Water Quality Forum with presentations focused on the current conditions in Crescent Lake and the need for engaging professionals to develop a Watershed-Based Management Plan
- July 6, 2024: Crescent Lake Association Annual Meeting presentation again focused on the need for a Watershed-Based Management Plan
- August 24, 2024: Buy-in/kickoff meeting and presentation to the CLA and interested lake residents.
- October 9, 2024: Crescent Lake shoreline survey. Members of CLA and the Town of Acworth Conservation Commission met at the boat launch. A member of the CLA Water Quality Group guided Stone staff along the shoreline.
- November 19-20, 2024: Watershed survey. Members of CLA, Town of Acworth, and Town of Unity met at various sites of interest. A member of the CLA Water Quality Group guided Stone staff.
- December 9, 2024: Presentation and discussion of Watershed Inventory StoryMap and project status.
- April 3, 2025: Project update on modeling efforts.
- May 8, 2025: Project update and accepting water quality goals.
- June 18, 2025: Project update and sharing the Implementation Plan.
- August 2, 2025: Final WBMP presentation.

1.4. Incorporating EPA's Nine Elements

The Environmental Protection Agency's (EPA) guidance requires that nine elements be included in WMBPs. The elements highlight important steps to improving and protecting water quality. These elements are presented in this plan as follows:

A. **Identification of Causes of Impairment and Pollutant Sources:** Sections 3 and 4 present the known sources of nonpoint source (NPS) pollution to Crescent Lake and the results of the shoreline and watershed surveys. These sources must be controlled to achieve the recommended load reductions in this plan.

- **B. Estimate Phosphorus Load Reductions Expected from Management Measures:** Sections 3 and 6 present the calculation of pollutant load to Crescent Lake and the amount of reduction needed to meet water quality goals and objectives.
- **C. Description of Nonpoint Source Management Measures Needed to Achieve Load Reductions:** Sections 5 and 6 present the methods recommended to achieve the necessary phosphorus load reduction.
- **D. Estimate of Technical and Financial Assistance Needed to Implement this Plan:** Section 6 presents descriptions of costs associated with the plan, sources of potential funding, and the entities responsible for certain actions.
- **E. Education and Outreach Component:** Section 5 includes an explanation of why the educational component of the plan is necessary and improvements to better enhance public engagement and understanding of the WBMP.
- **F. Schedule for Implementing the Nonpoint Source Management Measures:** Section 6 presents a list of action items to reduce the phosphorus load to Crescent Lake. Each action has a set schedule or timeframe for when it should take place. Scheduling should be reviewed by the CLA annually and adjusted if necessary.
- **G. Description of Interim Milestones for Determining Successful Implementation:** Section 6 presents indicators and milestones to track the progress of implementation.
- **H. Set of Criteria to Determine if Load Reductions are Being Achieved:** Sections 2 and 6 present criteria for determining if load reductions are occurring and water quality is improving over time.
- **I. A Monitoring Component to Evaluate Effectiveness:** Section 5 and 6 present the existing long-term monitoring strategy for Crescent Lake and how it can be improved to help measure the progress of this plan.

2. Water Quality Assessment

2.1. Water Quality Summary

2.1.1. Designated Uses and Water Quality Criteria

Criteria that help determine if a lake is healthy and safe come in multiple forms depending on how the waterbody is used. The Clean Water Act (CWA) requires states to determine designated uses for all surface waters. Aquatic Life Integrity (ALI) is the primary designated use considered in this plan. The ALI category takes into account water quality parameters tested several times annually for the Volunteer Lake Assessment Program (VLAP) – alkalinity, chloride, chlorophyll-a, dissolved oxygen, pH, total phosphorus, and turbidity. Other relevant uses include fish consumption, shellfish consumption, drinking water supply, primary contact recreation (swimming), secondary contact recreation (boating), and wildlife. Surface waters in New Hampshire are also classified as either Class A (drinking water supplies or high-quality waters) or Class B. Crescent Lake is classified as a Class B water, as are the majority of the surface waters in the state.

Lakes are also classified by trophic state as oligotrophic, mesotrophic, or eutrophic. Crescent Lake was classified as mesotrophic based on surveys conducted in 1979 and 1992, due to its existing trophic status indicators (dissolved oxygen, chlorophyll-*a*, transparency, and vascular aquatic plant growth). This puts it between oligotrophic lakes, which tend to be deeper and clearer and have low phosphorus concentrations and limited plant growth, and eutrophic lakes, which tend to be shallow with mucky bottom sediments, poor clarity, depleted dissolved oxygen, elevated phosphorus concentrations, and extensive rooted plant growth. Eutrophication, the process of accumulating nutrients and increasing biological production, is a natural process in lakes over extended timeframes (hundreds to thousands of years). However, human impacts on lake watersheds from stormwater runoff, erosion, and sewage can shorten that timeframe to decades.

2.1.2. Antidegradation Provisions

The water quality regulations in New Hampshire include antidegradation provisions (ENV-Ws 1708), which serve to preserve and protect the quality and beneficial uses of the state's surface waters by limiting degradation. The provisions put limits and reductions on future pollutant loading for activities such as development projects or other projects adjacent to waterways. The regulations also state that a permitted activity cannot use more than 20% of any remaining assimilative capacity of a high-quality water (Class A) on a parameter-by-parameter basis. Unimpaired waters are treated as high quality where there has been no formal designation.

2.1.3. Impairment Status

Crescent Lake has 12 Assessment Unit IDs (AUIDs) according to NHDES' 2024 Watershed Report Card, which summarizes information from the 2024 305(b)/303(d)lists (*NHDES 2024b*). However, only three locations - Crescent Lake, Cold River, and Northeast Inlet - have enough data for NHDES to formally designate them as marginally impaired. Crescent Lake is marginally impaired for Aquatic Life Integrity (ALI) due to low pH. According to NH DES, the desirable range for pH is 6.5 to 8.0. The state median pH value for the epilimnion in New Hampshire's lakes and ponds is 6.6, which indicates that the state surface waters are slightly acidic. Historical trend analysis since monitoring began indicates that the epilimnetic pH levels in Crescent Lake are stable, yet variable, fluctuating around the low end of the range. According to NHDES, due to the state's abundance of granite bedrock in the state and acid deposition received from snowmelt, rainfall, and atmospheric particulates, there is little that can be feasibly done to effectively increase lake pH. The Cold River and the Northeast Inlet river segments are marginally impaired for ALI due to low pH and for Primary Contact Recreation due to elevated *E. coli* bacteria concentrations exceeding thresholds during testing in 2010. Additionally, the NH Statewide Mercury Advisory that limits consumption of fish applies to all Assessment Units in the Crescent Lake watershed.

Table 1. NHDES Assessment Units in the Crescent Lake Watershed.

Assessment Unit Name	AUID	Map ID	Area (acres) / Length (miles)
Crescent Lake	NHLAK801070201-01	L*01	127.302
Cold River	NHRIV801070201-01	R*01	4.812
Unnamed Brook - To Crescent Lake From Northeast Inlet	NHRIV801070201-03	R*03	4.583
Unnamed Brook - To Crescent Lake	NHRIV801070201-04	R*04	0.705
Shorewood Inlet	NHRIV801070201-17	R*17	0.222
Crescent Lake-Page Rd	NHRIV801070201-18	R*18	0.398
Unnamed Brook	NHRIV801070201-19	R*19	0.629
Unnamed Brook	NHRIV801070201-20	R*20	0.420
Unnamed Brook	NHRIV801070201-21	R*21	0.613
Unnamed Brook	NHRIV801070201-22	R*22	0.336
Unnamed Pond	NHLAK801070201-03	L*03	9.035
Unnamed Brook	NHRIV801070201-21	R*25	0.613

2.1.4. Water Quality Data Collection

Volunteers from the Crescent Lake Association have been participating in the NHDES Volunteer Lake Assessment Program (VLAP) since the 1990s, with a focus on nutrients, dissolved oxygen, specific conductance, chloride, acidity, and water clarity. Figure 5 shows the current VLAP sampling locations at the two major tributaries to the lake: the West Inlet – CREACWW (Sleeper Brook) and the Northeast Inlet – CREACW1 (an unnamed stream originating from Potato Hill); the Deep Spot – CREACWD (the deepest point of the lake); and the Dam Outlet - CREACWO. Parameters sampled at the deep spot include temperature, dissolved oxygen, total phosphorus, chlorophyll-*a*, Secchi disc transparency, specific conductance, chloride, pH, color, turbidity, and alkalinity. Parameters sampled at the tributary inlets include total phosphorus, specific conductance, chloride, pH, and turbidity.

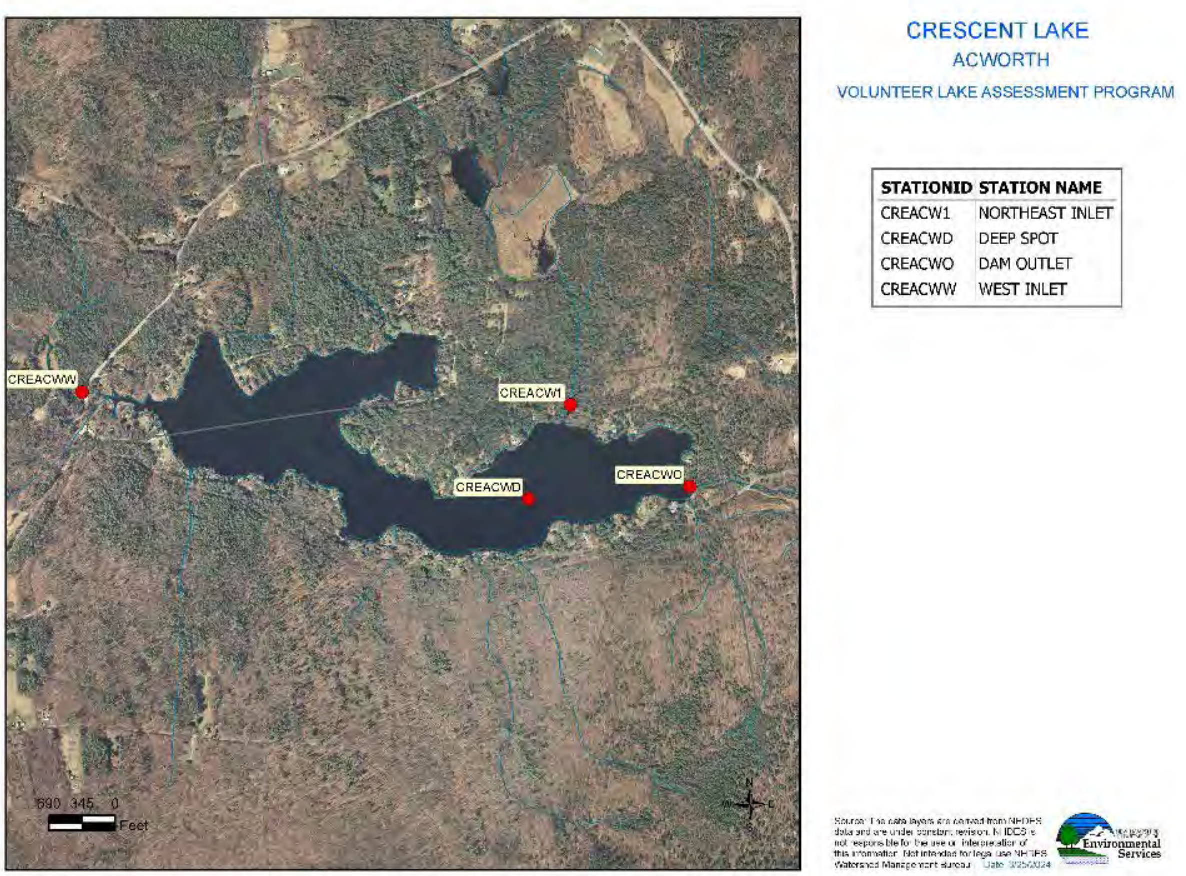

Figure 5. Long-term VLAP sampling locations at Crescent Lake.

2.1.5. Trophic State and Indicator Parameters

Total phosphorus, Secchi disc transparency, and chlorophyll-*a* are trophic state indicators; these indicators can be used to assess the biological productivity in a lake, establish its trophic state (the degree of eutrophication), and identify changes over time. The Aquatic Life Integrity (ALI) criteria for trophic classes in New Hampshire are presented in Table 2.

Table 2. ALI nutrient criteria ranges by trophic class in New Hampshire.

Trophic State	TP (μg/L)	Chl-*a* (μg/L)
Oligotrophic	< 8.0	< 3.3
Mesotrophic	> 8.0 – 12.0	> 3.3 – 5.0
Eutrophic	> 12.0 – 28.0	> 5.0 – 11.0

Total phosphorus measures all forms of organic and inorganic phosphorus present in a sample. Phosphorus in freshwater systems is a plant growth limiting nutrient, which means the amount of phosphorus available affects the amount of algae growth. Algae and cyanobacteria both contain the photosynthetic pigment chlorophyll-*a*, so the concentration of chlorophyll-*a* is used to measure algal and cyanobacterial abundance. A higher chlorophyll-*a* concentration means a larger algal and/or cyanobacteria biomass. Total phosphorus concentrations in Crescent Lake typically fall within the mesotrophic range. No statistically significant differences in concentrations of total phosphorus between the epilimnion and the hypolimnion have been observed (Figure 6), although the mean, median, and maximum concentrations are all higher in the hypolimnion. This suggests that there is minimal internal phosphorus loading (phosphorus release from sediment to the water column) occurring in this lake. Long-term trends for total phosphorus and chlorophyll-*a* in Figure 7 show stable concentrations since record keeping began, with a slight uptick in the last few years. Transparency has declined since the late 1990s.

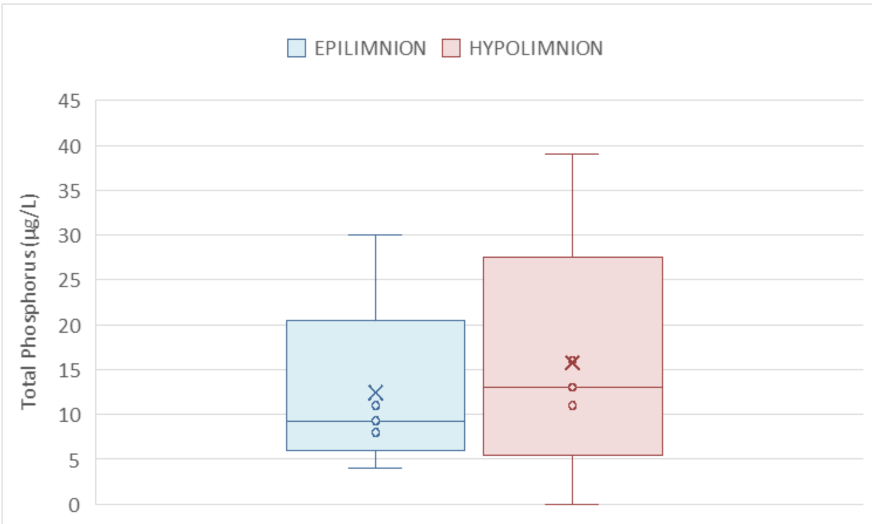

Figure 6. Boxplots showing the range of total phosphorus concentrations in the epilimnion and hypolimnion of the deep spot of Crescent Lake.

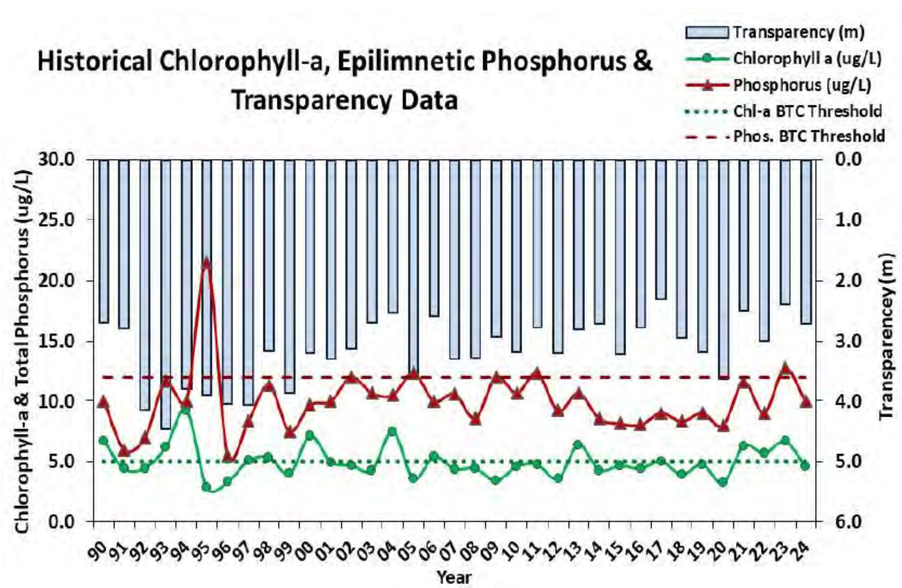

Figure 7. Long-term trends in total phosphorus, chlorophyll-a, and transparency in Crescent Lake from the 2024 VLAP Lake Report.

2.1.6. Dissolved Oxygen

Many lakes in New England are depleted of oxygen in their deepest areas through the summer. This is a natural process that can be made more severe by human disturbance. Biological and chemical processes occur in deeper waters, depleting oxygen through the summer months. Since these waters are colder and more dense, oxygen cannot be replenished through mixing in the water column or through photosynthesis, since plant growth is limited by lack of light. Dissolved oxygen concentrations lower than 5 mg/L are not tolerated by most aquatic organisms, causing stress and resulting in a lack of habitat. Anoxia—a condition when dissolved oxygen concentrations are less than 2 mg/L—can result in the release of sediment-bound phosphorus. This makes the water column conditions more favorable to algae and cyanobacteria growth.

Summer dissolved oxygen trends in Crescent Lake have remained consistent since the 1990s. Vertical profiles of dissolved oxygen concentration have historically been collected once per summer, with epilimnion concentrations averaging 8 mg/L and hypolimnion concentrations averaging as low as 1 mg/L as shown in Figure 8. This suggests organisms are consuming oxygen and that there is the potential for release of sediment-bound phosphorus.

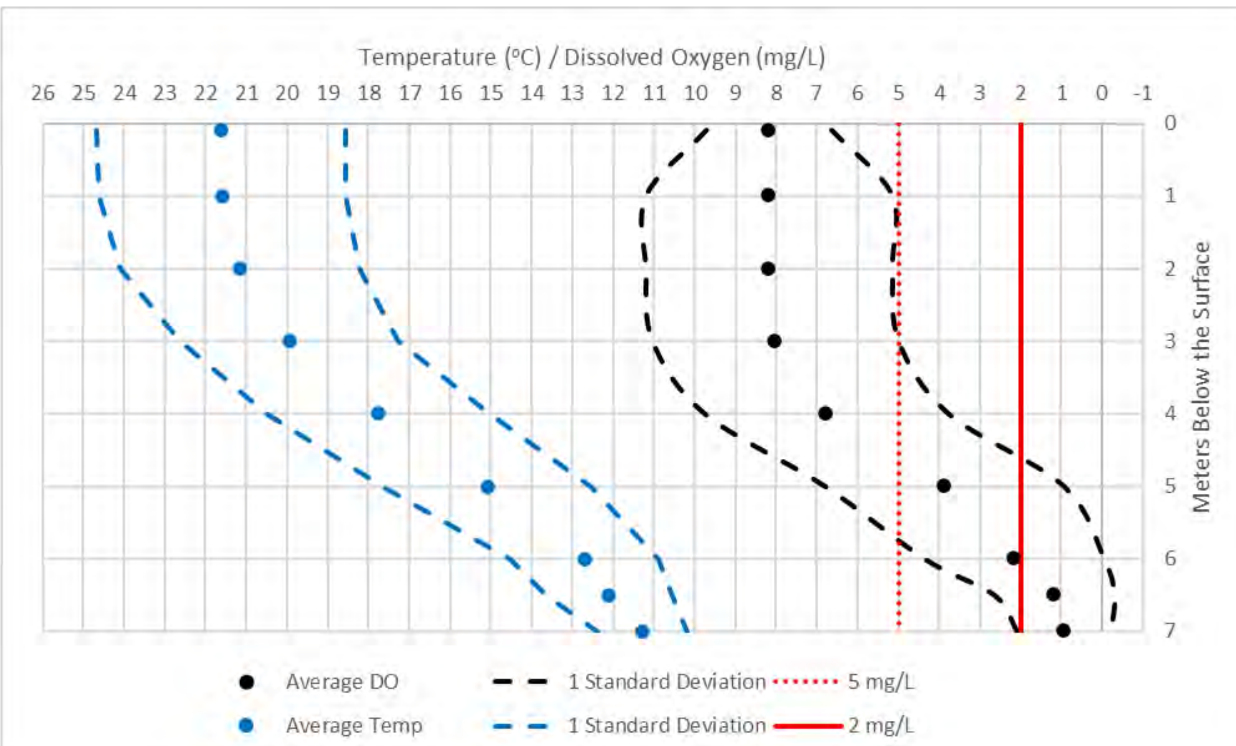

Figure 8. Dissolved oxygen profile summary 1990 to present.

2.1.7. Phytoplankton, Zooplankton, and Aquatic Plants

Phytoplankton and zooplankton samples were collected and analyzed during the 1979 and 1992 Lake Trophic Surveys (Table 3). The dominant phytoplankton species were *Asterionella* (diatom), *Chrysosphaerella* (golden-brown), *Rhizosolenia* (diatom), and *Dinobryan* (golden). The dominant zooplankton species were *Keratella* (rotifer), *Polyarthra* (rotifer), *Vorticella* (rotifer), and *Synchaeta* (rotifer). The 2024 VLAP Report also provides the relative percent cell count of various phytoplankton taxa in 2016, 2018, 2021, 2023, and 2024. Based on these data, diatoms and golden-browns typically dominate the phytoplankton community in Crescent Lake. However, large percentages of cyanobacteria were observed in the 2016 and 2024 sample events. The balance of biology in a lake system is constantly changing through growth cycles, competition, and predation so the results of a single sample for phytoplankton and zooplankton strongly depend on the time of year. Golden-brown algae are an indicator of clean, low-nutrient lakes. Diatoms tend to dominate in the spring and early summer before a lake fully stratifies and cyanobacteria use excess nutrients to form nuisance blooms. Additional data collected across multiple months during early spring and late fall would help clarify the phytoplankton dynamics in Crescent Lake. Thankfully, no nuisance cyanobacteria blooms have been reported to date.

Table 3. Phytoplankton and Zooplankton Data Summary for Crescent Lake from NHDES Lake Trophic Survey Reports.

Date	Phytoplankton Species (% Total)	Total Phytoplankton Count (cells/mL)	Zooplankton Species (% Total)	Total Zooplankton Count (cells/L)
3/1/1979	*Asterionella* (95%)	-	*Keratella* (80%)	-
7/7/1992	*Chrysosphaerella* (70%) *Asterionella* (15%) *Rhizosolenia* (5%)	705	*Keratella* (38%) *Polyarthra* (22%) *Vorticella* (14%)	244
2/1/1993	*Dinobryan* (95%)		*Synchaeta* (54%) *Keratella* (39%)	114

Aquatic plant communities were assessed in June 2002 by Lycott Environmental and are generally consistent with the plant communities in the lake today. No invasive aquatic plants were identified during the 2002 survey and none have been recorded according to the NHDES Lake Information Mapper. Figure 9 shows the submergent and floating plants (plants that live entirely underwater or float on top of the water) and Figure 10 shows emergent plants (plants with their roots in the sediment that extend above the water's surface). The plants identified during the 2002 survey are generally consistent with native plant communities in New Hampshire. The lake is monitored by volunteers for invasives. We would recommend additional plant community surveys every 5-10 years to monitor for changes and ensure that aquatic invasive species are caught early.

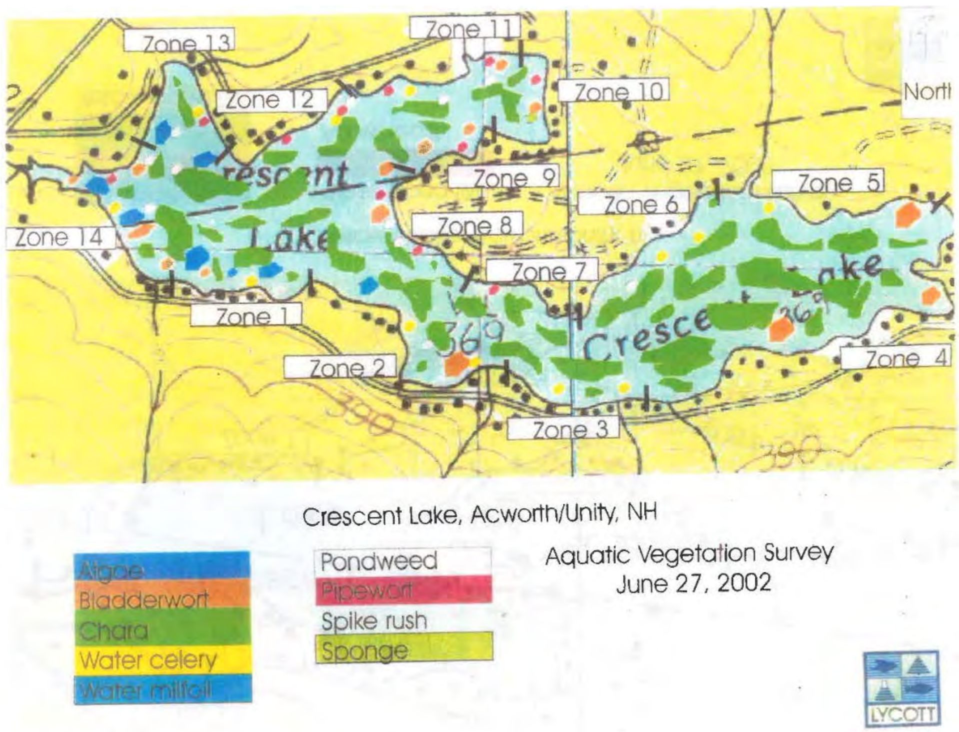

Figure 9. Native submergent and floating aquatic plants in Crescent Lake, 2002.

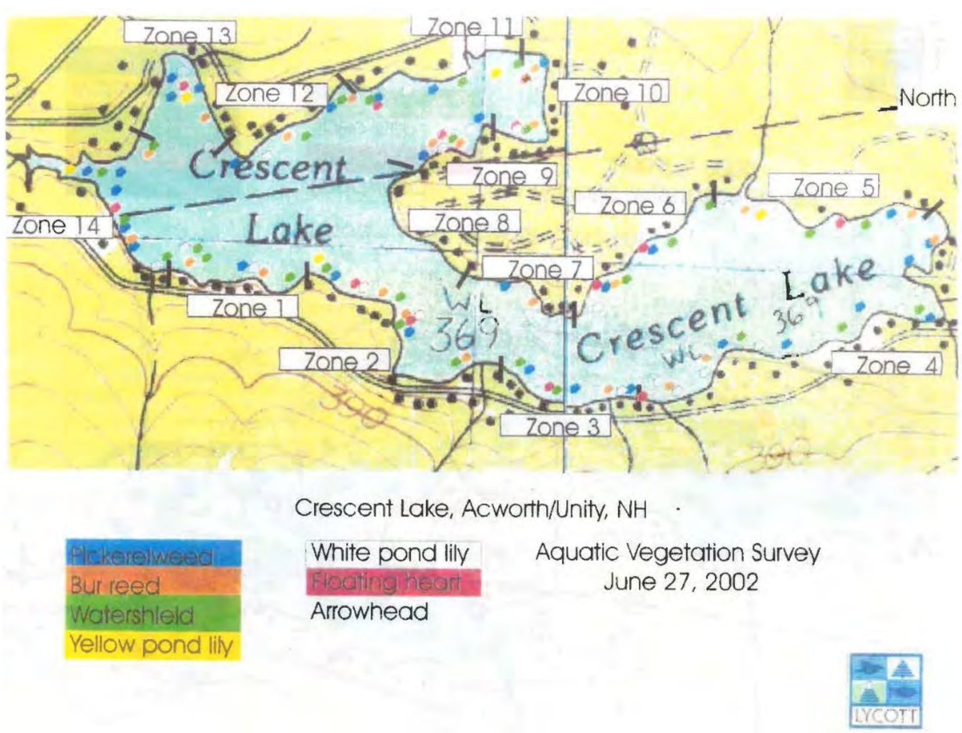

Figure 10. Emergent aquatic plants in Crescent Lake, 2002.

2.2. Assimilative Capacity

The assimilative capacity of a lake is the amount of a pollutant that can be added without exceeding the water quality criteria for its trophic state. For a mesotrophic lake like Crescent Lake, the criteria threshold is set at 12 μg/L for total phosphorus and 5 μg/L for chlorophyll-*a*, as shown in Table 2. NHDES also requires a 10% margin of safety between the best possible water quality and the water quality standard. This means that total phosphorus concentrations need to remain below 10.8 μg/L and chlorophyll-*a* concentrations below 4.5 μg/L.

Median values of total phosphorus and chlorophyll-*a* in Crescent Lake, using epilimnion data from the last 10 years, are 11 μg/L and 4.9 μg/L, respectively. This puts them below the threshold criteria but above the NHDES recommended buffer value. This means that Crescent Lake has low assimilative capacity, or no room for increases in nutrient loads. If nothing is done, the lake could transition to a eutrophic lake, leading to excessive vegetation growth, the increased probability of nuisance cyanobacteria blooms, and decreased water quality for recreation. Further reductions in total phosphorus loading are needed to reduce the risk of cyanobacteria blooms.

3. Watershed Modeling

The Lake Loading Response Model (LLRM) is an Excel model that uses a variety of environmental data to mathematically represent water and phosphorus loading budgets for lakes and their watersheds (*AECOM 2009*). LLRM was developed by AECOM for use in New England and modified for New Hampshire lakes by including New Hampshire land use total phosphorus export coefficients where available. The model calculates annual water and phosphorus loads from sources in the watershed, routed through tributaries, and into the lake. The model is built on watershed characteristics such as land cover, point sources (if applicable), number of septic systems, waterfowl counts, annual rainfall, lake volume and surface area, and internal phosphorus loading from lake sediments. The model was further refined with land cover coefficients for water and phosphorus loadings, phosphorus attenuation factors, and equations and default values from scientific literature on lakes, rivers, and nutrient cycling to improve predictions for annual average total phosphorus and chlorophyll-*a* concentrations, Secchi disk transparency, and algal bloom probability. These outputs can then be compared to field collected data for calibration. Once the model is calibrated it can be used to identify current pollutant sources and forecast future conditions. By comparing model outputs to target water quality criteria the model can be used to target specific areas in the watershed for nutrient load reduction projects.

3.1. Watershed Delineation

Watershed delineations are needed to calculate how the characteristics of a watershed such as land use and topography affect the amount of water and nutrients discharging to a lake. Stone completed the delineations by combining the USGS National Watershed Boundary Dataset (WBD) (HUC-12 01080107201 Headwaters Cold River) watershed delineation as well as USGS StreamStats watershed outputs for more detailed delineations. We manually edited the delineations based on our knowledge of the area and field observations.

The three main subwatersheds in the Crescent Lake watershed are Sleeper Brook, Potato Hill, and direct drainage to the lake, shown in Figure 11. The Potato Hill subwatershed is drained by an unnamed tributary that outlets at the northeast end of Crescent Lake.

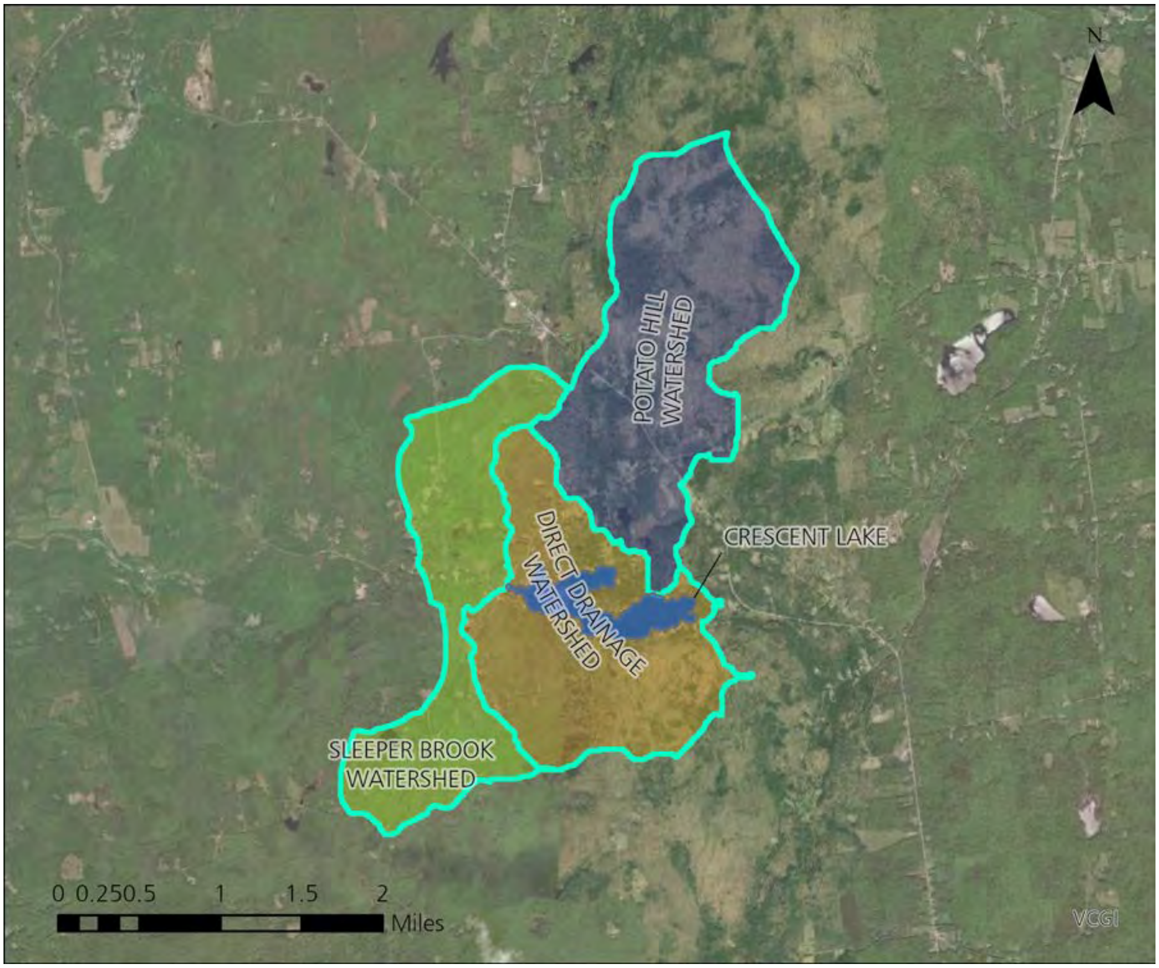

Figure 11. Crescent Lake sub-watersheds.

3.2. Land Cover

For the purposes of parameterizing the LLRM model we are interested in how land cover impacts phosphorus loads and water runoff. Without good quality land cover data in a model, results can vary significantly depending on scale. We found the best starting point for southwestern New Hampshire is the 2001 New Hampshire Landcover Database (NHLCD), a dataset comprised of 30-meter square grids collected between 1996 and 2001 (*Justice 2016*).

A 30-meter square grid can be useful for models at the state or national level. However, for a watershed model at the scale of the Crescent Lake watershed, this resolution is inadequate. Therefore, we compared the land cover dataset with the most recent New Hampshire aerial imagery, from 2021-2022. If differences between the aerial imagery and the land cover dataset were found, the land cover dataset was edited in ArcPro. Any new polygons were assigned the appropriate LLRM land cover category. An example of the type of land cover polygon update is shown in Figure 12 below:

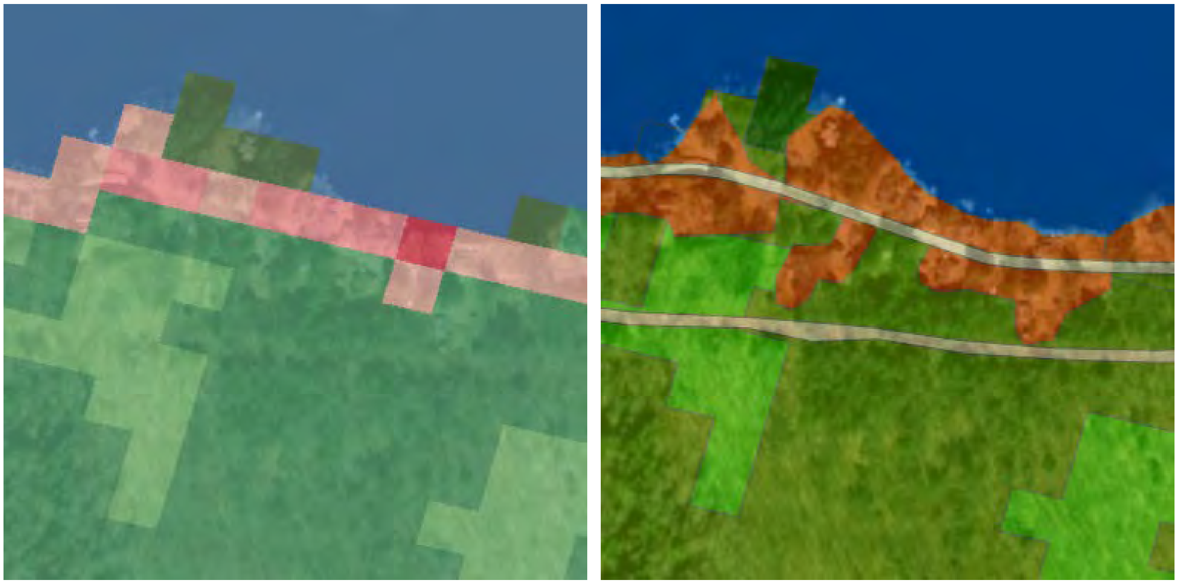

Figure 12. Example update to land cover dataset using ArcPro.

Assumptions we made in refining the land cover dataset were:

- Forest, forested wetlands, and wetlands were not edited unless they were shown as cleared in the aerial photographs
- Any new forest polygons were categorized as Mixed Forest
- Areas with logging were categorized as a mixture of Forest and Shrub/Scrub

Each land cover category in an LLRM model is given export coefficients representing typical phosphorus loads in runoff and baseflow. Agriculture and urban development land covers tend to release more phosphorus when it rains due to sources such as fertilizers or soil erosion, while forested and natural land covers release very little. Table 4 presents the land cover areas by watershed and the runoff and baseflow phosphorus export coefficients for each land cover in the model.

Table 4. Land Cover Areas (in Hectares) and Phosphorus (P) Export Coefficients (in Kg/Hectare/Year) for Crescent Lake Subwatersheds.

Land Cover	Runoff P Export Coefficient	Base Flow P Export Coefficient	Potato Hill (NE Inlet)	Sleeper Brook (West Inlet)	Direct Drainage Area
Pasture	0.80	0.010	4.36	2.95	0.80
Forest	0.02	0.004	488.83	321.26	397.38
Non-Forested Wetland	0.08	0.004	7.74	3.56	-
Open Land	0.80	0.004	8.68	-	-
Medium Density Residential	1.10	0.015	-	-	12.38
Low Density Residential	1.00	0.010	23.37	25.90	28.94
Very Low Density Residential	0.90	0.010	0.37	1.11	1.77

Land Cover	Runoff P Export Coefficient	Base Flow P Export Coefficient	Potato Hill (NE Inlet)	Sleeper Brook (West Inlet)	Direct Drainage Area
Transportation	1.50	0.010	11.18	9.89	10.45
Waste Disposal	1.10	0.010	-	-	-
Water	0.009	0.004	0.37	3.91	53.96
		TOTALS	**589.76**	**398.31**	**520.31**

Areas of high phosphorus export are primarily concentrated in the direct drainage watershed and the developed shoreline of Crescent Lake as well as development adjacent to roads in the Potato Hill and Sleeper Brook subwatersheds. Very Low to Medium Density Residential Development and Transportation land covers account for only 8.3% of the whole watershed while producing an estimated 76% of the surface runoff phosphorus load. On the other hand, Forested and Forested Wetland land cover accounts for 85% of the watershed area while producing only 14% of the surface runoff phosphorus load.

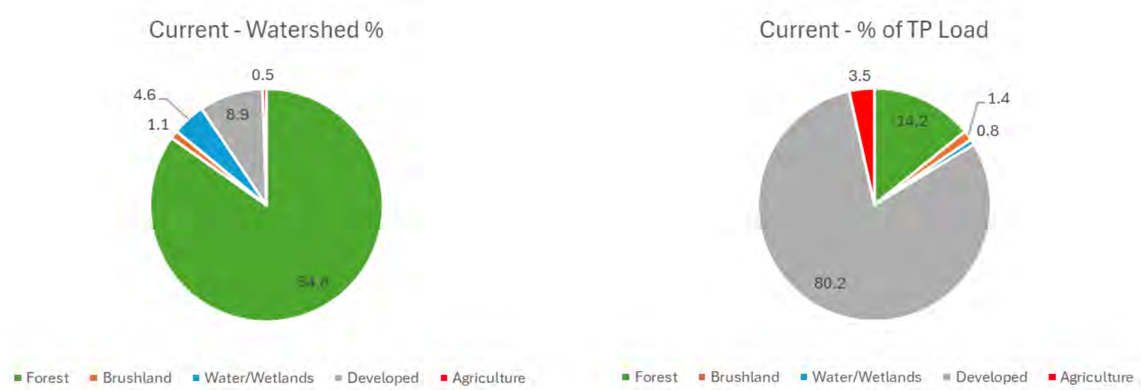

Figure 13. Watershed land cover percentage (left) and relative percentage of total phosphorus load by land cover (right).

3.3. Other LLRM Inputs

3.3.1. Precipitation Data

Daily precipitation data were analyzed from the National Oceanic and Atmospheric Administration's National Centers for Environmental Information (NOAA NCEI) for West Unity, NH (Station ID: US1NHSL0003). The average annual precipitation from 2010 to 2024 was input to the LLRM model (40.9 inches or 1.05 meters).

3.3.2. Lake Volume and Area Estimates

Lake volume and area estimates were derived from a bathymetric shapefile via NH GRANIT. This data is based on sounding data collected by the New Hampshire Fish & Game Department (NHFGD) and New Hampshire Department of Environmental Services (NHDES). The bathymetry contours were put into AutoCAD Civil 3D to calculate volumes of the entire lake and the hypolimnion.

3.3.3. Data for Septic Systems

All residents at Crescent Lake rely on septic systems to treat their wastewater as connection to a public sewer is not an option. Septic systems can be a source of phosphorus to freshwater systems, especially if the systems are aging or were not designed up to standards. Due to the density of camps and increasing number of year-round residences along the shoreline, this is a significant contributor of phosphorus loading to the lake. Data for septic systems for properties adjacent to Crescent Lake and within 250 feet of the shoreline were obtained from state and local records compiled by the CLA Water Quality Group. These data included the age and capacity of the system and an estimate of whether the property is a seasonal or full-time residence.

There are approximately 200 parcels within a 250-foot buffer around the lake. Of the developed parcels, information about septic systems was gathered from the NHDES septic system database for 129. Of these, 21 were permitted in the last 10 years, 24 in the last 20 years, 18 in the last 30 years, and 15 in the last 40 years. 51 of the parcels are assumed to have some sort of system, but permit data was not readily found in the NHDES database. The remaining properties are either undeveloped, or nothing is known about the system. Aging septic systems that do not meet current standards or are undersized for their current use are more likely to fail and contribute phosphorus to the lake.

For a model input, this data was simplified to aid in calibration. It was assumed that only properties with a habitable structure would contribute phosphorus to the lake via a septic system. This meant there were 139 properties with the potential to contribute phosphorus via domestic wastewater from individual subsurface septic systems. Based on anecdotal evidence it was assumed that 75% of the properties were seasonally occupied (90 days per year) and 25% were year-round residences (365 days per year). Both groups were assigned the default values of 2.5 people per dwelling, use 0.25 cubic meters of water per day per person, with a domestic wastewater phosphorus concentration of 8 mg/L. The attenuation factor was then adjusted within the reference variable range during calibration.

3.3.4. Waterfowl

Waterfowl counts are primarily based on anecdotal information from residents at the lake. The anecdotal values were confirmed by checking bird data collected on eBird (https://ebird.org/hotspot/L4464364) for Crescent Lake. Our best professional judgement was used to interpret anecdotal and count information. From these sources we assumed that an average of 30 waterfowl reside at the lake for half the year. It should be noted that while waterfowl are considered a direct source of nutrients to lakes in the model, the net effect may be less than assumed if they consume material from a lake and their waste returns to the same body of water. However, phosphorus taken up from the sediment by aquatic plants and consumed by waterfowl may be excreted in the lake in a form more supportive of algae growth.

3.3.5. Water Quality Data

Water quality data were retrieved from the NHDES Environmental Monitoring Database. Total phosphorus, chlorophyll-*a*, and Secchi disk transparency data at four sampling stations from 1990 to 2024 were analyzed for use in the model: Crescent Lake Deep Spot (CREACWD), the Northeast Inlet (CREACW1), the West Inlet (CREACWW), and the Dam Outlet (CREACWO). Recent total phosphorus data from the Northeast Inlet and West Inlet were used as guidelines for setting phosphorus attenuation factors in the Potato Hill and Sleeper Brook watersheds and confirming overall model calibration.

For lakes without large internal phosphorus loads or point sources (such as a wastewater treatment plant discharges), average summer epilimnion total phosphorus concentrations are typically lower than average annual concentrations by 14 to 40% with a median of 20% (Nürnberg 1996, Nürnberg 1998). This is due to low baseflow in summer limiting phosphorus transport from the watershed to the lake. With most sampling for the VLAP program occurring during the summer months (June-September), this likely drives the average and median total phosphorus concentrations down. Therefore, the median total phosphorus concentration in the epilimnion at the Crescent Lake Deep Spot sampling location (10.0 μg/L) was increased by 20% to 12 μg/L to calibrate the overall model.

3.3.6. Internal Loading Estimates

Phosphorus that enters the lake and settles in the sediment can be released when the dissolved oxygen concentration at the sediment-water interface declines. This "internal loading" supplies nutrients for algae, cyanobacteria, and plants, and contributes to eutrophication. Internal loading of phosphorus in Crescent Lake was evaluated using dissolved oxygen and temperature profiles and epilimnion/hypolimnion total phosphorus concentration data collected at the Deep Spot. Water with a dissolved oxygen concentration less than 1.0 mg/L is considered anoxic. With the anoxic volume of the lake, sediment surface area, and the difference in phosphorus concentration between the surface and bottom waters, we can estimate a mass of internal phosphorus loading per year.

There is evidence of an extended anoxic period between June and September. Measurement of dissolved oxygen was limited beyond the past few years, but historic dissolved oxygen profiles show that the bottom of the lake at the deep spot has reached anoxic levels since sampling began in 1990. However, based on the phosphorus concentration data, there is no evidence of significant internal loading in Crescent Lake. These results suggest that the sediment phosphorus store is not especially large or reactive (subject to release under low oxygen conditions).

3.4. Calibration

In order for an environmental model like an LLRM to reliably forecast future changes, it must be calibrated by bringing model results into agreement with measured data. As stated previously, total phosphorus concentration data from the Northeast Inlet and West Inlet were used as targets for setting phosphorus attenuation factors in the Potato Hill and Sleeper Brook subwatersheds. The median epilimnion total phosphorus concentration was used as the target for the overall model. To bring the model into agreement with these targets, the LLRM default parameter values were adjusted within reasonable ranges, considering environmental conditions and literature values.

The following calibration parameter values and assumptions were made for the model:

- **Standard water yield:** Selected 2.0 cubic ft/sq. m. This is the high end of the range for New England and reflects the watershed's steep slopes and high runoff potential.
- **Direct atmospheric deposition:** Since the Crescent Lake watershed is largely undeveloped, the phosphorus export coefficient was left as the default (0.11 kg/ha/yr; from *Schloss et al. 2013*).
- **Water attenuation factor:** Adjusted from default values according to Table 5. Water can be lost to the watershed through wetlands, evapotranspiration, and deep groundwater recharge. The LLRM model guidance recommends default values of 5% loss (95% pass through) for water. Due to the presence of wetland systems near the bottom of the Northeast Inlet and West Inlet watersheds, it made sense to increase the water attenuation factor, which was set to 15% (85% pass through) for both.
- **Phosphorus attenuation factor:** Adjusted from default values according to Table 2. Phosphorus can be removed through infiltration and plant uptake. The LLRM model guidance recommends default values of 10% (90% pass through) for phosphorus. Phosphorus attenuation factors were adjusted for the Potato Hill and Sleeper Brook subwatersheds to bring modeled watershed outlet concentrations within 10% of the measured values at the Northeast Inlet and West Inlet. This resulted in a 25% loss (75% pass through) for Potato Hill and no change from 10% (90% pass through) for the Sleeper

Brook. The direct drainage watershed values were left as the default because there were no observed data to target and because the steep slopes and lack of significant wetlands likely mean minimal water or phosphorus loss.

Table 5. LLRM Attenuation Factors

	Sleeper Brook	Potato Hill	Direct Drainage
Water Attenuation	0.85	0.85	0.95
Phosphorus Attenuation	0.75	0.90	0.90

- **In-lake phosphorus concentration prediction:** The LLRM uses an average of multiple empirical formulas published in the literature for predicting in-lake phosphorus concentrations. We excluded the Kirchner-Dillion 1975, Vollenweider 1975, Larsen-Mercier 1976, and Jones-Bachmann 1976 models because they all predicted phosphorus concentrations that were much higher (28-71%) than observed data. We retained two of the models (Reckhow General 1977 and Nurnberg 1998) because their predictions more closely matched observed phosphorus concentrations.
- **Septic system phosphorus attenuation factor:** The reference variable for the septic system phosphorus attenuation factor – or the portion of the phosphorus load that reaches the lake – falls within the range of 0.01 to 0.5 with a mean and median value of 0.10. This factor was adjusted within this range during calibration to a value of 0.13.

3.5. Model Limitations

It is important to understand the limitations of any model used when drawing conclusions. Without the benefit of significant monitoring data, we rely solely on default literature values and our best professional judgement to parameterize the model. We have a relatively high degree of confidence in the LLRM model predictions for Crescent Lake because the model incorporates long-term monitoring data. That said, we see the following as limitations of the model:

- The model is only a **snapshot in time**, estimating annual average concentrations based on the best information available. There is climatic, biological, and chemical variability throughout the seasons and over years that affect water quality. Therefore, the model should be regularly revisited and updated when significant changes occur in the watershed and as water quality data are updated.
- **Water quality data** for the watershed outlets is limited to grab samples in the summer. There are no flow-weighted concentration data for the watershed outlets, which would enable more accurate representations of pollutant loads during storms. Continued data collection at the existing sites paired with flow data would enable calculation of watershed loads.
- The **internal phosphorus loading estimates**, while a small portion of the overall load, are based on a limited dataset of early-season values. There is very little recent data collected in early spring prior to thermal stratification.
- **Land-cover export coefficients** were estimates from literature. While these have been updated to reflect New Hampshire-specific values, there could be local variation that is not accounted for.
- The **septic system phosphorus load** is based on a range of default literature values and rough approximations of year-round residences versus vacation homes.
- **Waterfowl** counts are based on limited observational data.

3.6. LLRM Results

3.6.1. Current Load Estimation

For the three areas of the model with observed total phosphorus data (Sleeper Brook, Potato Hill tributary, and Deep Spot), the model predictions were in good agreement, within 0-6% relative percent difference. Table 6 shows the model results compared with observed total phosphorus concentrations. At the Crescent Lake Deep Spot, the difference between values for chlorophyll-*a* and Secchi disk transparency was 18% and 4%, respectively. Variation is more likely in these values because the model does not account for all the biogeochemical processes occurring within the lake that contribute to these measures.

Table 6. Observed and Predicted Values for Total Phosphorus, Chlorophyll-a, and Secchi Disk Transparency.

	Sleeper Brook		**Potato Hill**		**Crescent Lake Deep Spot**	
	Observed	**Predicted**	**Observed**	**Predicted**	**Observed**	**Predicted**
Median Total Phosphorus (µg/L)	16	16	25	23	10 (12)*	12.03
Mean Chlorophyll-*a* (µg/L)	NA	NA	NA	NA	4.85	4.0
Mean Secchi Depth (m)	NA	NA	NA	NA	3.3	3.4

*This is the observed median total phosphorus concentration (10 µg/L) with the 20% increase in parentheses (12 µg/L).

With a calibrated model, it is possible to identify the relative contributions of phosphorus to the lake. Watershed runoff and baseflow were the largest phosphorus load contributors, accounting for 88% of the load (163.4 kg/yr). This was followed by septic systems at 8% (14.3 kg/yr), atmospheric deposition at 3% (5.7 kg/yr), and waterfowl at 2% (3.1 kg/yr). Internal loading made up a very small percentage of the overall load (0.04%, 0.1 kg/yr). This is shown in Figure 14 below:

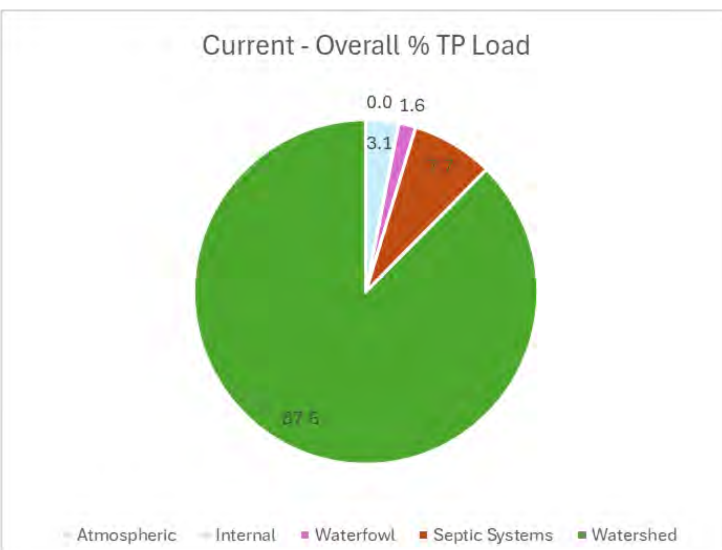

Figure 14. Overall percentage of total phosphorus load (kg/yr).

Of the three watersheds (Sleeper Brook, Potato Hill tributary, and the direct drainage area), the direct drainage area has the highest phosphorus load contribution per hectare. This makes sense because it is the most developed of the three watersheds, especially along the shoreline of Crescent Lake. The proximity to the lake also limits settling or uptake of phosphorus due to the steep slopes and reduced vegetation along the shoreline.

Table 7. Crescent Lake watershed outputs.

	Sleeper Brook	Potato Hill tributary	Direct drainage area
Total area (ha)	398.3	589.8	520.3
Percent developed (%)	9.3	5.9	10.3
Total TP Load (kg/yr)	48.3	50.2	64.9
TP Load by area (kg/ha/yr)	0.121	0.085	0.125

Since development is primarily concentrated along the shoreline, the direct drainage area also contains a substantial share of the septic systems. Septic systems and holding tanks located close to the shoreline of a lake often have little horizontal or vertical space for proper filtration of wastewater effluent. Improperly maintained or poorly sited systems can cause failures, leaching untreated wastewater effluent to the lake.

3.7. Base and Future Scenarios

3.7.1. Pre-Development Scenario

With a calibrated model, we can also change land cover and other factors to estimate pre-development phosphorus loading. The following assumptions were made to convert the current model to the pre-development scenario model:

- All Transportation and Residential Land Uses were changed to Forest,
- All septic tanks were removed from the model,
- Internal loading was set to 0

With these assumptions, the estimated pre-development total phosphorus loading to Crescent Lake was 33.2 kg/yr. The current loading estimate of 185.8 kg/yr is a 460% increase over pre-development conditions. These additional phosphorus sources are coming from watershed runoff, septic systems, atmospheric deposition, waterfowl, and internal loading. Water quality before settlement was predicted to be excellent with low phosphorus and chlorophyll-*a* concentrations and high water clarity (Table 11).

3.7.2. Future Scenario

A full build-out analysis for the Crescent Lake watershed has not been conducted. However, trends in population growth and knowledge of land and property use changes in the area were used to confirm minimal land-use changes in the watershed and to estimate a future land-use state. The primary changes around the lake in the last 20 years, based on observation and comparison to the NHDES Shoreland Permit database, were the conversion of older camps and cottages to larger houses and the addition of garages and/or accessory dwelling units. In addition, much of the undeveloped land in the watershed is enrolled in New Hampshire's Current Use Program. This would mean a significant one-time penalty and ongoing tax increases if that land were to be converted to development. As of 2023, the majority of the land area for the Towns of Acworth and Unity were designated as Current Use, as shown in Table 8 (State of New Hampshire 2023).

Table 8. Current Use Program Breakdown for Acworth and Unity.

	Acworth	Unity
Total area (acres)	24,917	23,657
Total CU (acres)	19,978	17,531
% CU	80.2	74.1

An analysis of potential population growth suggests there is likely to be minimal demand for new housing in Acworth and Unity in the next 20-30 years, and that the population will decrease below current levels by 2050. The New Hampshire Department of Business and Economic Affairs published projected populations from 2020-2050 for Acworth and Unity (State of New Hampshire 2022), which are summarized in Table 9.

Table 9. Population Projections for Acworth and Unity, New Hampshire.

Year	Population in Acworth	% Change	Population in Unity	% Change
2020	853	NA	1518	NA
2025	870	2	1549	2
2030	880	1.1	1566	1.1
2035	880	0	1566	0
2040	871	-1	1549	-1.1
2045	854	-2	1520	-1.9
2050	835	-2.2	1485	-2.3

The current-use program enrollment data and population change projections indicate that land-use change due to increased population growth and the potential for a theoretical "full build-out" scenario are unlikely.

Observations of property changes from the CLA Water Quality Group, which are summarized in Table 10, document activities that have increased or decreased impervious area on properties along the shoreline at Crescent Lake. Based on these observations, there is a trend toward increasing the amount of impervious surface on properties around the lake.

Table 10. Property changes from 2005 to 2025 at Crescent Lake.

Property Change	2005-2014	2015-2025
Demolish structure, leave lot vacant	0	3
Expand cottage	3	4
Add garage	5	7
New house on vacant lot	0	3
New house to replace cottage	9	9
Total property changes that increase impervious	**17**	**20**

To represent this land-use change, it was assumed that all of the properties adjacent to Crescent Lake, except for those properties in conservation easements, will eventually be completely developed to a Medium Density Residential level (50-79% impervious). Approximately half of the shoreline properties already meet the 50%

threshold, leaving around 60 properties that are either undeveloped or classified as Low Density Residential. If we assume that approximately 20 properties (based on the observational data) every 10 years go through some sort of land use change that increases impervious area to the 50% threshold, the lake shoreline will be fully Medium Density Residential by 2055. The number of septic tanks within 250 feet of the shoreline were not increased in the future state LLRM model. However, the phosphorus attenuation values were increased from 0.13 to 0.15 for the existing tanks, an increase of 2.2 kg P/yr, to represent the potential for increased use from accessory dwellings and new development.

Crescent Lake, like other places in New England, has experienced high intensity rainstorms in recent years, causing flooding and road damage. Modeling this change and its effects within the LLRM is difficult. The Future Scenario model did not assume an increase in precipitation over the next century (NOAA Technical Report NESDIS 142-1, 2013), because this would have resulted in a lower predicted in-lake phosphorus concentration. This is because the model cannot account for the rate and distribution of the future increase in precipitation, only a total volume. Storm frequency and intensity models predict higher intensity rain events that may increase soil erosion and transport of phosphorus-laden sediment to surface waters.

Based on these model changes, the Future Scenario model predicted that total phosphorus loading to Crescent Lake may increase from current conditions by 9.9%, from 186.5 kg/yr to 204.9 kg/yr from 2025 to 2055. The model predicted higher phosphorus concentrations, higher chlorophyll-*a*, and lower water clarity compared to current conditions, as shown in Table 11. Using the current and predicted values for chlorophyll-*a*, an estimate for algal bloom frequency was calculated in the LLRM that estimates an increase from a 1.9% probability to a 9.3% probability. This means that under current conditions, algal blooms are predicted to occur on approximately seven days of the year and that, if future loads are not mitigated, algal blooms could increase to over a month each year. While seven days of blooms are not currently being observed in Crescent Lake, the order of magnitude increase from single-digit days to tens of days is the important output to consider.

Table 11. In-Lake Water Quality Predictions for Crescent Lake.

Model Scenario	Median TP (μg/L)	Predicted Median TP (μg/L)	Mean Chl-*a* (μg/L)	Predicted Mean Chl-*a* (μg/L)	Mean Secchi Depth (m)	Predicted Mean Secchi Depth (m)	Probability of Algal Bloom (μg/L >10)
Pre-Develop	NA	2.7	NA	0.4	NA	10.8*	0%
Current	10 (12)	12.0	4.9	4	3.3	3.4	1.9% (7 bloom days)
Future	NA	16.3	NA	5.8	NA	2.7	9.3% (34 bloom days)

*Predicted Secchi depth is greater than the depth of Crescent Lake.

3.8. Water Quality Goals and Objectives

The modeling results suggest that there was a significant increase in the in-lake phosphorus concentrations from pre-development to present day. If modest development in the watershed continues and is paired with more intense rainstorms, water quality will continue to decrease in Crescent Lake. Current chlorophyll-*a* and total phosphorus concentrations are at the upper limits of the NHDES recommended nutrient targets for aquatic life integrity for mesotrophic lakes (12 μg/L for total phosphorus; 5 μg/L for chlorophyll-*a*), leaving limited reserve capacity for Crescent Lake to assimilate additional nutrients if no changes are made. Therefore, we highly recommend setting strong objectives to protect water quality, including:

Objective 1: Reduce annual phosphorus loading from existing conditions by 10.2% (19 kg/yr) to meet the NHDES recommended reserve capacity in-lake concentration of 10.8 μg/L.

Objective 2: Mitigate phosphorus loading from future development by 6 kg/yr to maintain average summer in-lake phosphorus concentrations for the next 10 years (2035).

Along with establishing high-level objectives, setting interim goals builds in the flexibility to reassess water quality objectives after more data collection, potential increases in phosphorus loading from development, and increased frequency of intense rainstorms. At each interim goal year, progress toward the high-level objectives should be evaluated by updating the water quality data and the model. If the goal has not been met, the reasons should be identified and the interim goals adjusted to reflect this. For example, if water quality continues to deteriorate despite completing the recommended number of projects to meet the objectives, perhaps development is outpacing the original estimate. A more aggressive strategy should be employed to mitigate phosphorus loading from new development.

Table 12. Water Quality Objectives for Crescent Lake.

Water Quality Objective	**Interim Goals**		
	2026	2030	2035
Objective 1: Reduce annual Total Phosphorus (P) loading from existing conditions by 10.2%			
	Achieve 2.5% reduction in TP loading	Achieve 5% reduction in TP loading; re-evaluate water quality goals and progress	Achieve 10.2% reduction in TP loading; re-evaluate water quality goals and progress
Objective 2: Mitigate Total Phosphorus (P) loading from future development by 6 kg/yr			
	Avoid or offset 2 kg/yr in TP loading from new development	Avoid or offset 4 kg/yr in TP loading from new development; re-evaluate water quality goals and progress	Avoid or offset 6 kg/yr in TP loading from new development; re-evaluate water quality goals and progress

4. Pollutant Source Assessment

Sediment and soil erosion is a major contributor of phosphorus loading to waterbodies. Unstable or bare soils from clearing or construction, unvegetated shorelines, and eroding stream banks can contribute sediment due to fluctuating water levels and intense rain storms. Once in a waterbody, nutrients can be released from soil particles to the water column. This contributes to excess nutrient loading and eutrophication. Steep slopes in a watershed can make the problem worse by providing stormwater more energy and power to erode soil particles. It also reduces the chance for settling and infiltration.

The soils in the Crescent Lake watershed are a result of the weathering of the surficial geology in the area, formed over millennia through the layering of sediment, the retreat of the shallow sea that covered much of the northeastern United States, and the high heat and pressure that changed sedimentary rock to metamorphic rock. Bursts of molten material also contributed granite, an igneous rock, to the geology of the area. The shape of the landscape was formed during the end of the Great Ice Age when glaciers that covered much of North America melted, carving the bedrock and depositing unsorted glacial till material (Goldthwait et al 1951).

The soils in the Crescent Lake watershed are composed of 16 different soil series. The Monadnock fine sandy loam, very stony makes up the largest component (980 acres, 26%), with Monadnock-Lyman-Rock outcrop complex, very stony (543 acres, 15%), Peru fine sandy loam, very stony (419 acres, 11%), Marlow fine sandy loam (378 acres, 10%), Lyme-Moosilauke stone loams (318 acres, 9%), and a combination of 11 other soil series making up the remaining 29% of the watershed. The Monadnock fine sandy loam is a well-drained soil series and makes up the majority of the shoreline and steep hillsides of the watershed. This suggests that capturing and infiltrating stormwater is possible in the highest developed areas of the watershed. The watershed is relatively steep with 54% in the 0-10% slope range, 34% in the 10-20% range, and 13% greater than 20% slope. Steeper slopes are concentrated along the shoreline and the small mountains surrounding the lake as shown in Figure 15.

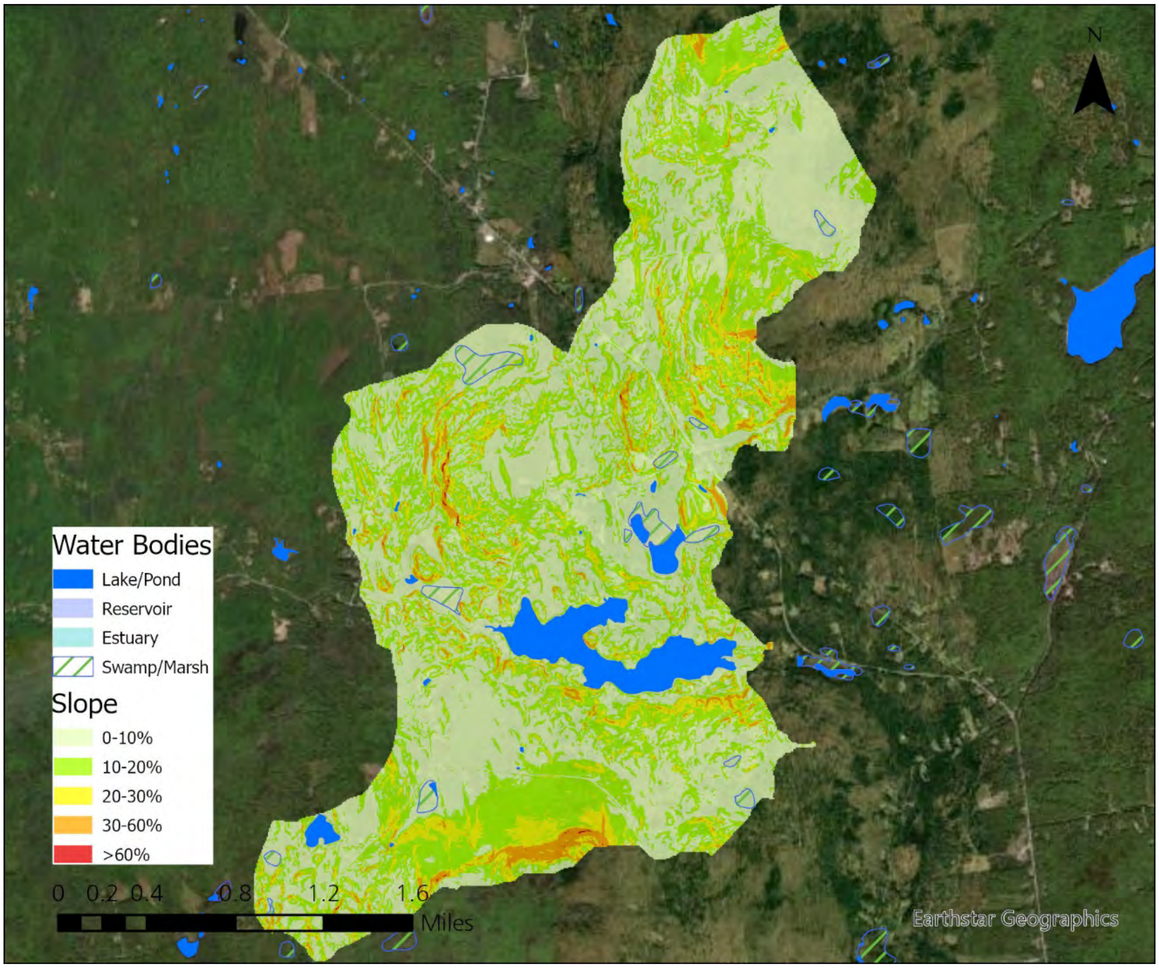

Figure 15. Land slope (%) in the Crescent Lake watershed.

4.1. Shoreline Assessment

Lake shorelines in New Hampshire are covered under the Shoreland Water Quality Protection Act (RSA 483-B) which establishes a 250-foot Protected Shoreland Area around the perimeter of lakes greater than 10 acres. The act regulates certain activities within the protected shoreland such as subdivisions, land development, and vegetation management. Two zones are regulated, the Waterfront Buffer and the Woodland Buffer. The Waterfront Buffer is the area of the shoreline located within 50 feet of the lake and was the primary area assessed during the shoreline assessment. This area is important in terms of shoreline stabilization, aquatic habitat and food sources, and filtering stormwater before entering a waterbody. Development around lakes in the northeast and legacy property management methods has left shorelines stripped of woody vegetation, structures close to shorelines, and unstable shorelines contributing sediment and nutrients to lakes.

Exposed shoreline sediment that is inundated at high water levels or hit with wind and wave action can erode and contribute sediment and phosphorus to a waterbody. Fluctuating water levels can also affect plants and animals along the shoreline by altering habitat or soil saturation conditions, impacting nesting locations, or altering food sources. Crescent Lake manages its water level for recreation purposes through raising and lowering the dam at the outlet. Raising the water level, paired with wakes from boats, and reduced vegetation along the shoreline is likely contributing phosphorus to the lake.

Stone staff engineers Alex Huizenga and Jared Ardman conducted a shoreline assessment of Crescent Lake on October 9, 2024. They were accompanied by a member of the CLA Water Quality Group who provided guidance and insight into known problem areas along the shoreline as the group traveled by canoe and kayak around the lake. Stone documented the condition of the shoreline for each property by taking photos for reference and inspection, identifying the type of shoreline (e.g., beach, seawall, natural, stone riprap) and percentage of the shoreline covered in vegetation, and assigning scores to the depth/extent of erosion. Using this information, Stone assigned an overall condition score (Good, Fair, Poor) and an initial priority (High, Medium, Low) for each property. After completing the field assessment of the shoreline, the results were further analyzed during a desktop exercise to review photos, confirm each property's assessment, measure the lengths of disturbed shoreline, assess the slope of the property, and update the overall condition score and priority for each property as needed.

Stone assessed 142 properties along Crescent Lake's shoreline. At the request of the CLA, no maps or photos of the shoreline assessment have been included in this report to protect the privacy of property owners. The CLA will hold a copy of the locations and recommendations to share individual property information to owners if requested. Histograms of the erosion and vegetation results are shown in Figure 16 and Figure 17 below. The Crescent Lake shoreline had relatively few major erosion issues where bare soil was exposed to wave action. Most of the issues identified were properties with minimal vegetation getting undercut through stone armoring due to shallow root structure. In many cases the grass along the shoreline is discolored or dying because of the lack of soil beneath it. The shoreline survey documented 86 properties had 30% or less vegetation cover along their shorelines and 41 properties with greater than 70%. Figure 18 shows the breakdown of properties based on the final overall condition score.

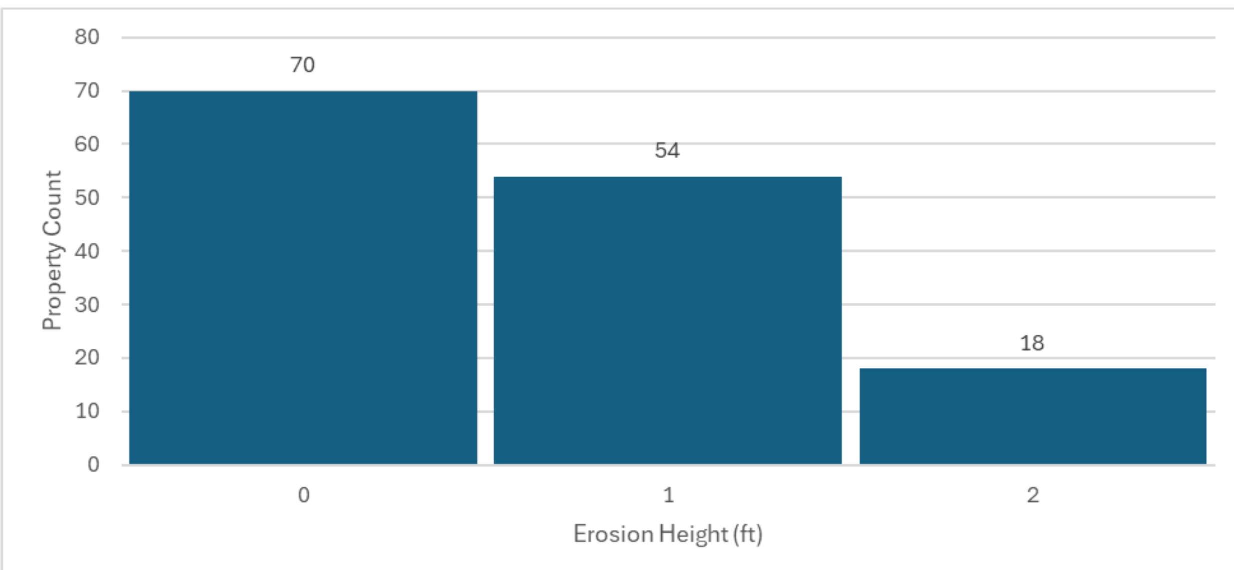

Figure 16. Histogram of Crescent Lake shoreline erosion.

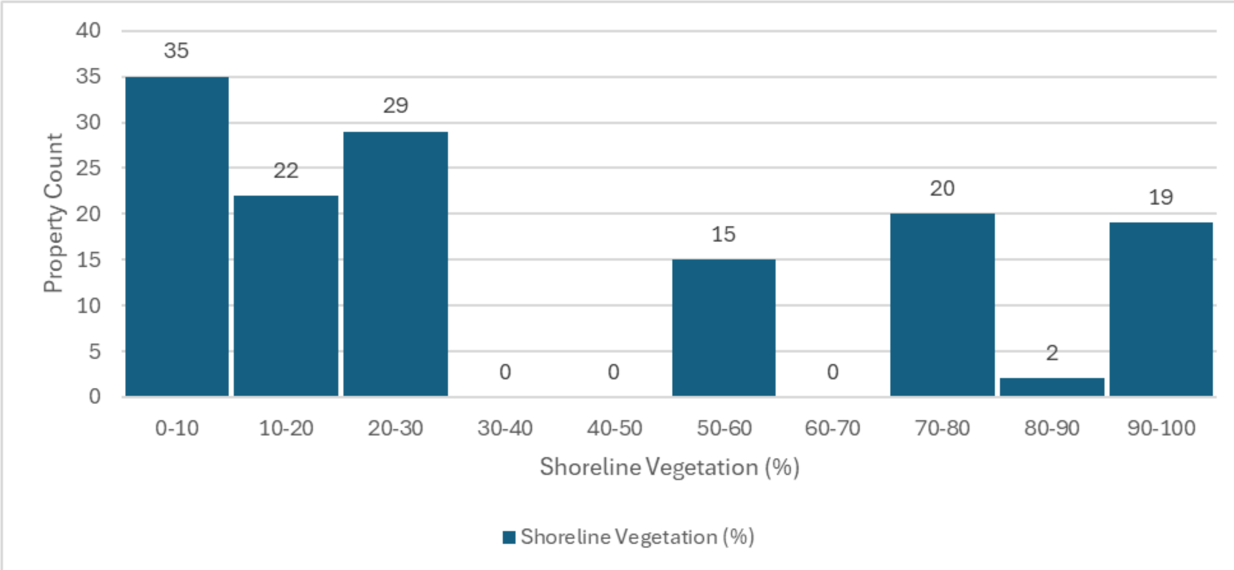

Figure 17. Histogram of Crescent Lake property shoreline vegetation cover percentage.

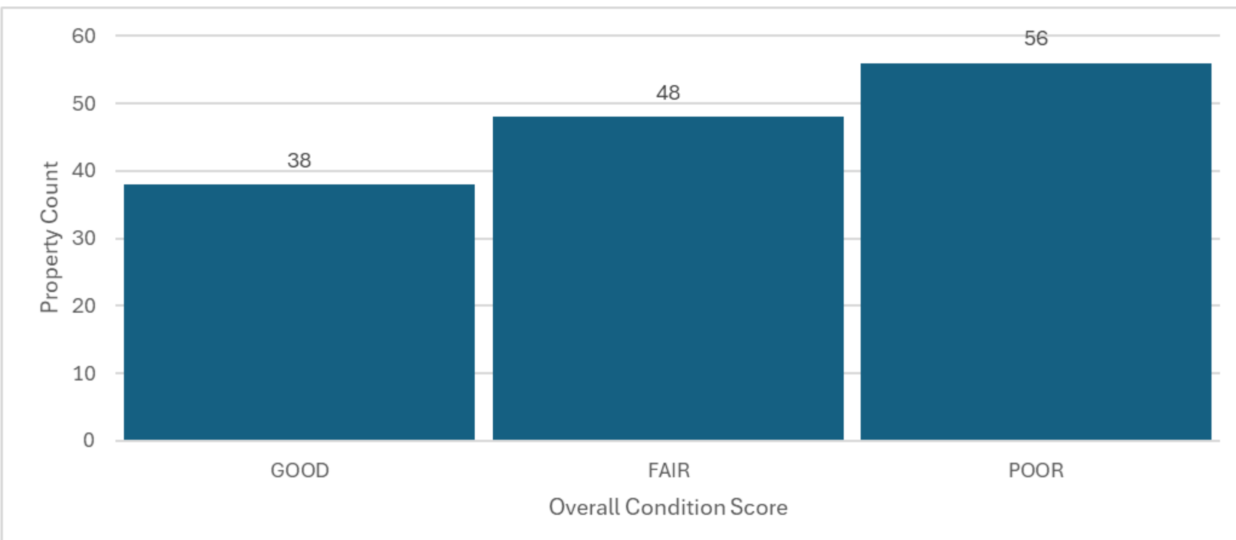

Figure 18. Histogram of Crescent Lake Property Shoreline Overall Condition Scores.

Stone staff then used the *Interim Phosphorus Reduction Calculation Tool* (https://dec.vermont.gov/document/interim-phosphorus-reduction-calculator-tool*)*, a tool developed by the State of Vermont that has been modified to represent New Hampshire-specific conditions, to estimate phosphorus loadings and reductions to the lake. The tool was modified by altering the average sediment phosphorus content to reflect a typical value for New Hampshire soils. The tool uses measured values of length of eroded shoreline and average bank height paired with an estimated shoreline recession rate (in inches per year) to calculate a volume of eroded sediment per year. The tool then uses the average phosphorus content value to estimate the mass of phosphorus entering the lake. Erosion rates typically occur in the range of zero to six inches per year with shallow, sloped, well-vegetated shorelines on the lower end and steep, vegetation-free shoreline or sandy beaches on the higher end. Based on the observed shoreline armoring practices and visible erosion occurring at the lake, we estimated a moderate shoreline recession rate of three inches/year for all properties. However, shoreline recession rates are difficult to estimate without multiple years of measurements at different locations, meaning some properties may have higher or lower rates.

We used phosphorus loads calculated by the tool for 55 properties with a final overall condition score of Poor and a priority ranking of Medium or High to analyze phosphorus reduction potential. One property, the Boat Launch, was omitted because that property is included in the Watershed assessment. These properties showed signs of active erosion and lacked vegetative cover, implying they are the largest source of phosphorus to the lake along the shoreline and the best opportunities for shoreline restoration. These properties are estimated to contribute approximately 18 kg (39 lbs.) of phosphorus to the lake per year. Shoreline restoration and stabilization is estimated to reduce phosphorus loading by 85%. This would require full shoreline restoration by planting a woody buffer of at least 15 feet. If all of the 55 property owners planted and stabilized their shorelines, that would reduce phosphorus loading to the lake by an estimated 15 kg (33 lbs.) of phosphorus per year.

The survey and related maps provided to the CLA identify which shoreline areas contribute most to phosphorus loading of the lake and therefore provide the greatest opportunity for restoration. We recommend planting the shorelines with native woody vegetation and improving vegetated buffers to the extent possible. In some locations, a more significant stabilization project using coir logs, encapsulated soil lifts, and/or stone toes may be necessary to re-establish a stable shoreline. These types of projects will require additional technical assistance to design and construct with the help of an experienced professional. Figure 19 presents an example of a well vegetated buffer and Figure 20 provides example details of a more significant shoreline stabilization project.

Figure 19. Example of well vegetated buffer along a lake shoreline. Source – nhlakes.org

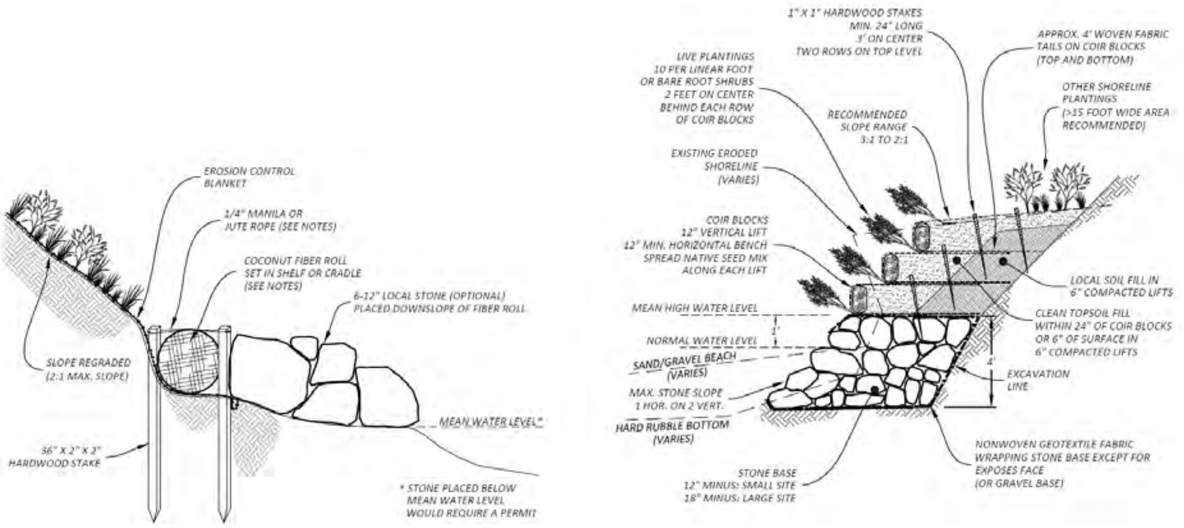

Figure 20. Left - Stone toe and coir roll bank stabilization. Right - Encapsulated soil lifts bank stabilization. Adapted from the Vermont Bioengineering Manual.

Property owners may be resistant to this sort of change, preferring a sandy beach or cleared view. However, shoreline restoration can be a great way to improve a property's aesthetic value, increase habitat, shade and cool the lake shallows, as well as reduce erosion. Encouraging participation in New Hampshire Lakes LakeSmart program (https://nhlakes.org/lakesmart/) and offering informational site visits to interested landowners are good ways of building awareness of the importance of well-functioning vegetative buffers and other lake-friendly practices.

Finally, we recommend continuing to monitor the lake for signs of shoreline erosion through a formal survey every 5-10 years, and informal observation during recreation. Changes in property ownership or signs of new construction are good opportunities to educate landowners about water quality.

4.2. Watershed Assessment and Nonpoint Source Sites

Stone conducted a watershed assessment in the Crescent Lake watershed to identify nonpoint source (NPS) sites contributing phosphorus to the lake to aid in the development of the WBMP. The survey was performed on November 19 and 20, 2024, by Alex Huizenga and Jared Ardman, accompanied by a member of the CLA Water Quality Group. Representatives from the Towns of Acworth and Unity met with Stone staff to discuss known problem areas along Crescent Lake Road and North Shore Road. Most of the public and private roads surrounding Crescent Lake were inspected for clogged culverts or failing stormwater drainage, eroding roadsides and ditches, and stream crossings.

NPS sites were documented with a short description of the issues, recommended actions for improvement, and photographs. We also took measurements of culvert inlets and outlets, bankfull and flood-prone widths for streams, and gully and ditch erosion lengths. The results were further analyzed during a desktop exercise to review photos, confirm the issue at each site, and update recommendations. Impact scores were assigned to each project (Low, Medium, High) based on their severity and hydrologic connectivity to the lake.

Phosphorus load reduction estimates and cost estimates were calculated to prioritize the 24 sites for implementation of SCMs. Phosphorus load reductions were calculated using the *EPA Region 5 Model for*

Estimating Load Reductions for culvert and gully restorations (https://19january2021snapshot.epa.gov/nps/region-5-model-estimating-pollutant-load-reductions_.html) and the online *Pollutant Load Estimation Tool (PLET)* for road and stormwater drainage projects (https://www.epa.gov/nps/plet).

Low- and high-cost estimates are presented to provide a cost range for each NPS implementation project. These estimates were based on similar projects Stone has completed and may not reflect local conditions such as town road crew labor rates and machinery use. The cost estimates should be further refined during project development to better reflect individual project conditions. Using the phosphorus load reduction value and the average cost estimate, we calculated an initial cost per kilogram of phosphorus reduction. This was further adjusted using the impact score to more heavily weight high-impact projects. Impact scores were assigned based on proximity to the lake, hydrologic connectivity to a stream that reaches the lake, and phosphorus loads. The projects were then ranked according to this impact-weighted cost per kg of phosphorus removal. The results of this analysis, a map of the project locations and project summaries can be found in Appendix A.

The total phosphorus reduction possible from the 24 projects is estimated to be 8.7 kg/yr. The sites with the largest contributions of sediment and phosphorus loads in the watershed were undersized, eroding culverts and streambank erosion. Gravel road erosion was another contributor with many small erosion sites on public and private roads around the lake. The top five cost-impact weighted projects are presented in Table 13 below. While these projects may not have the highest impact, they are the cost-effective projects with direct impacts on phosphorus loading to the lake. Conceptual designs for these projects along with a selection of other projects are included in Appendix B. These concept designs are high level and should be revisited prior to implementation to determine if more engineering analysis is required.

Table 13. Top five cost-impact weighted projects from the watershed survey.

Site ID	Location/Description	Impact	TP Load Reduction (kg/yr)	Estimated Avg Cost	Rank
W-14	Near 164 Crescent Lake Road Stream Erosion (AOC3* stream erosion)	High	0.68	$17,500	1
W-23	Hedgehog Hill Road/Ditch Erosion	Medium	0.36	$7,500	2
W-12	Cold Pond Road Ditch Erosion	Medium	0.34	$7,500	3
W-15	East Shore Road Erosion	Medium	0.29	$7,500	4
W-17	Near 89 Gove Road Culvert Outlet Erosion	Medium	0.28	$7,500	5

*AOC means Area of Concern visited by Town officials and the Stone team during the watershed assessment.

4.3. Watershed-Scale Projects

Many of the proposed NPS and shoreline projects are isolated locations with easily definable boundaries and phosphorus reduction estimates. In addition, the Stone team also identified two watershed-scale projects for Crescent Lake that can be implemented at multiple locations throughout the watershed and will also contribute to phosphorus reduction.

4.3.1. Wood Addition

The direct drainages and intermittent streams along the southern side of Crescent Lake are steep, concentrating stormwater runoff from the hillside during large storms. This leads to flooding on Crescent Lake Road and transports sediment to the lake from eroding streams and roadsides. Some of these drainages have been selectively logged or cleared along Gove Road for housing plots, reducing the amount of natural wood in the streams and increasing the amount of runoff. Woody material in streams naturally controls velocity, creating pockets within the steep drainage where flow slows down. Reintroduction of wood to these streams may be an effective way to reduce velocities in the stream, promote some infiltration and flow diversion where possible, and deposit sediment before it reaches the lake.

Stone performed an analysis in ArcGIS Pro to identify potential wood addition locations on the direct-drainage streams to Crescent Lake, which are shown in Appendix C. To produce the streamlines and proposed wood addition locations shown, we mapped depressions in topography that indicated a stream or drainage area. Streamlines were then traced to show areas where runoff will concentrate and flow down to Crescent Lake Road. Some of these streamlines correspond with currently mapped streams, but others indicate large drainage areas that may only flow during storms. Locations for wood addition were chosen based on major stream bends or confluences and areas where the topography is flatter to promote more sediment accumulation and velocity reduction. Stone recommends 40 wood addition locations as preliminary locations to be refined through a more detailed assessment including stream walks of each drainage area with an experienced wood addition professional familiar with the permitting requirements and methods recommended in New Hampshire.

While the primary goal of wood addition is to reduce velocity and promote stormwater infiltration, this strategy can also reduce the amount of phosphorus reaching the lake from these watersheds through deposition of sediment. It is difficult to estimate the amount of phosphorus reduction that would result from wood addition given the variability of site condition. However, the State of Vermont has developed a component of the *Interim Phosphorus Reduction Calculator Tool* that can provide rough estimates for floodplain and stream restoration practices for the major watersheds draining to Lake Champlain. This tool is calibrated to the Lake Champlain TMDL, however, it can be used to provide an order-of-magnitude estimate for this area. Assuming that the 40 locations each restored 2000 square feet (0.05 acres) of stream floodplain, the tool produces phosphorus reduction values in the range of 1.0 – 3.0 kg (2.2 – 6.6 lbs) per year.

Typical recommendations for wood addition are to add at least four pieces of large wood per 100 feet of stream with a larger, more structurally stable wood addition to capture loose pieces and sediment every 300 ft. Wood additions can be anchored in place with stone or wedged between live trees on either side of the stream to reduce the risk of movement. They can also be placed above natural bends in the stream, so if movement does occur, they are caught in the bend rather than travel further downstream. It is recommended that wood should not be added within 300-500 feet above road crossings. Further information and recommendations on wood addition in New Hampshire can be found through the UNH Extension website here: https://extension.unh.edu/resource/wood-streams.

4.3.2. Crescent Lake Road Improvements

Our second watershed-scale project recommendation is to improve Crescent Lake Road through increased general maintenance and improvements to drainage. This is a difficult road to maintain given the slope of the hill on the southern side and the density of homes. The road drainage system has developed incrementally as houses are constructed, redirecting small streams around properties through undersized culverts. The Town of Acworth road crew has done a great job upgrading certain culverts and ditches to date, however, our observations indicate some locations still need to be addressed or considered before the planned reconstruction of Crescent Lake Road in 2029-2030. Addressing the following issues, shown in Appendix D, will improve road drainage, alleviate flooding issues, and reduce the transport of sediment and phosphorus to the lake.

- Build the entire road up so that creating roadside ditches and encouraging sheet flow is easier.

- Clear plugged culvert at 66 Crescent Lake Road.
- Establish ditching from 103 to 84 Crescent Lake Road and clear plugged culvert. With additional flows reaching this location the culvert will likely need to be upsized as well.
- Grade from 128 to 122 Crescent Lake Road so that the road sheet flows to the vegetated area to the south.
- Establish ditching from 160 to 154 Crescent Lake Road and clear driveway culverts.
- Upsize the culvert at 166 Crescent Lake Road. Armor newly cut ditches with stone. See project W-17.
- Clear plugged culvert inlet at 178 Crescent Lake Road.
- Establish ditching and clear driveway culverts on the uphill side of road between 228 and 205 Crescent Lake Road. Upsize culvert at 219 Crescent Lake Road.
- Ditching between 268 and 260 Crescent Lake Road. This will require significant tree removal and bank cutting.
- Clear culvert inlet at 279 Crescent Lake Road.
- Improve ditching between 294 and 288 Crescent Lake Road.
- Ditching between 10 White's Way and the boat launch, especially on the uphill side of the road. This may require tree removal in the right-of-way.
- Install a culvert between 328 Crescent Lake Road and 10 White's Way to reduce the amount of flow down to the boat launch culvert.
- Clear the culvert in front of 336 Crescent Lake Road.

A phosphorus reduction estimate for upgrading the entire length of Crescent Lake Road was also estimated using the *Interim Phosphorus Reduction Calculator Tool*. The tool uses a length of road, an assumed phosphorus load estimate for paved roads in kg/km/yr, and a scale of 1-Does Not Meet Standards, 2-Partially Meets Standards, and 3-Fully Meets Standards to calculate a load reduction. Upgrading a road from one level to the next (e.g., from 1 to 2) provides 40% phosphorus load reduction. Stone chose to represent the upgrade of Crescent Lake Road as moving from 2-Partially Meets to 3-Fully Meets Standards because approximately half of the road is in good condition with functioning culverts and ditches. The tool is calibrated to the Lake Champlain TMDL, however, it can be used to provide an order-of-magnitude estimate for these road improvements. Putting these variables into the tool results in a range of phosphorus load reduction ranging from 1.5 to 2.5 kg per year (3.3 to 5.5 lbs.) per year.

5. Management Strategies

This section describes management strategies for meeting the water quality goals and objectives using a combination of structural and non-structural techniques, educational outreach, and an adaptive management approach. Structural SCMs such as shoreline restoration and culvert replacements provide a direct reduction in sediment and nutrients to the lake, while non-structural SCMs can take the form of town zoning requirements or conservation easements that have a more general effect on nutrient reduction in the watershed as a whole.

5.1. Structural SCMs

Structural SCMs can be categorized into four main types based on their function: Volume Reduction, Infiltration, Filtering, and Stabilization. They are typically engineered infrastructure that intercepts and reduces the velocity of stormwater; storing and/or treating it before it reaches a waterbody. Structural SCMs are an important tool to reduce the watershed phosphorus load and protect water quality. A summary of the four main types of structural SCMs is presented below:

- **Volume Reduction SCMs** – These practices provide storage of stormwater runoff to control flow downstream. They are used to reduce peak flows and provide a means to settle out suspended sediment from the water column. Wet ponds, dry ponds, and gravel wetlands are examples of this type of SCM.
- **Infiltration SCMs** – These practices encourage water to infiltrate into the ground. This reduces stormwater runoff volume and provides treatment of dissolved nutrients such as nitrogen and phosphorus. Bioretention areas (rain gardens), infiltration chambers or trenches, porous pavement, and drywells are examples of this type of SCM.
- **Filtering SCMs** – These practices filter or remove suspended and/or dissolved sediment and other pollutants. Grass swales, buffer plantings, sand filters, and manufactured stormwater treatment devices are examples of this type of SCM.
- **Stabilization SCMs** – These practices stabilize or prevent erosion of soils from stormwater runoff. Streambank stabilization, replacement of undersized culverts, and stabilization of shorelines are examples of this type of SCM. Stabilization techniques can include erosion control matting, plantings, live fascines, or rock placement.

Twenty-four stormwater projects and 55 shoreline restoration projects were identified during the field surveys conducted at Crescent Lake. Most of the projects will need to be constructed or implemented to meet the phosphorus reduction goal of Objective 1. The CLA should work with experienced professionals for the proper design and installation of structural SCMs, particularly on sites that require a high degree of technical skills, such as steep eroding shorelines, large culvert replacements, or gravel wetland design. The Implementation Plan, presented in Section 6, establishes a detailed plan to meet the water quality objectives.

5.2. Non-structural SCMs

Non-structural SCMs include a range of activities that contribute to nutrient and sediment reduction in a watershed. They can take the form of operational measures such as regular ditch and culvert clearing by town road crews to behavioral changes such as individual fertilizer use on lawns or pet waste disposal. Other forms of non-structural SCMs include zoning and ordinance updates, land conservation, septic system regulation, agricultural practices, nuisance wildlife controls, and in-lake treatment. In-lake treatment was not included in the Implementation Plan; however, we recommend further sampling of total phosphorus in the fully mixed water column as well as sediment core samples to confirm the extent of internal phosphorus loading.

5.2.1. Pollutant Reduction

Pollutant reduction best practices include activities such as improving road management and drainage, and changes to municipal operations to protect water quality. The Towns of Acworth and Unity should adhere to the New Hampshire Stormwater Manual (NHDES 2025) for road maintenance and drainage practices where possible. Conventional stormwater management focuses on removing stormwater from a site as quickly as possible to reduce flooding and damage. Though this is still an important element to maintain road quality and condition, a shift in focus to include managing stormwater on-site can reduce the impacts downstream.

5.2.2. Development Regulations

Development regulations that affect the Crescent Lake watershed fall under the jurisdiction of the federal government, the State of New Hampshire, and the Towns of Acworth and Unity. The list below is not exhaustive but highlights the pertinent provisions of each regulation and their impact on Crescent Lake. Any development project should do a complete review of the requirements before any action is taken.

Federal Requirements

- **Dredge and Fill permit –** According to section 404 of the Clean Water Act, dredging and filling waters of the United States is regulated. A permit is required for these activities. This includes many waterfront activities such as the construction of beaches, break walls, and boat houses.
- **Stormwater permit** – A federal stormwater permit (NPDES – Phase II Construction Permit) is required for any land disturbance greater than 1 acre.

State Requirements

- **Site Specific Permit –** A Site Specific Permit is required if a project disturbs 100,000 square feet or more of land, or if a project disturbs more than 50,000 square feet of land in the Shoreland zone (within 250 feet of a lake or tributary).
- **State Septic Permit –** Permits for on-site wastewater disposal that are required for new construction or expansion of current use to include more bedrooms.
- **Shoreland Water Quality Protection Act –** Requires a permit for activities in the 250-foot buffer zone from the shoreline of a lake or tributary.

Local Municipal Requirements

Local land use planning and zoning can be an effective strategy for watershed protection. Rules that towns put in place can prevent significant pollutant runoff from new and redeveloped sites in the watershed. The towns of Acworth and Unity maintain some regulations such as setbacks and land disturbance thresholds, as well as stormwater and erosion control requirements in their respective Zoning Ordinances. A preliminary review of these documents is summarized in Appendix E; however, the towns should consider a more thorough analysis and review of these ordinances with an eye toward improving natural resource protection.

Improvements to zoning ordinances and land development rules should encourage stormwater treatment and shoreline rehabilitation but also incorporate resiliency strategies that protect water quality. Some examples of improvements include:

- Installing green infrastructure, nature-based solutions and using low-impact development strategies
- Protecting and re-establishing wetlands
- Encouraging tree planting and promotion of native vegetation
- Removing the potential for development through conservation easements
- Local bans on lawn fertilizers
- Participation in voluntary commercial and municipal Green SnowPro training for watershed Towns and residences
- For new development/construction ordinances:
    - Incorporating low-impact development (LID) requirements:
        - Dry wells
        - Infiltration trenches
        - Bioretention areas
        - Rain Barrels
    - Minimize disturbed area during construction
    - Maintain natural buffers
    - Maximize setbacks from lakes and tributaries
    - Minimize impervious cover
    - Minimize construction footprint
    - Encourage use of pervious pavers/pavement
    - Minimize soil compaction
    - Require a no-net increase in phosphorus export for development
    - Prohibit stormwater discharges into existing road or road drainage system
- Enforcement of ordinances

5.2.3. Land Conservation

Land conservation is a valuable tool for protecting water quality in the long-term. It also promotes the protection of water resources and recreation. Approximately 470 acres of the Crescent Lake watershed is already classified as publicly conserved land, primarily concentrated to the southern hillside, including the Sirkin Easement and the Acworth Town Forest. Local groups should continue to promote and pursue land conservation in the watershed, focusing on the properties that abut or include the lake, streams, or wetlands, or have steep slopes that would pose a risk of erosion if they were developed. Many of these areas are also mapped by the New Hampshire Fish & Game (NHFG) Department as areas of Supporting Landscape in terms of wildlife habitat ranking. Habitat rankings are published in the state's 2020 Wildlife Action Plan and are used to prioritize conservation in New Hampshire. While only one small area in the headwaters of the Potato Hill watershed is considered highest-ranked habitat in the region, the Supporting Landscape areas are still important areas to conserve because they support the function of adjacent core habitat areas.

5.2.4. Septic System Regulations

Individual subsurface septic systems can treat residential wastewater effectively if appropriately designed, installed, operated, and maintained. However, aging drywells or systems designed prior to regulatory requirements may be contributing significant nutrient loads to the lake. The State of New Hampshire passed a law regarding sales or other ownership transfers of developed properties served by on-site systems in 2024.

The law now states that buyers are required to have the system examined by a permitted septic system evaluator and in some cases a licensed designer. This new law should be adhered to and encouraged for properties along Crescent Lake to ensure that wastewater from individual subsurface septic systems is treated before it enters the lake. Landowners should also take responsibility for understanding their impact on the lake and upgrading their systems if deemed necessary.

Education on septic systems is a great way to raise people's awareness of the impact of wastewater and what they can do to be better stewards of their lake. In the short term, regular workshops on proper septic function and maintenance for lake residents can be an effective communication strategy. Alternatively, a more formal tracking system and development of local regulations related to septic tanks could be developed to enforce proper maintenance and inspections. In the next 10 years, the CLA should consider reaching out to the Towns of Acworth and Unity to develop a septic system inventory, a starting point for developing regulations requiring maintenance and adherence to state rules, which could be tracked by the lake association or the Towns. We also recommend a zoning overlay for septic systems within 250 feet of the lake. The overlay would require regular inspections and pump-outs of the septic tanks to ensure they are functioning properly to minimize their impact on the lake. Overlay practices have been adopted by an increasing number of nearby towns to protect their lakes and watersheds. Additional recommendations related to septic system management in the watershed include:

- Reaching out to local septic inspection and pumping businesses to coordinate pump-outs and inspections at a discounted group rate. This encourages a group mentality around septic system management. It also helps property owners to know that the group effort is non-regulatory.
- Replacement rebate or grant programs that fund replacement or upgrades of aged or failing septic systems.
- Engaging with local banks for low or no-interest loans for septic system upgrades and replacement.

5.2.5. Agricultural Practices

Manure, unstable soil erosion, and fertilizer use are the primary sources of phosphorus from agricultural practices. There are no major agricultural operations in the Crescent Lake watershed, but direct outreach by the Crescent Lake Association should be conducted for any small scale farms. Runoff from steep pastureland to intermittent or perennial streams should be intercepted and treated.

5.2.6. Nuisance Wildlife Controls

Development along shorelines has altered the habitats of wildlife, restricting access for some and encouraging access for others. Cleared shorelines attract ducks and geese, and an abundance of waterfowl can be a source of phosphorus to a lake. For locations with large or regular concentrations of waterfowl, harassment programs can be implemented to repel them from the waterbody. The estimated load attributed to waterfowl at Crescent Lake is less than 2% so we do not recommend any specific wildlife controls. Individual landowners can be encouraged to take individual action using scarecrows, kites, or modification of the habitat. A well vegetated buffers is also a proven way to discourage waterfowl from lawns.

5.2.7. In-Lake Treatment

It is unlikely that Crescent Lake is a candidate for in-lake treatment to reduce the internal phosphorus load. Modeling suggests that the internal load is less than 0.1% of the overall load to the lake. If further sampling of the fully mixed water column and sediment cores suggests a larger contribution, it will still be necessary to address watershed sources to be considered and approved at the state level for in-lake treatment. NHDES typically requires a WBMP, significant progress toward completion of phosphorus reduction goals, and significant further engineering work before approving any in-lake treatment. Alum treatment is the typical method for reducing internal phosphorus loads. Aluminum is added to the bottom of the lake as aluminum sulfate, which binds with phosphorus and minimizes its release from bottom sediments. Only four lakes in New Hampshire have received in-lake alum treatments since 1989 (Kezar Lake, Nippo Lake, Laka Kanasatka, and Partridge Lake).

5.3. Outreach and Education

Education and outreach provide a low-cost but highly effective method for protecting and restoring water quality and natural resources. Most people who are drawn to a rural lifestyle or a vacation rental want to be good stewards but might be unaware of the impact they have on their environment. The CLA already provides many educational and informational resources to residents of Crescent Lake through its website, annual meetings, the creation of the Water Quality Group, and the creation of this plan.

The CLA and WQG should continue their current education and outreach strategies as well as develop other outreach campaigns for watershed residents. Some examples include distribution of educational material through regular newsletters, social media postings, and community events on topics such as water quality, septic system maintenance, invasive species, shoreline buffers, gravel road and property maintenance, and SCMs. Some other effective education and outreach methods are described below:

- Encourage as many property owners as possible to engage with the New Hampshire Lakes LakeSmart and NHDES Soak Up the Rain programs. These programs are designed to help landowners manage their properties so they impact the lake as little as possible. LakeSmart includes a site visit by NH Lakes staff and looks at a wide variety of activities that impact lake health. Property owners receive a report with an individualized assessment and recommendations. The programs promote planting and restoring natural shorelines and infiltrating stormwater prior to entering the lake. We recommend starting with community workshops describing the programs and distributing brochures and information.
- Engage with watershed property owners about the Shoreland Water Quality Protection Act through newsletters and workshops covering what are allowable practices in the 250-foot Protected Shoreland Area and what activities require permits.
- Set up demonstration sites with tours at successfully completed or active restoration projects to convince hesitant lake residents of the beauty and benefits of a natural lawn and shoreline.
- Add signage near completed projects such as infiltration basins, rain gardens, and shoreline plantings to educate residents on the impact of stormwater and erosion on the lake.
- Provide septic system care/maintenance information to residents.

5.4. Research and Monitoring

Additional research and monitoring at Crescent Lake can improve model inputs and fill knowledge gaps for the largest impacts to water quality. The volunteers from the CLA participating in the NHDES VLAP has monitored Crescent Lake since 1990, and Crescent Lake participates in the Lake Host program. The Lake Host program educates boaters and examines boats and trailers for aquatic invasive plants and animals that may be moving between lakes. The VLAP sampling program paired with the education of the Lake Host program is a great source of long-term data and is generally sufficient to track progress toward the goals of this WBMP.

Long-term sampling is conducted at one deep station, two major tributaries, and the outlet of the lake:

- The deep spot is monitored at least three times each summer between June and September for total phosphorus, conductivity, turbidity, and pH in the epilimnion and hypolimnion; alkalinity and chloride in the epilimnion; a composite sample for chlorophyll-*a*; Secchi disk transparency; and dissolved oxygen and temperature profiles at one meter depth intervals.

- Annual samples for phytoplankton are collected via a grab sample from the water column.
- Monitoring at the northeast inlet, western inlet, and the outlet occurs two to three times per year and includes samples for chloride, pH, total phosphorus, conductivity, and turbidity.
- Monitoring of the lake for cyanobacteria blooms with plans to notify NHDES immediately if any are found should be continued.

We recommend the following modifications to the existing monitoring program:

1) Collect tributary stream samples from the Western and Northeastern inlets during both wet and dry periods, with multiple samples collected during long storm events. Flow measurements paired with the sample collection would also allow for calculation of loads rather than estimation in the model. These activities will require consultation with the NHDES VLAP coordinator.
2) Collect intermittent stream water quality samples from smaller drainage areas on the southern side of the lake during dry and wet weather. Many of the steep drainages south of Crescent Lake Road are likely contributing phosphorus to the lake, especially during heavy rain events. Samples from these locations would improve model inputs for the Direct Drainage watershed and provide information on which drainage areas to target for improvement.
3) Monitor the beaver dam wetland complexes upstream of the Western and Northeastern inlets to develop a better understanding of the nutrient cycling in those systems. Wetlands can act as a source or a sink of phosphorus under certain conditions. Understanding the dynamics of the two major wetland systems in the Crescent Lake watershed would improve the model and identify their function as sources or sinks. We suggest monitoring stations upstream and downstream of the wetlands as well as water quality and sediment core samples from within the wetlands.
4) Collect a fully mixed total phosphorus sample before ice-out occurs. This data can help confirm the minimal internal phosphorus loading to Crescent Lake. The last sample collected prior to ice-out was from 1992.
5) Sediment core sampling at the existing Deep Spot monitoring location and two other locations of deep water may provide useful insights into the internal phosphorus load. Based on water quality sampling in the epilimnion and hypolimnion, the internal load is a tiny fraction of the overall phosphorus load to Crescent Lake. However, knowledge of the sediments and their ratios of phosphorus, aluminum, and iron will be useful information to characterize the biological availability of phosphorus.

6. Plan Implementation

6.1. Plan Oversight

The recommendations in this plan will be carried out by the CLA WQG with assistance from stakeholders, including municipalities, conservation commissions, state or federal agencies, nonprofit organizations, land trusts, and landowners. The Implementation Plan will need to be revisited and updated regularly to guarantee progress, to adapt to any changes in watershed activities based on monitoring, and to ensure opportunities for water quality improvement are acted on. Stone recommends revisiting the plan to confirm or update milestones every two years, with a minimum of every five years. As the guiding entity of this plan, the WQG is responsible for the following objectives:

- **Developing a plan for sustainable funding.** Multiple revenue streams should be developed in the pursuit of implementing this plan. Insufficient funding can slow or stop the implementation of a watershed plan.
- **Continuing public outreach.** Maintain public outreach during the implementation of the plan to encourage participation, publicize successes, and build support.
- **Developing and adhering to a long-term monitoring program.** Documenting progress toward goals such as water quality improvements or septic system workshops is a good way to maintain momentum during implementation. Celebrating short-term successes during a 10-year plan can help maintain enthusiasm.
- **Establishing measurable milestones.** Make milestones clear and measurable. A list of action items and target dates for short-term and long-term schedules is essential to continue making progress.

6.2. Adaptive Management

Stone recommends an adaptive management approach for implementation of this plan. Using this approach allows flexibility in the plan because the lake cannot be protected by a single restoration action or in a short time frame. This enables the CLA and stakeholders to develop plans for water quality improvement and then change course if certain methods are more or less effective. By continually evaluating progress against milestones and monitoring data, the plan can be updated or changed depending on funding availability, watershed changes, changes due to increased storm frequency and intensity, regulatory changes, and technological advances. The plan should be considered a living document that is regularly revisited and altered as conditions change. The adaptive management approach recognizes that even the best-laid plan, using the most up-to-date information at that time, may need adjusting with the introduction of new information or as experience increases.

6.3. Implementation Plan

The full Implementation Plan is included in Appendix F and provides a roadmap of Action Items to reduce phosphorus loading to Crescent Lake, targeting the proposed water quality goal and objectives. Approaches include directly addressing pollutant sources, land conservation and regulatory changes, education and outreach, and increased water quality monitoring. The total cost of implementing the plan is estimated to be between $660,000 and $1.03 million over the next 10 or more years. It should be noted that costs are high-level estimates for planning purposes and should be updated as better information becomes available. In addition to costs for property improvements covered by individual landowners, some of the cost may be covered by a combination of grants, partner funding, private donations, and municipal in-kind and dedicated funding.

Table 14 presents a summary of the Implementation Plan with total phosphorus reduction values and cost estimates for the summarized action items. Five culvert replacement projects (Cold Pond/Gove Road Intersection, North Shore Road, near 71 Crescent Lake Road, near 164 Crescent Lake Road, and near 199 Crescent Lake Road) were separated from the Watershed & Shoreline SCM line item to show their relative cost and total phosphorus reduction. The Boat Launch Culvert replacement project was not included in this grouping due to its high phosphorus reduction potential and connection to the Boat Launch project. While the culvert replacement projects would provide significant hydraulic relief along Crescent Lake Road, Cold Pond Road, and North Shore Road, their cost-effectiveness for phosphorus reduction may be prohibitive. Including these projects doubles the overall cost of implementing the plan. For the culverts along Crescent Lake Road, it is worth waiting for the full rehabilitation of the road by the Town of Acworth (proposed for 2029-2030). The Town may spread the work on the major culverts over several years leading up to the full rehabilitation of the road. In the short-term, we recommend advocating for the upsizing of culverts at the known problem areas to ensure they are incorporated in the road rehabilitation project. In the meantime, available funds will have a higher impact on water quality if directed to other projects throughout the watershed such as shoreline stabilization, buffer plantings, and stormwater issues.

Table 14. Total Phosphorus Reductions by Action Item from the Implementation Plan with Estimated Total Cost and Estimated Annual Cost Based on a 10-Year Timeline.

Summary Action Item	TP Reduction (kg/yr)	Estimated Total Cost	Estimated Annual Cost
Watershed & Shoreline SCMs (Action Items 1-7, 9)	18	$575,000-$905,000	$57,500-$90,000
Large Culvert Replacements (Action Item 8)	*2*	*$330,000-$880,000*	*$33,000-$88,000*
Road Management and Municipal Operations (Action Items 10-13)	TBD	$4,500	$450
Land Use Planning & Zoning/Land Conservation Action Items (14-17)	6*	$4,000	$400
Septic System Management Action Items (18-20)	3	$8,000	$800
Education and Outreach (Action Items 21-23)	TBD	$15,000-$30,000	$1,500-$3,000
Research/Monitoring (Action Items 24-27)	NA	$55,000-$80,000	$5,500-$8,000
Total with Large Culvert Replacements	29	$991,500-$1,911,500	$99,200-$191,200
Total without Large Culvert Replacements	**27**	**$661,500-$1,031,500**	**$66,200-$103,2000**

Estimated increase in phosphorus load from new development along shoreline in the next 10 years.

To reduce the in-lake total phosphorus concentration to 10.8 μg/L and meet the Objective 1 water quality goal, the total phosphorus load to Crescent Lake needs to be reduced by approximately 19 kg/yr. Based on Table 14 and the Implementation Plan, this can be accomplished by completing watershed and shoreline projects identified in the Plan as Action Items 1-2 and 5-7 as well as septic system management in Action Items 18-20.

The culvert replacement projects, except for the Boat Launch Culvert, are not necessary to meet Objective 1. We recommend that the CLA focus their outreach, landowner engagement, and fundraising efforts to implement Action Items 1 and 2 as well as the private property projects from Item 5. These actions address some easy-to-fix stormwater issues, and financial assistance for shoreline stabilization and buffer plantings will have the largest impact on the water quality of Crescent Lake per dollar spent of the entire Implementation Plan. These projects will cover 70% of the phosphorus load reduction required to meet Objective 1.

Objective 2 is to prevent or offset additional phosphorus loading from new development in the watershed. New development in the form of accessory dwelling construction and upgrades to existing camps is expected to increase the phosphorus load by 6 kg/yr in the next 10 years. Offsetting this expected increase in load can be achieved through land conservation, land-use planning, and zoning ordinance updates such as requiring lower impact development and capturing and infiltrating runoff from any new impervious surfaces.

The following figures show the necessary funding schedule to complete the Implementation Plan in the next ten years. Figure 21 shows the full implementation plan funding schedule and includes the Large Culvert Replacement line item. Figure 22 presents the implementation plan funding schedule without that line item. The blue bars show the low estimate, orange bars the high estimate, and the labeled green line is the average cost estimate for funding requirements in each year. Figure 21 shows significant costs between 2027 and 2030 due to the Large Culvert Replacement line item. We assumed that these culverts would be replaced before and during the reconstruction of Crescent Lake Road. These figures confirm that the large culverts are cost prohibitive in the overall plan, given their relatively low phosphorus reduction. These projects should instead be rolled into the Crescent Lake Road project.

Figure 21. *Schedule of funding requirements to complete the Full Implementation Plan.*

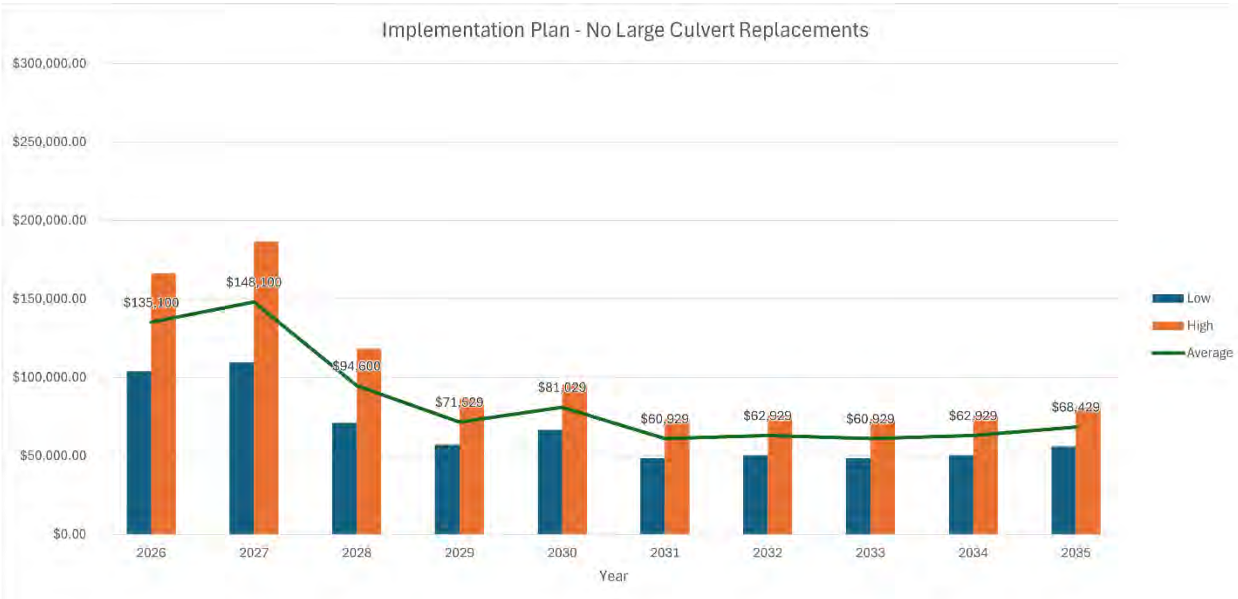

Figure 22. Schedule of funding requirements to complete the Implementation Plan without Large Culvert Replacements.

6.4. Funding Sources

It is important for the CLA to identify funding sources or raise the money necessary to help with the implementation of the recommendations in the Implementation Plan. With recent changes at the Federal level, many national and state grant and loan programs may have been cut or may not exist in the future. This might necessitate other fundraising efforts, such as the one supporting the creation of this plan or other non-government funds. For example, funding to cover ordinance changes could be raised through tax collection by towns. However, funding to improve septic systems, private roads, and shoreline buffers will likely need to come from the impacted propery owners. If federal or state funds still exist for certain programs or if they are reinstated in the future, the following funding sources could assist CLA with water quality improvement projects on Crescent Lake:

- **EPA/NHDES 319 Grants (Watershed Assistance Grants)** – This NPS grant is designed to support local initiatives to restore impaired waters (priorities identified in the Nonpoint Source Management Program Plan 2025-2029, updated October 2024) and protect high-quality waters. In 2024 there was $500,000 available from these grants. Recipients were also required to provide a 40% non-federal match (cash, labor, materials, equipment, in-kind professional hours, etc.) of the total project cost. https://www.des.nh.gov/business-and-community/loans-and-grants/watershed-assistance
- **NH State Conservation Committee (SCC) Grant Program (Moose Plate Grants)** – County Conservation Districts, municipalities (including commissions engaged in conservation programs), and qualified nonprofit organizations are eligible to apply for the SCC grant program. Projects must qualify in one of the following categories: Water Quality and Quantity; Wildlife Habitat; Soil Conservation and Flooding; Best Management Practices; Conservation Planning; and Land Conservation. The maximum grant award is $40,000. These are 100% non-federal funds and can be

used to match federal grant sources like NHDES Section 319 Watershed Assistance Grants. https://www.mooseplate.com/grants/

- **Land and Community Heritage Investment Program (LCHIP)** – This grant provides matching funds to help municipalities and nonprofits protect the state's natural, historical, and cultural resources. Specifically, the Natural Resource Acquisition Grants support the permanent protection of ecologically significant lands through acquisition of property or easement interests. https://www.lchip.org/index.php/for-applicants/general-overview-schedule-eligibility-and-application-process
- **Aquatic Resource Mitigation Fund (ARM)** – This grant provides funds for projects that protect, restore, or enhance wetlands and streams to compensate for impacted aquatic resources. The fund is managed by the NHDES Wetlands Bureau that oversees the state In-Lieu Fee (ILF) compensatory mitigation program. For 2025, there is over $7.5 million available to fund compensatory mitigation activities, with over $1 million available for the Lower Connecticut watershed. https://www.des.nh.gov/business-and-community/loans-and-grants/aquatic-resource-mitigation-fund
- **Northeast Forests and Rivers Fund (NFWF NEFRF)**– This grant awards $75,000 to $300,000 to projects that restore and sustain healthy forests and rivers through habitat restoration, fish barrier removal, and stream connectivity such as culvert upgrades. https://www.nfwf.org/newengland/Pages/home.aspx
- **Aquatic Invasive Plant Control, Prevention and Research Grants (NHDES AIPC)** – Funds are available each year for projects that prevent new infestations of exotic plants, including outreach, education, Lake Host programs, and other activities. https://www.des.nh.gov/business-and-community/loans-and-grants/rivers-and-lakes
- **Clean Water State Revolving Fund (NHDES CWSRF)** – This fund provides low-interest loans to communities, nonprofits, and other local government entities to improve and replace wastewater collection systems with the goal of protecting public health and improving water quality. A portion of the CWSRF program is used to fund NPS pollution prevention, watershed protection and restoration, stormwater planning, and estuary management projects that help improve and protect water quality in New Hampshire. https://www.des.nh.gov/business-and-community/loans-and-grants/clean-water-state-revolving-fund
- **Regional Conservation Partnership Program (RCCP)** – This NRCS grant provides conservation assistance to producers and landowners for projects carried out on agricultural land or non-industrial private forest land to achieve conservation benefits and address natural resource challenges. Eligible activities include land management restoration practices, entity-held easements, and public works/watershed conservation activities. https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/rcpp/
- **Agricultural Conservation Easement Program (ACEP)** – This NRCS grant protects the agricultural viability and related conservation values of eligible land by limiting nonagricultural uses which negatively affect agricultural uses and conservation values, protect grazing uses and related conservation values by restoring or conserving eligible grazing land, and protecting, restoring, and enhancing wetlands on eligible land. Eligible applicants include private landowners of agricultural land, cropland, rangeland, grassland, pastureland, and non-industrial private forestland. https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/acep/
- **Conservation Stewardship Program (CSP)** – This NRCS grant helps agricultural producers maintain and improve their existing conservation systems and adopt additional conservation activities to address priority resource concerns. Eligible lands include private agricultural lands, non-industrial

private forestland, farmstead, and associated agricultural lands, and public land that is under control of the applicant. https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/csp/

- **Environmental Quality Incentives Program (EQIP) –** This NRCS grant provides financial and technical assistance to agricultural producers and non-industrial forest managers to address natural resource concerns and deliver environmental benefits. Eligible applicants include agricultural producers, owners of non-industrial private forestland, water management entities, etc. https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/
- **National Fish and Wildlife Federation (NFWF) Five Star and Urban Waters Restoration Grants (NFWF 5-Star) –** Grants seek to address water quality issues in priority watersheds, such as erosion due to unstable streambanks, pollution from stormwater runoff, and degraded shorelines caused by development. Eligible projects include wetland, riparian, in-stream and/or coastal habitat restoration; design and construction of green infrastructure SCMs; water quality monitoring/assessment; outreach and education. https://www.nfwf.org/programs/five-star-and-urban-waters-restoration-grant-program
- **North American Wetlands Conservation Act (NAWCA) Grants –** The U.S. Standard Grants Program is a competitive, matching grants program that supports public-private partnerships carrying out projects in the United States that further the goals of the North American Wetlands Conservation Act (NAWCA). These projects must involve long-term protection, restoration, and/or enhancement of wetlands and associated uplands habitats for the benefit of all wetlands-associated migratory birds. https://www.fws.gov/service/north-american-wetlands-conservation-act-nawca-grants-us-standard
- **National Park Service - Land and Water Conservation Fund Grant Program (LWCF) –** Eligible projects include acquisition of parkland or conservation land; creation of new parks; renovations to existing parks; and development of trails. Municipalities must have an up-to-date Open Space and Recreation Plan. Trails constructed using grant funds must be ADA-compliant. This is a 1:1 matching grant program. Project sponsors must contribute 50% of the overall project costs. Grant award amounts range between $50,000 and $500,000. https://www.nhstateparks.org/about-nh-parks/conservation-fund-grant

6.5. Indicators to Measure Progress

Environmental, program engagement, and social indicators can all be used to measure the progress of this plan in meeting the goals and objectives for Crescent Lake. Table 15 shows benchmarks for all indicators in the short-term (2026), mid-term (2030), and long-term (2035). These benchmarks are taken from the Implementation Plan and paired with a monitorable task or measure in order to track progress. As with everything in this plan, the benchmarks should be revisited regularly to determine if progress is being made or if the plan needs to change because milestones are not being met.

Table 15. Environmental, Program Engagement, and Social Indicators for the Crescent Lake Watershed-Based Management Plan.

Indicators	Milestone 2026	Milestone 2030	Milestone 2035
Environmental			
Achieve an average epilimnion total phosphorus concentration of 10.8 µg/L at the deep spot stations in Crescent Lake	<12	<11	<10.8
Maintain an average epilimnion chlorophyll-*a* concentration of less than 5 µg/L at the deep spot stations in Crescent Lake	<5	<5	<5
Eliminate the occurrence of cyanobacteria or algal blooms in Crescent Lake (based on model results)	7 days/yr	4 days/yr	0 days/yr
Achieve an average summer water clarity of four meters or deeper at the deep spot station in Crescent Lake	3 m+	4 m+	5 m+
Prevent and/or control the introduction and/or proliferation of invasive aquatic species for all waterbodies	Absence of invasives	Absence of invasives	Absence of invasives
Program Engagement			
Amount of cumulative funding secured from grants, fundraisers, donations, and municipal/private work	$100,000	$500,000	$1,000,000
Number of stormwater/watershed projects remediated	5	15	24
Linear feet of buffers stabilized/planted in the shoreland zone	500	2500	5000
Percentage of shorefront properties with LakeSmart certification (cumulative)	5%	25%	50%
Number of workshops and trainings for stormwater improvements to residential properties (e.g., NH Lakes LakeSmart)	1	5	10
Number of updated or new ordinances that target water quality protection	1	2	3
Number of voluntary or required septic system inspections (seasonal conversion and property transfer)	2	10	25
Number of septic system upgrades	2	10	25
Number of informational workshops and/or trainings for landowners, municipal staff, and/or developers/landscapers on local ordinances, watershed goals, and/or best practices for road management	1	3	6
Number of parcels with new conservation easements or number of parcels put into permanent conservation	1	2	5
Number of new best practices for road management and winter maintenance implemented on public and private roads by the municipalities	2	4	6

Indicators	Milestone		
	2026	2030	2035
Social			
Number of attendees at informational meetings, workshops, trainings, SCM demonstrations, or group septic system pumping	25	50	100
Number of watershed/shoreline residents participating in LakeSmart	5	25	50
Number of groups or individuals contributing funds for project implementation	10	20	30

7. Helpful Resources

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9. Appendices

Appendix A –Watershed Project Sites

Appendix B – Project Conceptual Plans

Appendix C – Wood Additions Map

Appendix D – Crescent Lake Road Projects

Appendix E – Local Regulations

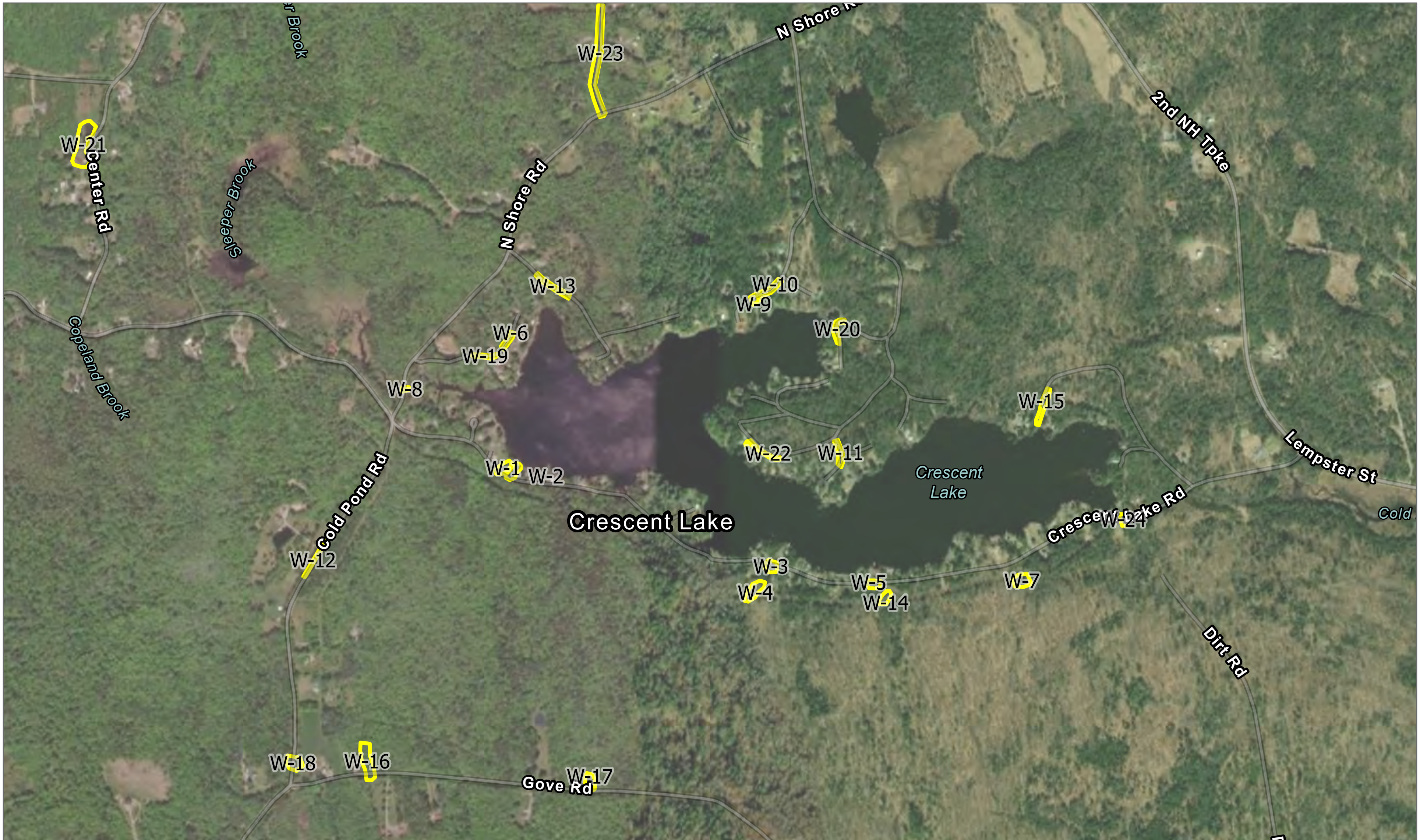
Appendix F – Implementation Plan

Appendix A – Watershed Project Sites

Site	Location/Description	Ownership	Impact	TP Load Reduction (kg/yr)	Est. Low Cost	Est. High Cost	Est. Avg Cost	Rank
W-14	Near 164 Crescent Lake Road Stream Erosion (AOC3* stream erosion)	Public/Private	High	0.68	$15,000	$20,000	$17,500	1
W-23	Hedgehog Hill Road/Ditch Erosion	Public	Medium	0.36	$5,000	$10,000	$7,500	2
W-12	Cold Pond Road Ditch Erosion	Public	Medium	0.34	$5,000	$10,000	$7,500	3
W-15	East Shore Road Erosion	Private	Medium	0.29	$5,000	$10,000	$7,500	4
W-17	Near 89 Gove Road Culvert Outlet Erosion	Public	Medium	0.28	$5,000	$10,000	$7,500	5
W-21	Center Road Farm Runoff	Private	Medium	0.44	$10,000	$20,000	$15,000	6
W-4	Near 199 Crescent Lake Road Stream Headcuts (AOC2*)	Private	Medium	0.57	$15,000	$25,000	$20,000	7
W-22	Anderson Road Erosion/Depression Flooding	Private	Medium	0.31	$10,000	$20,000	$15,000	8
W-1	Boat Launch Culvert (AOC1*)	Public	High	1.42	$100,000	$200,000	$150,000	9
W-16	Near 23/25 Gove Road Culvert Outlet Erosion	Public	Medium	0.31	$15,000	$25,000	$20,000	10
W-13	Page Road Erosion	Public	Low	0.24	$5,000	$10,000	$7,500	11
W-11	Breezy Point Road Erosion	Private	Low	0.20	$5,000	$10,000	$7,500	12
W-6	Emerson Road Erosion 1	Private	Low	0.17	$5,000	$10,000	$7,500	13
W-7	Near 108 Crescent Lake Road Powerline berm erosion	Utility Corridor	Low	0.22	$10,000	$15,000	$12,500	14
W-18	Cold Pond/Gove Road Intersection Culvert Erosion	Public	High	0.63	$20,000	$200,000	$110,000	15
W-8	North Shore Road (Unity Sleeper Brook Inlet Culvert)	Public	Medium	0.36	$10,000	$80,000	$45,000	16
W-19	Emerson Road Erosion 2	Public	Low	0.18	$10,000	$15,000	$12,500	17

W-20	Lake Road Erosion	Public	Low	0.22	$10,000	$20,000	$15,000	18
W-10	Shorewood Estates Road Erosion	Private	Low	0.14	$5,000	$15,000	$10,000	19
W-5	Near 164 Crescent Lake Road (AOC 3* Culvert - Crescent Lake Road)	Public/Private	High	0.67	$150,000	$300,000	$225,000	20
W-2	Boat Launch Area	Public	Low	0.12	$25,000	$35,000	$30,000	21
W-3	Near 199 Crescent Lake Road (AOC 2* - Cistern/Culverts)	Public/Private	Medium	0.36	$100,000	$200,000	$150,000	22
W-24	Near 71 Crescent Lake Road (AOC 4* Culvert - 70 CLR. Flooding from upstream)	Public	Low	0.18	$50,000	$100,000	$75,000	23
W-9	Crescent Cove Association Parking Erosion	Private	Low	0.06	$25,000	$35,000	$30,000	24

*AOC1-AOC4 are Areas of Concern visited by Town officials and the Stone team during the watershed assessment.



LEGEND

ProjectLocations

N

0 250 500

Feet

Attachment 2. Nonpoint Source Project Locations

Crescent Lake Watershed Management Plan

Service Layer Credits: World Imagery: Maxar
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Path: C:\Users\ahuizenga\OneDrive - Stone Environmental Inc\Documents\LocalWork\Crescent Lake NH\GIS_Feb2025\LocalCrescentLake\LocalCrescentLake.aprx Project LocationsExported: 8/18/2025 3:53 PM by ahuizenga

Nonpoint Source Sites Project Descriptions

Site W-1: Boat Launch Culvert (AOC1)

Impact: High

Estimated Cost: $100,000 - $200,000

GPS Coordinates: 43.26752, -72.26053

Observations: This site is located adjacent to the public boat launch. The existing 3 ft culvert is likely too small for the intermittent stream that flows under Crescent Lake Road, especially during large storms. The Town of Acworth has observed flooding on Crescent Lake Road at this location and the outlet of the culvert has developed a gully and sediment deposition.

Recommendations: Bankfull width at this location is approximately 9 ft so a larger box culvert structure is likely necessary. The outlet of the culvert will also need to be stabilized with large stone and erosion matting to reduce bank erosion.

Figure A-1. Crescent Lake Road crossing culvert.

Figure A-2. Crescent Lake Road crossing culvert outlet erosion.

Site W-2: Boat Launch Area

Impact: Low

Estimated Cost: $25,000 - $35,000

GPS Coordinates: 43.26743, -72.26020

Observations: At the time of inspection, the boat launch area had a crumbling asphalt boat access pad and showed signs of rill erosion and small eroding ditches forming in the surface of the gravel.

Recommendations: Since inspection, the asphalt pad has been replaced with a concrete pad. Further recommendations include regrading the boat launch so water sheet flows to the sides of the parking area into vegetated areas rather than straight to the water, or adding a vegetated or stone lined swale on either side of the boat launch to capture and filter runoff before entering the lake. Porous pavement or grid pavers to reduce sediment loss from the gravel surface is also an option.

Figure A-3. Crescent Lake boat launch from the water.

Figure A-4. Vegetated area to the west of the boat launch.

Site W-3: Near 199 Crescent Lake Road
Cistern/Culverts (AOC 2)

Impact: Medium

Estimated Cost: $100,000 - $200,000

GPS Coordinates: 43.2651, -72.25163

Observations: The property at this location is built at the bottom of two extensive drainage areas south of Crescent Lake Road. Two culverts have been installed under this lawn and the neighboring property's lawn to direct the intermittent streams around this property to a single cistern which outlets via a 2.5 ft culvert. The cistern is often overwhelmed during heavy storms and floods Crescent Lake Road.

Recommendations: The bankfull widths of the intermittent streams are approximately 11 ft with drainage areas of approximately 80 acres. Upsizing the culverts from behind these properties or daylighting the streams through the properties to larger culverts crossing under Crescent Lake Road is recommended. Erosion is also present at the outlet of the cistern culvert. The outlet of the culvert will need to be stabilized with large stone and erosion matting to reduce bank erosion.

Figure A-5. Cistern structure that collects drainage pipes from around property.

Figure A-6. Outlet pipe from cistern.

Site W-4: 164 Crescent Lake Road Stream Erosion (AOC 2 Stream)

Impact: Medium

Estimated Cost: $15,000 - $25,000

GPS Coordinates: 43.26459, -72.25218

Observations: Two similarly sized headcuts have formed upstream of the AOC 2 location. They are approximately 8 ft wide and 4.5 ft deep and will continue to erode if left unchecked.

Recommendations: We recommend stabilizing the eroding sediment with stone and establishing a grade control through the addition of large wood crossing the stream that is anchored to prevent movement.

Figure A-7. Headcut above AOC 2.

Site W-5: Near 164 Crescent Lake Road (AOC 3 Culvert)

Impact: High

Estimated Cost: $150,000 - $300,000

GPS Coordinates: 43.26477, -72.24822

Observations: The property at this location is built at the bottom of an extensive drainage area south of Crescent Lake Road. A series of culverts have been installed under Crescent Lake Road with a 90 degree turn to cross under a driveway to direct the intermittent stream around this property to a 1.5 ft culvert. This area has historically flooded but recent improvements to provide multiple flow paths appear to have alleviated some of the issue.

Recommendations: The bankfull width of the intermittent stream is approximately 8 ft with an 80-acre drainage area. Upsizing the culvert crossing under Crescent Lake Road and providing a more direct route to the lake is recommended.

Figure A-8. Crescent Lake Road and driveway culverts.

Figure A-9. 90 degree driveway culvert.

Site W-6: Emerson Road Erosion 1

Impact: Low

Estimated Cost: $5,000 - $10,000

GPS Coordinates: 43.27061, -72.26042

Observations: Gully and rill erosion is forming on the northern end of Emerson Road, running off into driveways and eventually the lake.

Recommendations: Regrade and possibly pave this steep section of road to reduce material loss. Another alternative would be to build up this section of road to cut ditches and line with stone. There is also room for a small settling or infiltration basin at the bottom of the steep section of road to capture sediment and promote infiltration.

Figure A-10. Emerson Road erosion into driveway.

Site W-7: Near 108 Crescent Lake Road Powerline berm erosion

Impact: Low

Estimated Cost: $10,000 - $15,000

GPS Coordinates: 43.26487, -72.24328

Observations: An intermittent stream is eroding a section of berm in the cleared powerline right-of-way.

Recommendations: Regrade the berm and stabilize with erosion control matting. Stabilize the channel that has formed through this section of right-of-way with stone. It is unlikely that woody plantings will be allowed under the powerlines.

Figure A-11. Berm erosion in powerline right-of-way.

Site W-8: Sleeper Brook Culvert

Impact: Medium

Estimated Cost: $10,000 - $80,000

GPS Coordinates: 43.26942, -72.26382

Observations: 2.5-ft culvert is undersized for the size of the stream entering the lake. Erosion is visible at the outlet.

Recommendations: The bankfull width at this location is 13 ft with a significantly sized drainage area. Beaver dams likely retain a lot of flow but during large storms this location is likely inundated and is at risk of failure. We recommend upsizing the culvert to accommodate bankfull flows and stabilizing the outlet with stone and erosion control measures.

Figure A-12. North Shore Road Sleeper Brook crossing

Figure A-13. Culvert inlet with debris grate.

Site W-9: Crescent Cove Parking Erosion

Impact: Low

Estimated Cost: $25,000 - $35,000

GPS Coordinates: 43.27166, -72.2522

Observations: Large dirt and gravel parking area showing signs of erosion and accumulation of sediment in ditch. Cleared edges of driveway provide very little settling or sediment capture before entering ditch.

Recommendations: Grading the parking area so that water sheet flows to the sides of the parking area rather than pooling or flowing directly to the lake. Creation of a grass or vegetated swale along the entire perimeter of the parking area before it enters the drainage ditch would provide sediment capture and stormwater infiltration. The ditch along the eastern side of the parking area should be cleared of sediment and stabilized against erosion. A settling basin should be constructed at the bottom of the ditch to capture any sediment/material coming from upstream.

Figure A-14. View of the parking area.

Figure A-15. Grass area near parking area.

Figure A-16. View of the drainage ditch towards the lake.

Site W-10: Shorewood Estates Road Erosion

Impact: Low

Estimated Cost: $5,000 - $15,000

GPS Coordinates: 43.27192, -72.25170

Observations: Runoff from Shorewood Estates Road is causing ditch erosion and road material loss which is eventually reaching the lake. Some road material is entering the wooded area next to the snowmobile trail access, but most is running down a grassy ditch and entering the lake.

Figure A-17. Accumulated sediment on Shorewood Estates Road low point.

Recommendations: Installing check dams in the existing ditches on Shorewood Estates Road would reduce the amount of material reaching the low point. Creation of an infiltration basin or grass swale with check dams at the outlet of the ditch on the lake side of the road would allow for runoff to infiltrate rather than flow straight to the lake.

Figure A-18. Existing grass lined ditch along Shorewood Estates Road.

Figure A-19. View down to the lake from Shorewood Estates Road

Site W-11: Breezy Point Road Erosion

Impact: Low

Estimated Cost: $5,000 - $10,000

GPS Coordinates: 43.26793, -72.24938

Observations: This is a steep section of road that regularly erodes and loses material. Material reaches downhill lawns and driveways and eventually enters the lake.

Recommendations: Redirecting runoff using open-topped culverts or water bars in the road would reduce the velocity of runoff and send sediment to the wooded edges. The road is currently well-graded but cutting ditches and stone-lining them or adding stone check dams would also reduce the amount of sediment reaching the lake.

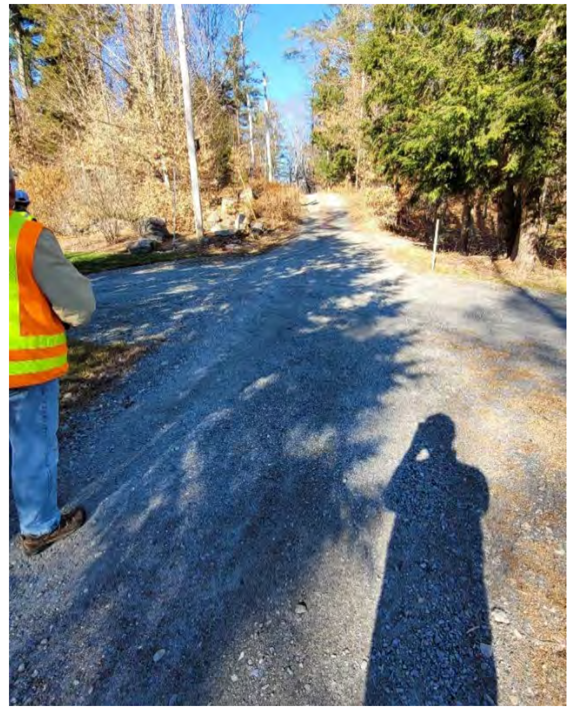


Figure A-20. Looking uphill on Breezy Point Road.

Site W-12: Cold Pond Road Ditch Erosion

Impact: Low

Estimated Cost: $5,000 - $10,000

GPS Coordinates: 43.2654, -72.26668

Observations: Ditches along Cold Pond Road are eroding and accumulating sediment. The ditches are lightly vegetated and there are very few interruptions or diversions allowing the water to build velocity and erode the banks of the ditches.

Recommendations: Install stone check dams and more heavily vegetate the ditch. Stone-lining may also be necessary in steeper sections to reduce runoff velocity. Create infiltration or settling basins at the bottom of long stretches of the hill to infiltrate runoff.

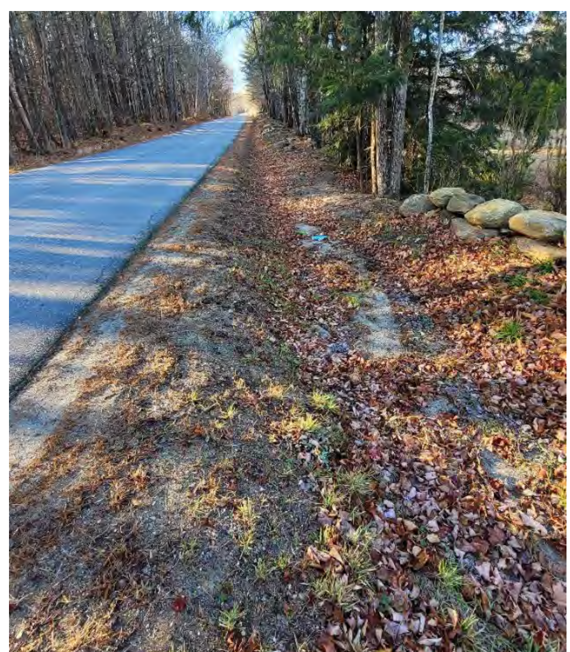


Figure A-21. Looking up the ditch along Cold Pond Road.

Site W-13: Page Road Erosion

Impact: Medium

Estimated Cost: $5,000 - $10,000

GPS Coordinates: 43.27193, -72.25893

Observations: This is a long section of road that shows signs of erosion and loss of material. Material is accumulating at the bottom of the hill and eventually washing into a stream that flows to the lake.

Recommendations: Redirecting runoff using open-topped culverts or water bars in the road would reduce the velocity of runoff and send sediment to the wooded edges. The road is currently well-graded but cutting ditches and stone-lining them or adding stone check dams would also reduce the amount of sediment reaching the lake.

Figure A-22. Looking uphill on Page Road and accumulated sediment.

Site W-14: Near 164 Crescent Lake Road Stream Erosion (AOC 3 Stream Erosion)

Impact: High

Estimated Cost: $15,000 - $20,000

GPS Coordinates: 43.26444, -72.24783258

Observations: A 60-ft-long stretch of stream is showing signs of bank and channel erosion

Recommendations: Regrade banks and stabilize the channel with stone. Possible location for wood addition or a stone settling pool to act as a grade control and allow for sediment settling. Care should be taken when adding material to this location as it is above an undersized culvert at AOC 3. Also recommend a project concept meeting with the NHDES Land Resources Management Bureau and Wetlands permitting staff.

Figure A-23. Photo looking upstream at eroded banks.

Site W-15: East Shore Road Erosion

Impact: Medium

Estimated Cost: $5,000 - $10,000

GPS Coordinates: 43.26912, - 72.24264

Observations: This is a long section of road that shows signs of erosion and loss of material. Material is accumulating at the bottom of the hill and eventually washing through a parking area that flows to the lake.

Recommendations: Install stone check dams and more heavily vegetate the ditch. Stone-lining may also be necessary in steeper sections to reduce runoff velocity. Create infiltration or settling basins at the bottom of the hill to infiltrate runoff.

Figure A-24. Looking uphill on East Shore Road and accumulated sediment.

Site W-16: Near 23/25 Gove Road Culvert Outlet Erosion 1

Impact: High

Estimated Cost: $15,000 - $25,000

GPS Coordinates: 43.26038, -72.26499

Observations: Intermittent stream banks and channel are eroding downstream of the culvert crossing Gove Road. The channel is approximately 8 ft wide with 2 ft bare banks on either side.

Recommendations: Cleared undergrowth has reduced the bank stability at this location. If the landowner is amenable, cutting back the banks and stabilizing with low woody vegetation and stone will stabilize the eroded banks. Alternatively, a settling basin at the outlet of the culvert will reduce the velocity of the stormwater running through the culvert and reduce bank erosion.

Figure A-25. Culvert crossing Gove Road and erosion downstream.

Site W-17: Near 89 Gove Road Culvert Outlet Erosion 2

Impact: Low

Estimated Cost: $5,000 - $10,000

GPS Coordinates: 43.25992, -72.25759

Observations: Small gully forming around the roots of trees at the outlet of the culvert. Banks approximately 4 ft in height.

Recommendations: Cut back the banks and stabilize with erosion control measures. Stabilize the channel gully with stone and construct a settling basin at the culvert outlet. Also a good spot for wood addition to act as grade control and promote infiltration.

Figure A-26. Looking upgradient at the forming gully and erosion around tree roots.

Site W-18: Cold Pond/Gove Road Culvert Erosion

Impact: High

Estimated Cost: $20,000 - $200,000

GPS Coordinates: 43.26033, -72.26742

Observations: The double culverts below the intersection of Cold Pond Road and Gove Road are undersized and too sharply angled under the road causing erosion of stream banks downstream of the culvert outlets.

Recommendations: At a minimum the banks downstream of the culvert should be cut back and stabilized with stone and vegetation. Addition of large wood or rock grade controls downstream may also help reduce stream velocity. The bankfull width of the stream at this location is 8 ft so upsizing to a box culvert with capacity to carry bankfull flows and oriented to reduce bank scour is recommended.

Figure A-27. Upstream culvert inlets and downstream bank scour.

Site W-19: Emerson Road Erosion 2

Impact: Medium

Estimated Cost: $10,000 - $15,000

GPS Coordinates: 43.27023, -72.26116

Observations: This is a long section of private road with two steep driveways that show signs of erosion and loss of material. Material is accumulating at the bottom of the hill and washing through a culvert directing flows to the lake.

Recommendations: Stabilize the uphill driveway with geogrid and gravel to reduce concentration of flows. Regrade road so that flows are contained in roadside ditches. Add stone lining or check dams to ditches and create a small infiltration basin at the outlet of the culvert under Emerson Road.

Figure A-28. Signs of erosion on Emerson Road.

Site W-20: Lake Road Erosion

Impact: Medium

Estimated Cost: $10,000 - $20,000

GPS Coordinates: 43.27093, -72.24948

Observations: This is a bend in Lake Road that shows signs of erosion and material loss down a steep hillside to the lake.

Recommendations: Create a ditch/swale and regrade the road to send water to the uphill side. This will promote infiltration of runoff rather than sheet flow off the side of the road and parking area. Install a riser structure at the end of the swale to direct higher flows to a new culvert crossing under Lake Road and additional settling basin on the downhill side of the road (with landowner approval).

Figure A-29. Eroding road and parking area on Lake Road.

Site W-21: Center Road Farm Runoff

Impact: Medium

Estimated Cost: $10,000 - $20,000

GPS Coordinates: 43.27530, -72.27456

Observations: This is a small farm with sheep pasture along a roadside ditch which also carries a mapped stream. The stream is a tributary of Sleeper Brook and eventually reaches the lake. There is minimal vegetation along the edge of the pasture and animal manure is likely running off into the stream during high flows.

Figure A-30. Sheep pasture and culvert outlet on Center Road.

Recommendations: Work with the landowner to create a vegetated buffer and/or infiltration trench between the pasture and the ditch/stream. This will capture pasture runoff and infiltrate stormwater before it enters the stream. May require engaging with a representative from the NRCS.

Site W-22: Anderson Road Erosion and Flooding

Impact: Medium

Estimated Cost: $10,000 - $20,000

GPS Coordinates: 43.26798, -72.25194

Observations: This is a stretch of dirt/gravel private road that shows signs of erosion and sediment accumulation in areas adjacent to the lake.

Recommendations: Regrade and build up the road so water sheet flows to the sides into forested areas where possible. Create roadside ditches with stone check dams to capture additional sediment. The lowest depression area could be converted to an infiltration basin with an overflow structure to reduce lawn flooding.

Figure A-31. Road erosion on Anderson Road and low area that floods adjacent lawns.

Site W-23: Hedgehog Hill Road/Ditch Erosion

Impact: High

Estimated Cost: $5,000 - $10,000

GPS Coordinates: 43.27737, -72.25750

Observations: This is a long stretch of dirt/gravel road that shows signs of erosion on the road surface and in the roadside ditches. The ditches terminate at a culvert crossing North Shore Road which leads to an intermittent stream down to the lake.

Recommendations: Stone line or vegetate the ditches and install stone check dams down the entire length to reduce the amount of sediment reaching the stream. Install a settling basin or engineered turnout towards the bottom of the ditch to direct water into the forested area before it enters the stream and culvert.

Figure A-32. Looking uphill at Hedgehog Hill Road and downhill at the culvert entrance.

Site W-24: Near 71 Crescent Lake Road Culvert (AOC4)

Impact: High

Estimated Cost: $50,000 - $100,000

GPS Coordinates: 43.26638, -72.23995

Observations: This is a 1.25-ft culvert crossing under Crescent Lake Road with an extensive drainage area to the south. The area has a history of flooding and evidence of erosion in the channel downstream.

Figure A-34. Outlet of undersized culvert under Crescent Lake Road.

Recommendations: The bankfull width of the intermittent stream is approximately 6 ft with a 50 acre drainage area. It may be necessary to upsize the culvert crossing under Crescent Lake Road and stabilize the outlet with large stone and erosion matting to reduce bank erosion.

Appendix B – Project Conceptual Plans

W14-Near 164 Crescent Lake Road (AOC3) Stream Erosion & W-5 Culvert Replacement

Site Description

The Town of Acworth identified Area of Concern 3 is a combination of 1) stream erosion and 2) road culvert issues. There is 60 feet of stream showing signs of bank and channel erosion upstream of a series of culverts that direct flow under and around Crescent Lake Road. The road and associated driveways have been washed out previously.

Proposed Improvement

1) Cut back stream banks and cover with erosion control fabric with live stakes. Put two stone grade control structures to create velocity reduction and promote sedimentation.

2) If the current configuration of primary and overflow culverts fails, installation of a 12' wide by 100' long culvert may be necessary to protect the road and driveway.

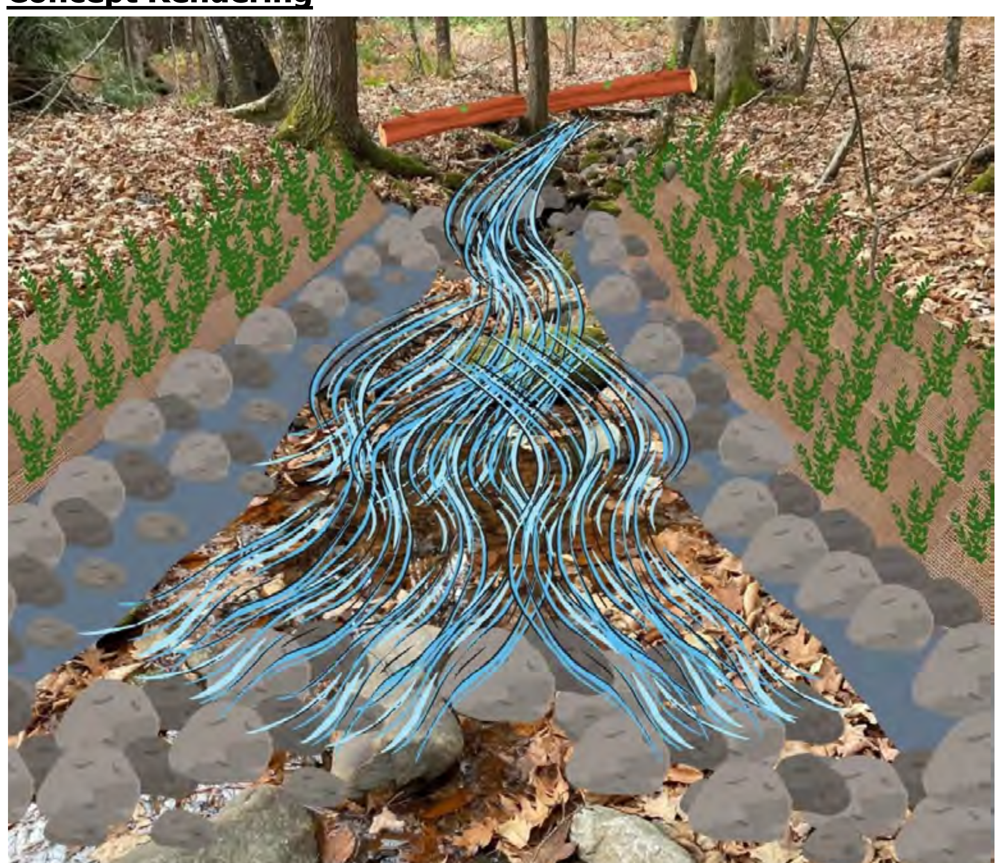
Estimate Cost

1) $15,000 - $20,000   2) $150,000 - $300,000

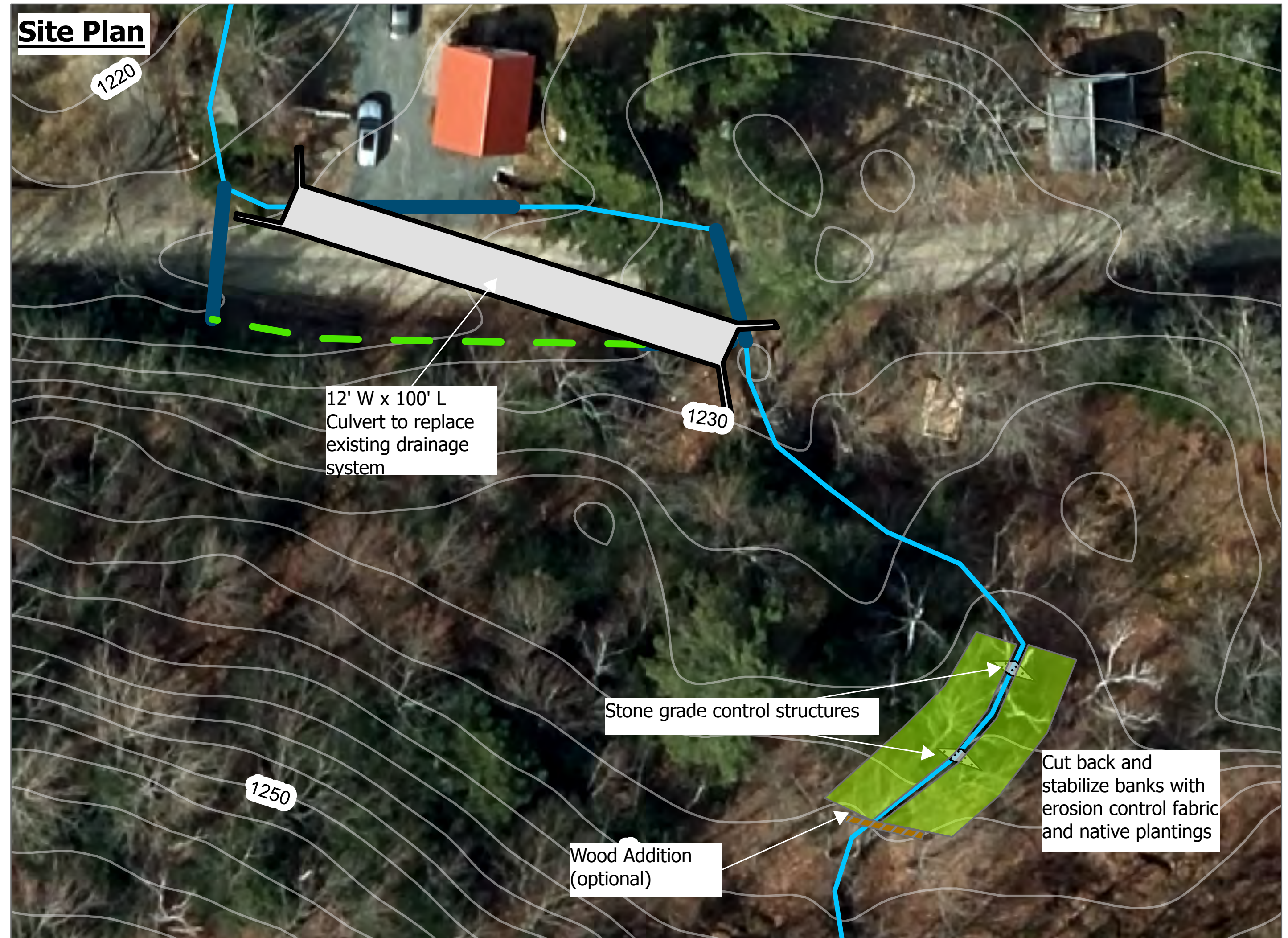
Estimated Phosphorus Reduction

Impact: 1) High 2) High
Total Phosphorus Reduction: 1) 0.68 kg/yr   2) 0.67 kg/yr

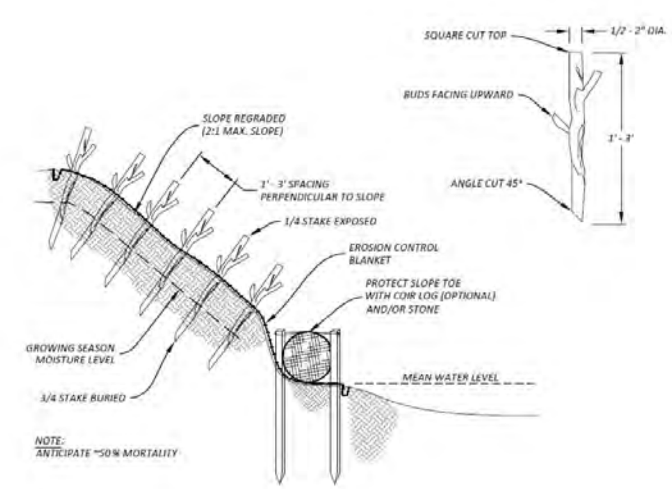
Concept Rendering



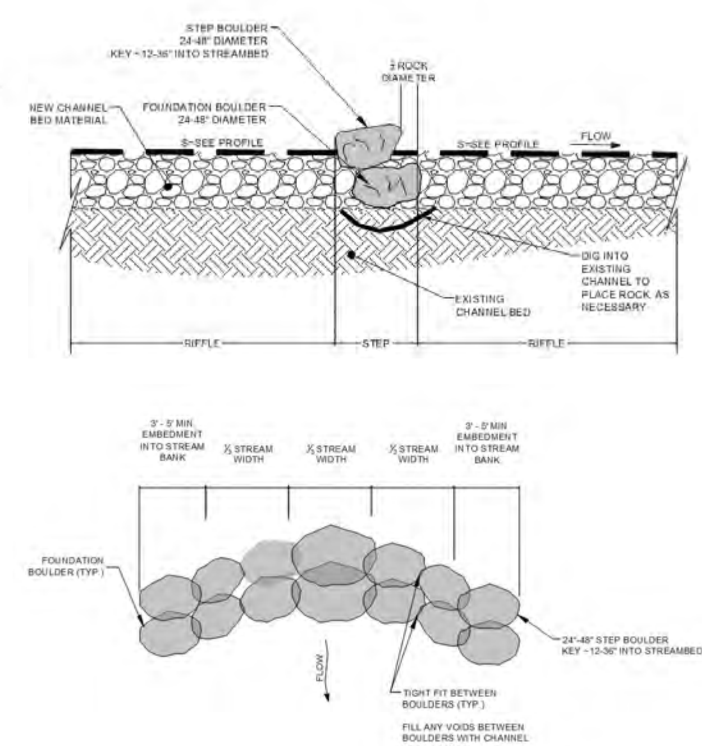
Site Plan



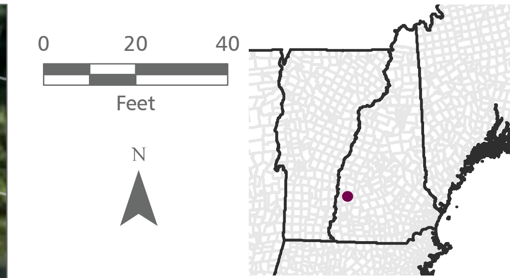
Typical Detail/Cross Section



Bank stabilization detail



Stone grade control structures details



LEGEND

- Beach Area
- Infiltration Steps
- Coir Roll
- Grass Path
- Planting Area
- Stone Toe
- Bluestone Parking
- Check Dam
- New Culvert
- Sedimentation Basin
- Ditch
- Stream
- Existing Culvert
- Stormwater
- NH Contours (2 ft)
- Parcels

Sources: NH Granit 2021/2022 Imagery, Vermont Bioengineering Manual

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Near 164 Crescent Lake Road Stream & Culvert

Crescent Lake Watershed Management Plan

Crescent Lake Association

STONE ENVIRONMENTAL

W23 Hedgehog Hill Rd

Site Description

Steep gravel roadway with long, uninterrupted stretches of bare dirt roadside ditches. Downstream point accumulated sediment and clogging culvert under North Shore Road.

Proposed Improvement

Install engineered turnouts and stone check dams to capture sediment before it enters the culvert and stream system.

Estimate Cost

$5,000 - $10,000

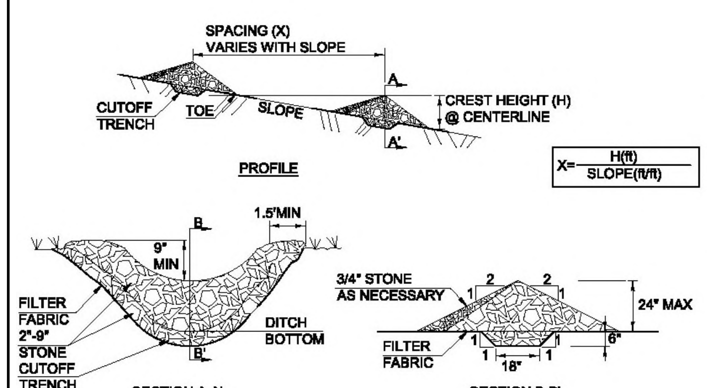
Estimated Phosphorus Reduction

Impact: Medium
Total Phosphorus Reduction: 0.36 kg/yr

Concept Rendering

Site Plan

Typical Detail/Cross Section

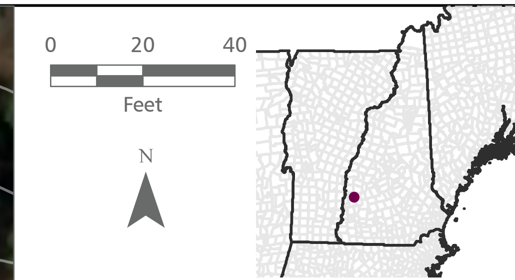


CONSTRUCTION SPECIFICATIONS

1. STONE WILL BE PLACED ON A FILTER FABRIC FOUNDATION.
2. CHECK DAMS SHALL BE SPACED SO THAT THE ELEVATION OF THE CREST OF THE DOWNSTREAM DAM IS AT THE SAME ELEVATION AS THE TOE OF THE UPSTREAM DAM.
3. 3/4" FILTERING STONE MAY BE ADDED TO THE FACE OF THE CHECK DAM AS NECESSARY.
4. EXTEND THE STONE A MINIMUM OF 1.5' BEYOND THE DITCH BANKS TO PREVENT CUTTING AROUND THE DAM.
5. PROTECT CHANNEL DOWNSTREAM OF THE LOWEST CHECK DAM FROM SCOUR AND EROSION WITH STONE OR LINER AS APPROPRIATE.
6. ENSURE THAT CHANNEL APPURTENANCES SUCH AS CULVERT ENTRANCES BELOW CHECK DAMS ARE NOT SUBJECT TO DAMAGE OR BLOCKAGE FROM DISPLACED STONE.

NOTES:

1. REFER TO "THE VERMONT STANDARDS & SPECIFICATIONS FOR EROSION PREVENTION & SEDIMENT CONTROL -2006- " FROM THE VT AGENCY OF NATURAL RESOURCES FOR ADDITIONAL GUIDANCE.
2. THIS WORK SHALL BE PERFORMED IN ACCORDANCE WITH SECTION 653 FOR TEMPORARY STONE CHECK DAM, TYPE I (PAY ITEM 653.25)



LEGEND

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- Parcels

Sources: NH Granit 2021/2022 Imagery, Vermont Bioengineering Manual

Path: O:\PROJ-24\WRM\20241075-Crescent_Lake_Watershed_Assessment\Design\GIS_W23 Hedgehog Hill Exported: 6/27/2025 11:20 AM by ahuizenga

Hedgehog Hill Rd

Crescent Lake Watershed Management Plan

Crescent Lake Association

STONE ENVIRONMENTAL

W12 Cold Pond Road Ditch Erosion

Site Description

This is a steep section of Cold Pond Road showing signs of erosion and sediment accumulation in the ditch on the west side of the road. This ditch has the potential to discharge to a small tributary of Sleeper Brook and eventually to Crescent Lake.

Proposed Improvement

Stone line this section of ditch to reduce runoff velocity from the paved road and stabilize the ditch. Create settling basins or armored turnouts at the bottom of the slope to dissipate stormwater runoff to vegetated areas.

Estimate Cost

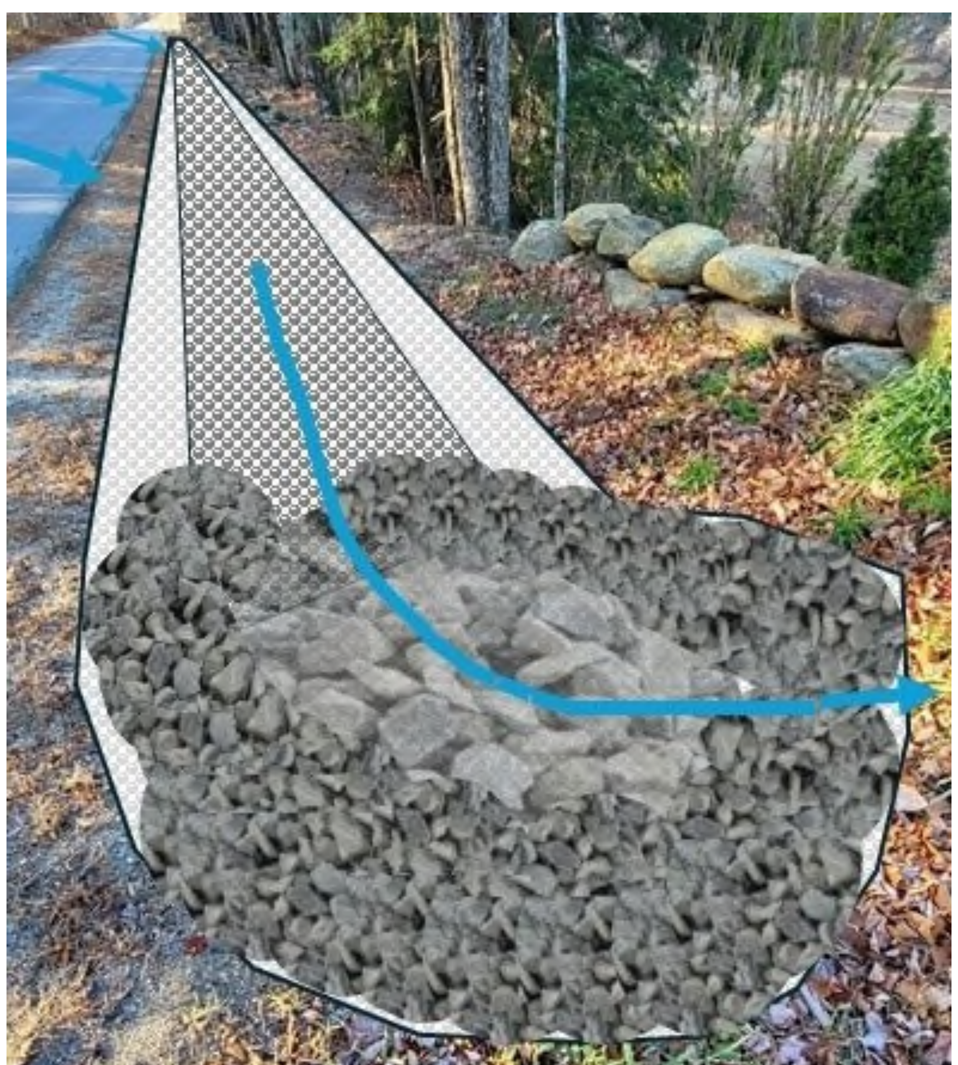
$5,000 - $10,000

Estimated Phosphorus Reduction

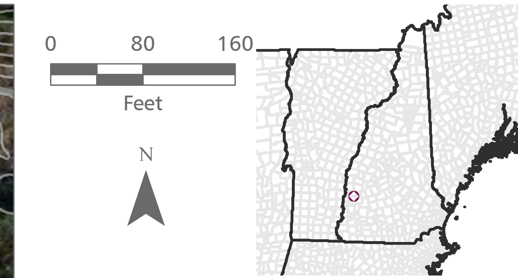
Impact: Medium

Total Phosphorus Reduction: 0.34 kg/yr

Concept Rendering



Site Plan



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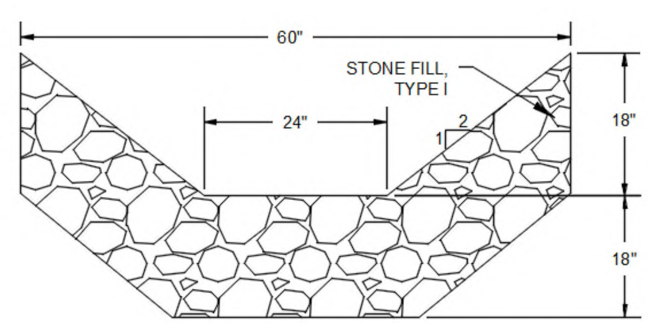
Typical Detail/Cross Section



STONE LINED STORMWATER SWALE DETAIL

NOT TO SCALE

NOTES:

1. TRACKING PAD SHALL BE INSTALLED PRIOR TO SITE DISTURBANCE.
2. TRACKING PADS WILL REQUIRE PERIODIC CLEANING TO MAINTAIN EFFECTIVENESS, WHICH MAY INCLUDE REMOVAL AND RE-INSTALLATION OF STONE.
3. STONE SHALL BE REPLACED WHEN STONE BECOMES BURIED OR SEDIMENT IS NOT BEING REMOVED EFFECTIVELY FROM TIRES.
4. SEDIMENT TRACKED INTO ROADWAYS SHALL BE REMOVED IMMEDIATELY.

Sources: NH Granit 2021/2022 Imagery, Vermont Bioengineering Manual

Path: O:\PROJ-24\WRM\20241075-Crescent_Lake_Watershed_Assessment\Design\GIS_W12 Cold Pond Road Ditch Erosion Exported: 6/27/2025 11:20 AM by ahuizenga

Cold Pond Road

Crescent Lake Watershed Management Plan

Crescent Lake Association

STONE ENVIRONMENTAL

W15 East Shore Road Erosion

Site Description

This is a steep section of East Shore Road showing signs of erosion and sediment accumulation at the bottom of the hill. Stormwater runoff flows unrestricted to open lawn and then to the lake.

Proposed Improvement

Direct road runoff either by grading or open topped culvert to a settling basin halfway down the eastern side of the road. Stormwater can then be discharged to the wooded area in a distributed manner. Establish ditch on western side of road and either stone line or add check dams to capture sediment.

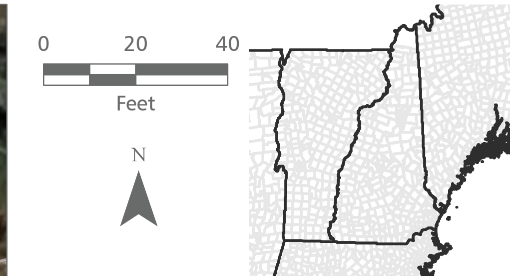
Estimate Cost

$5,000 - $10,000

Estimated Phosphorus Reduction

Impact: Medium
Total Phosphorus Reduction: 0.29 kg/yr

Site Plan



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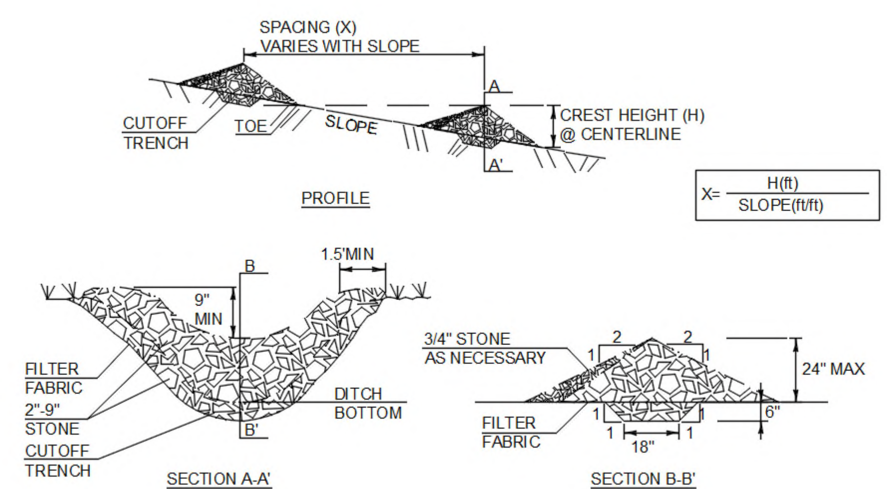
Concept Rendering

Typical Detail/Cross Section



CHECK DAM DETAIL

4. EXTEND THE STONE A MINIMUM OF 1.5' BEYOND THE DITCH BANKS TO PREVENT CUTTING AROUND THE DAM
5. PROTECT CHANNEL DOWNSTREAM OF THE LOWEST CHECK DAM FROM SCOUR AND EROSION WITH STONE OR LINER AS APPROPRIATE
6. ENSURE THAT CHANNEL APPURTENANCES SUCH AS CULVERT ENTRANCES BELOW CHECK DAMS ARE NOT SUBJECT TO DAMAGE OR BLOCKAGE FROM DISPLACED STONE

Sources: NH Granit 2021/2022 Imagery, Vermont Bioengineering Manual

Path: O:\PROJ-24\WRM\20241075-Crescent_Lake_Watershed_Assessment\Design\GIS_W-15 East Shore Road Exported: 6/27/2025 11:21 AM by ahuizenga

East Shore Road

Crescent Lake Watershed Management Plan

Crescent Lake Association

STONE ENVIRONMENTAL

W17 - Near 89 Gove Road Culvert Outlet Erosion

Site Description

This is a 24" HDPE culvert with a 6' wide, 3 ' deep gully eroding 20' downstream of the outlet. This might be due to the steepness of the drop after the culvert and velocity of the stormwater discharge.

Proposed Improvement

Construct a plunge pool at the outlet of the culvert to reduce velocities. This will require the removal of a maple tree at the outlet. If downstream landowners are amenable use the root wad of the tree to add additional roughness to the channel to reduce erosion.

Estimated Cost

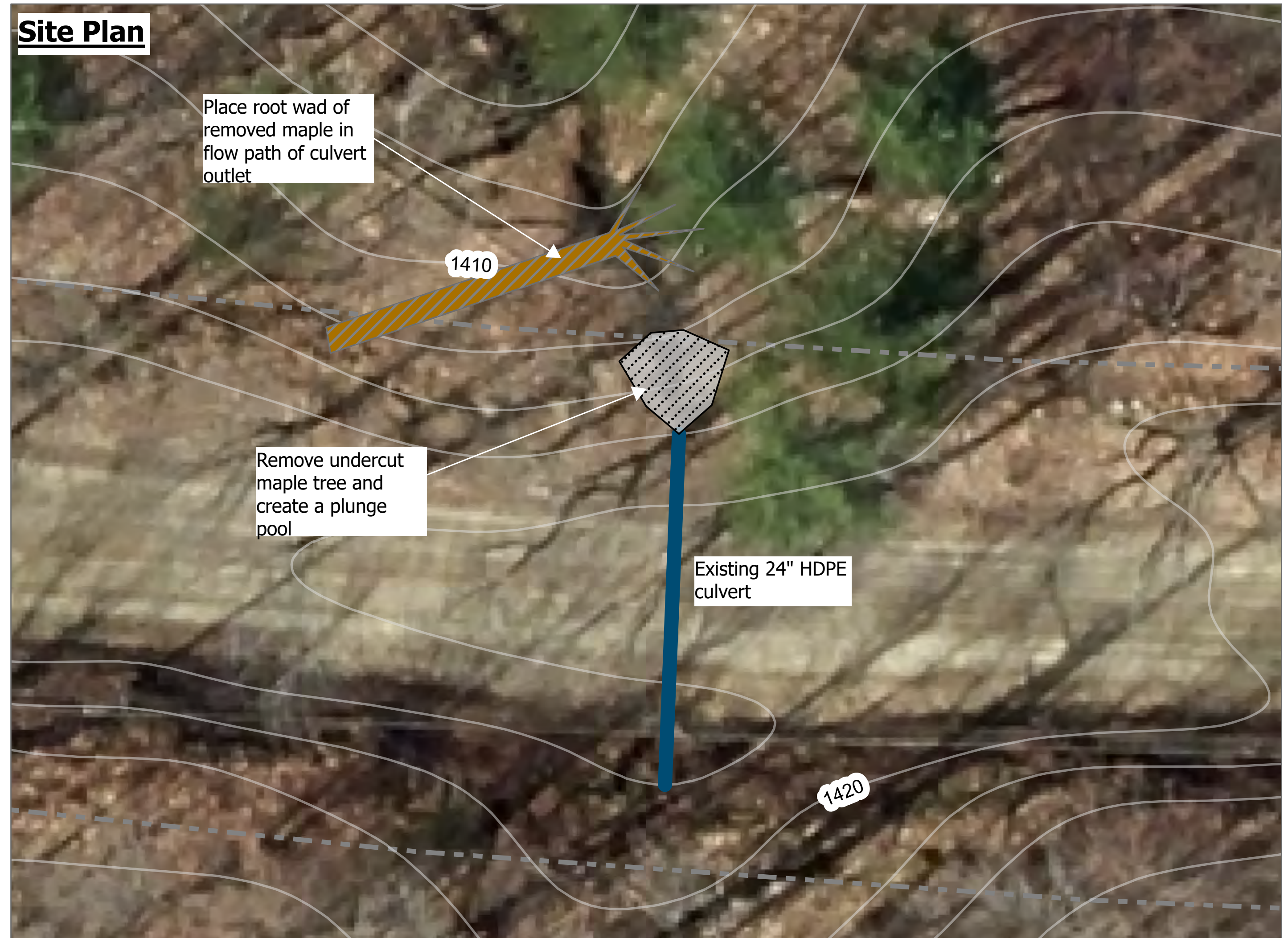
$5,000 - $10,000

Estimated Phosphorus Reduction

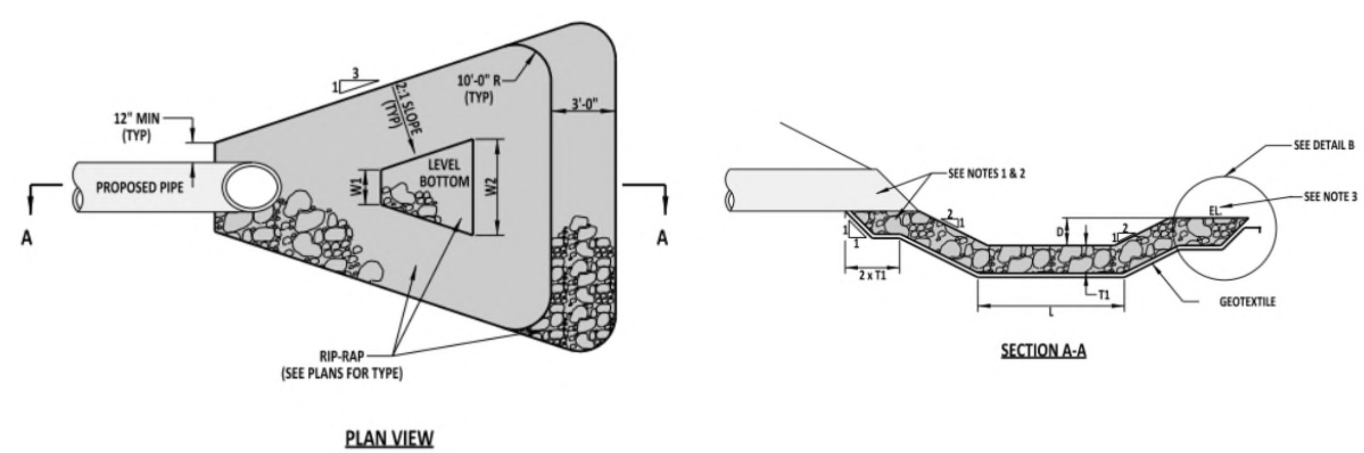
Impact: Medium
Total Phosphorus Reduction: 0.28 kg/yr

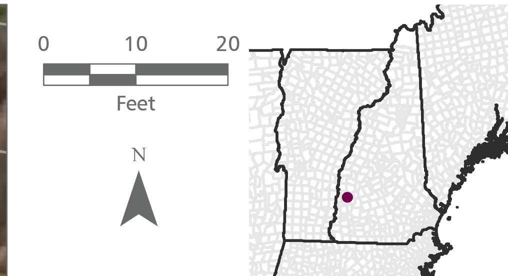
Concept Rendering

Site Plan



Typical Detail/Cross Section





LEGEND

- Beach Area
- Infiltration Steps
- Coir Roll
- Grass Path
- Planting Area
- Stone Toe
- Bluestone Parking
- Check Dam
- New Culvert
- Sedimentation Basin
- Ditch
- Stream
- Existing Culvert
- Stormwater
- NH Contours (2 ft)
- Parcels

Sources: NH Granit 2021/2022 Imagery, Vermont Bioengineering Manual

Path: O:\PROJ-24\WRM\20241075-Crescent_Lake_Watershed_Assessment\Design\GIS_W17 89 Gove Rd Culvert Outlet Exported: 6/27/2025 11:22 AM by ahuizenga

Near 89 Gove Road Culvert Outlet Erosion

Crescent Lake Watershed Management Plan

Crescent Lake Association

STONE ENVIRONMENTAL

W1 & W2 Boat Launch Area

Site Description

There is an undersized, 3' diameter culvert crossing Crescent Lake Road adjacent to the boat launch. Significant sediment accumulation is occurring downstream of the culvert. The adjacent gravel boat launch shows signs of erosion and sediment transport to the lake via rill erosion and concentrated runoff.

Proposed Improvement

1) Replace the undersized culvert with a 13' wide, 40' long culvert and stabilize the streambanks downstream of the outlet with erosion control fabric, live stakes, and stone. If necessary, reestablish stream access to the lake by removing sediment plume.

2) Crown the boat launch so water sheet flows to the vegetated sides of the area. Establish stone lined ditches on either side of the boat launch to capture sediment and reduce runoff velocity.

Estimate Cost

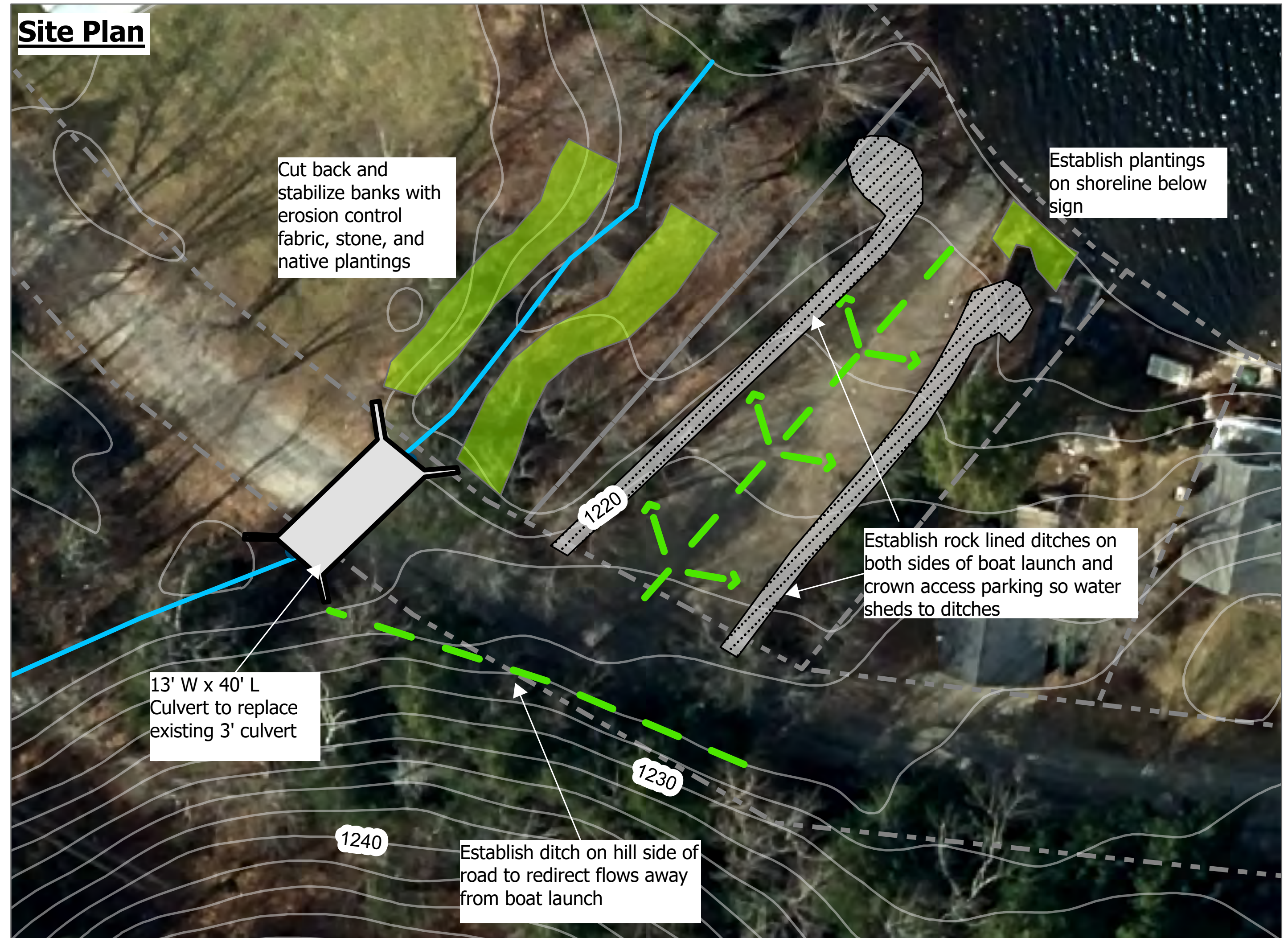
1) $100,000 - $200,000   2) $25,000 - $35,000

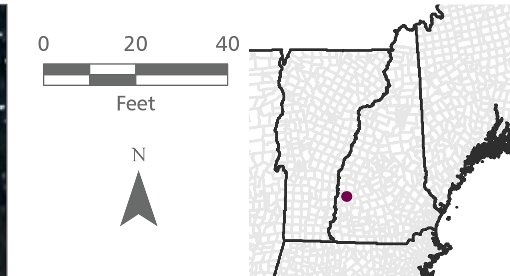
Estimated Phosphorus Reduction

Impact: 1) High 2) Low
Total Phosphorus Reduction: 1) 1.42 kg/yr   2) 0.12 kg/yr

Concept Rendering

Site Plan





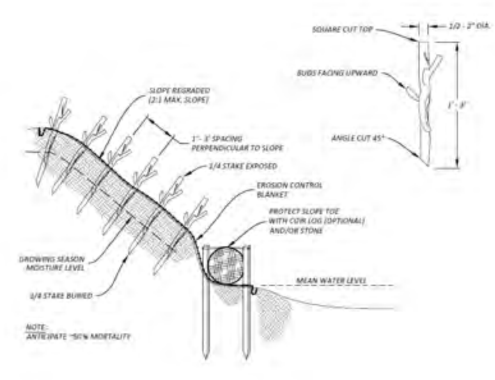
LEGEND

- Beach Area
- Infiltration Steps
- Coir Roll
- Grass Path
- Planting Area
- Stone Toe
- Bluestone Parking
- Check Dam
- New Culvert
- Sedimentation Basin
- Ditch
- Stream
- Existing Culvert
- Stormwater
- NH Contours (2 ft)
- Parcels

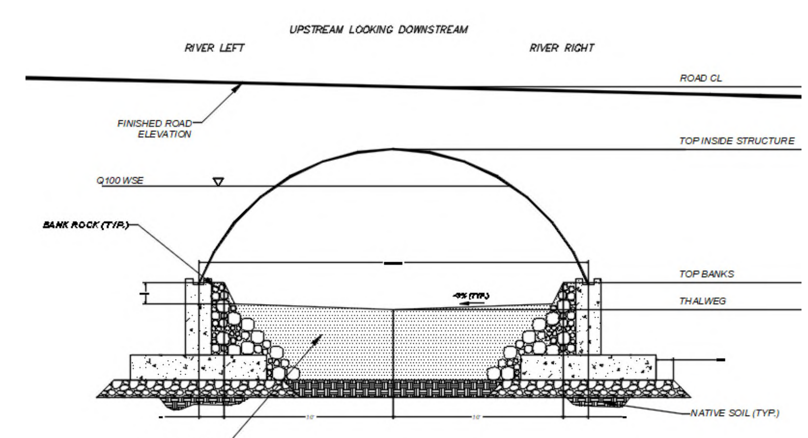
Sources: NH Granit 2021/2022 Imagery, Vermont Bioengineering Manual

Path: <LINK>O:\PROJ-24\WRM\20241075-Crescent_Lake_Watershed_Assessment\Design\GIS_LINK> W1&2 Boat Launch Exported: 6/27/2025 12:53 PM by ahuizenga

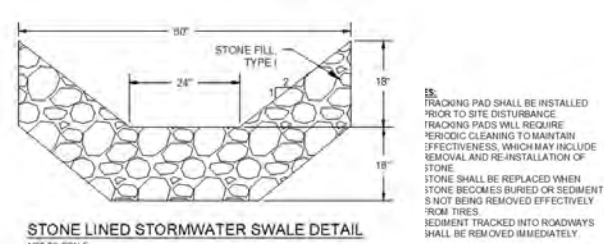
Typical Detail/Cross Section



Bank stabilization detail



Multi-plate pipe arch culvert cross section



STONE LINED STORMWATER SWALE DETAIL

Boat Launch Area

Crescent Lake Watershed Management Plan

Crescent Lake Association

STONE ENVIRONMENTAL

W9 & W10 Crescent Cove Parking & Shorewood Estates Road Erosion

Site Description

The Crescent Cove parking area has eroding roadway, ditches, and parking area runoff to an intermittent stream and lakeshore. Undersized culverts under driveways and road causes flooding.

Proposed Improvement

Install check dams in ditches to capture sediment from road runoff. Extend the ditch on the lake side of the road to the vegetated area. If vehicle access is necessary to beach, install culvert at old snowmobile trail to cross ditch. Install a sedimentation basin on both sides of Shorewood Estates Road. Define parking area with a grass swale and plantings between the edge of parking and the intermittent stream. Regrade and resurface parking area with bluestone to drain to swale to infiltrate or overflow to the lake during high flows.

Estimated Phosphorus Reduction

Impact: Low

Total Phosphorus Reduction: 0.20 kg/yr

Estimated Cost

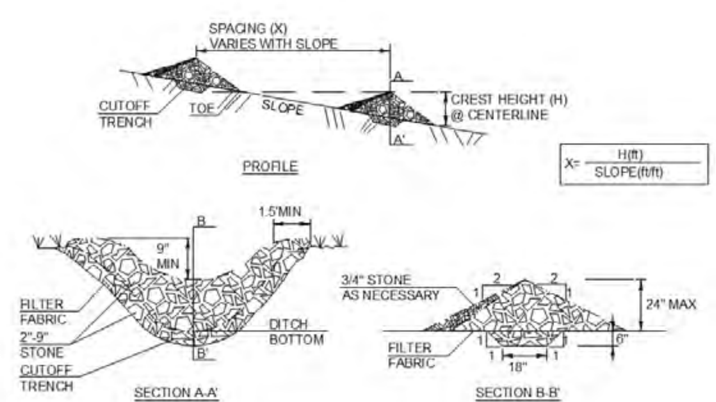
$30,000 - $50,000

Concept Rendering

Example roadside sedimentation basin.

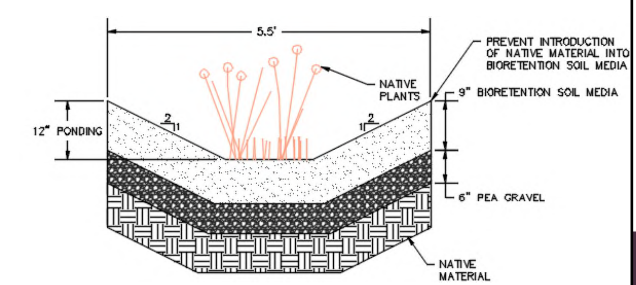
Site Plan

Typical Details/Cross Sections



CHECK DAM DETAIL

1. STONE WILL BE PLACED ON A FILTER FABRIC FOUNDATION.
2. CHECK DAMS SHALL BE SPACED SO THAT THE ELEVATION OF THE CREST OF THE DOWNSTREAM DAM IS AT THE SAME ELEVATION AS THE TOE OF THE UPSTREAM DAM.
3. 3/4" FILTERING STONE MAY BE ADDED TO THE FACE OF THE CHECK DAM AS NECESSARY.
4. EXTEND THE STONE A MINIMUM OF 1.5' BEYOND THE DITCH BANKS TO PREVENT CUTTING AROUND THE DAM.
5. PROTECT CHANNEL DOWNSTREAM OF THE LOWEST CHECK DAM FROM SCOUR AND EROSION WITH STONE OR LINER AS APPROPRIATE.
6. ENSURE THAT CHANNEL APPURTENANCES SUCH AS CULVERT ENTRANCES BELOW CHECK DAMS ARE NOT SUBJECT TO DAMAGE OR BLOCKAGE FROM DISPLACED STONE.

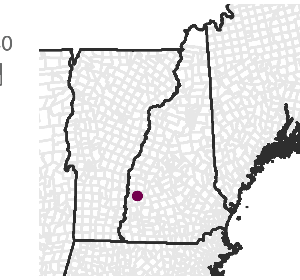


BIOSWALE DETAIL

1. PEAK VELOCITY SHALL BE NON-EROSIVE (3.5-5 FPS)
2. BOTTOM OF THE SWALE SHALL BE BETWEEN 2 AND 8 FT WIDE
3. TRAPEZOIDAL OR PARABOLIC CROSS SECTION WITH SIDE SLOPES LESS THAN OR EQUAL TO 2H:1V

0 20 40 Feet

N



LEGEND

- Beach Area
- Infiltration Steps
- Coir Roll
- Grass Path
- Planting Area
- Stone Toe
- Bluestone Parking
- Check Dam
- New Culvert
- Sedimentation Basin
- Ditch
- Stream
- Existing Culvert
- Stormwater
- NH Contours (2 ft)
- Parcels

Sources: NH Granit 2021/2022 Imagery, Vermont Bioengineering Manual

Path: <LINK>O:\PROJ-24\WRM\20241075-Crescent_Lake_Watershed_Assessment\Design\GIS_LINK> W3 & W8 Shorewood Estates Road/Parking

Exported: 6/27/2025 11:32 AM by ahuizenga

Crescent Cove Parking & Shorewood Estates Road Erosion

Crescent Lake Watershed Management Plan

Crescent Lake Association

STONE ENVIRONMENTAL

W3 - Near 199 Crescent Lake Road (AOC2)

Site Description

The town identified Area of Concern 2 near 199 Crescent Lake Road as an existing stormwater drainage system that is regularly overwhelmed during high flows. The lid of the existing cistern at the corner of the driveway is lifted up and the road is washed away. Two undersized culverts and a yard drain discharge to the cistern and then to a 2.5' outlet pipe.

Proposed Improvement

Daylight 85' of stream to the west of the house and parking area and replace culvert and cistern system with a 14' wide culvert crossing Crescent Lake Road. Replace 15" driveway cross culvert with a 3' diameter culvert crossing Crescent Lake Road.

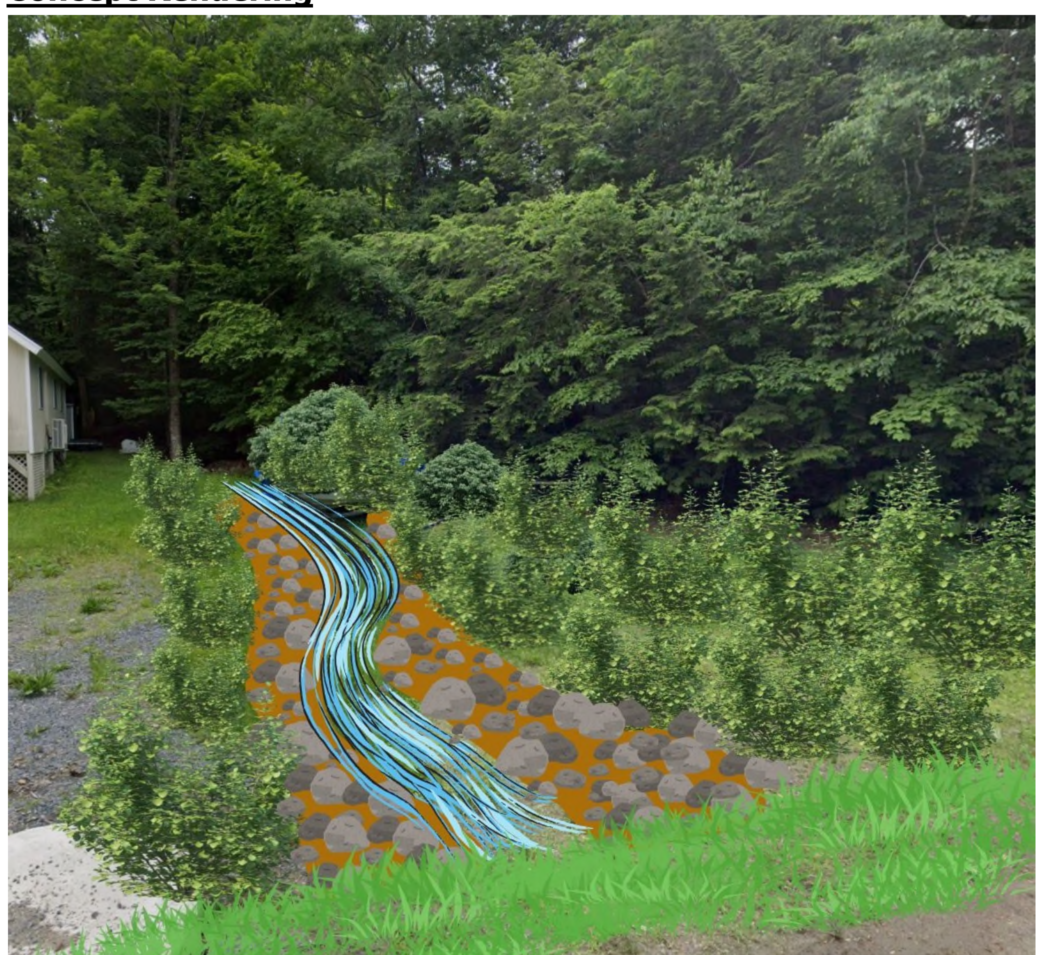
Estimated Cost

$100,000 - $200,000

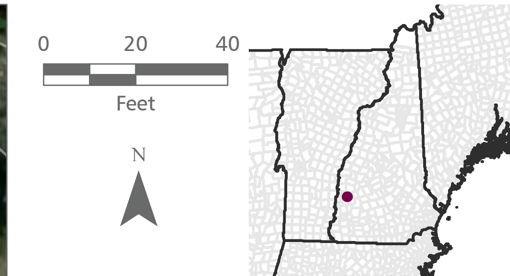
Estimated Phosphorus Reduction

Impact: Medium
Total Phosphorus Reduction: 0.36 kg/yr

Concept Rendering



Site Plan



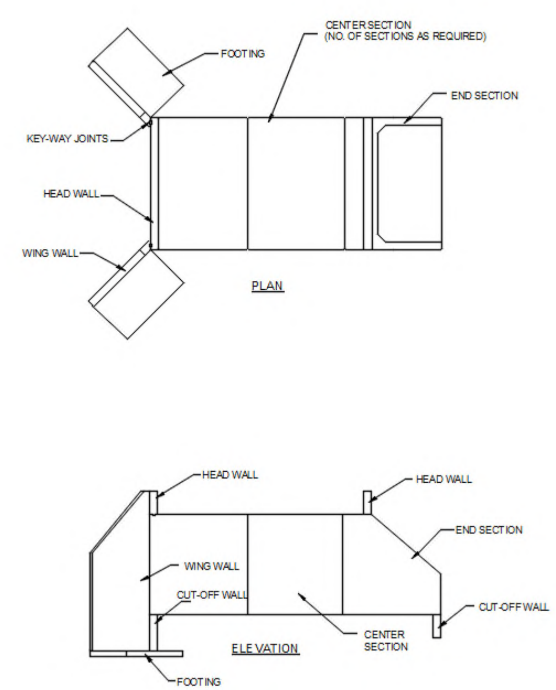
LEGEND

- Beach Area
- Infiltration Steps
- Coir Roll
- Grass Path
- Planting Area
- Stone Toe
- Bluestone Parking
- Check Dam
- New Culvert
- Sedimentation Basin
- Ditch
- Stream
- Existing Culvert
- Stormwater
- NH Contours (2 ft)
- Parcels

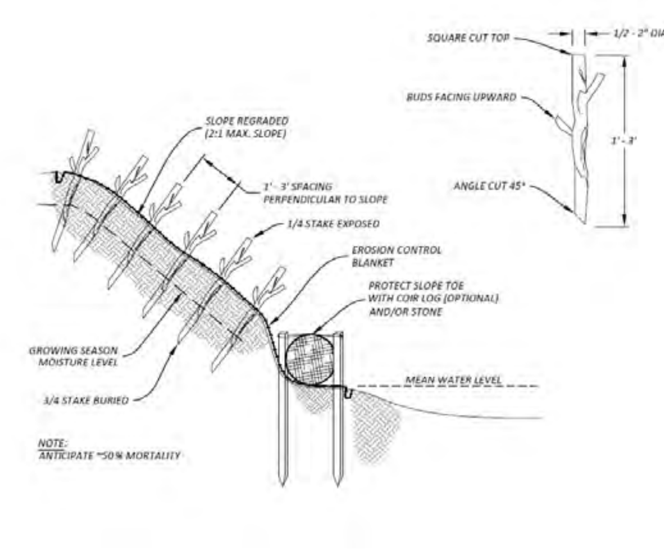
Sources: NH Granit 2021/2022 Imagery, Vermont Bioengineering Manual

Path: O:\PROJ-24\WRM\20241075-Crescent_Lake_Watershed_Assessment\Design\GIS_W4 - AOC 2 Exported: 6/27/2025 11:34 AM by ahuizenga

Typical Detail/Cross Section



Box Culvert detail



Bank stabilization detail

Near 199 Crescent Lake Road Culvert

Crescent Lake Watershed Management Plan

Crescent Lake Association

STONE ENVIRONMENTAL

W24 - Near 70 Crescent Lake Road (AOC4)

Site Description

The town identified Area of Concern 4 near 70 Crescent Lake Road as an existing 15" culvert that is regularly overwhelmed during high flows. The road is often flooded and there is a risk of washout of driveways and roads.

Proposed Improvement

Replace the existing 15" corrugated metal pipe with a 6' diameter culvert. The stream downstream of the culvert has been narrowed to accommodate a stone path. This may need to be adjusted or moved to allow more room for the stream.

Estimated Cost

$50,000 - $100,000

Estimated Phosphorus Reduction

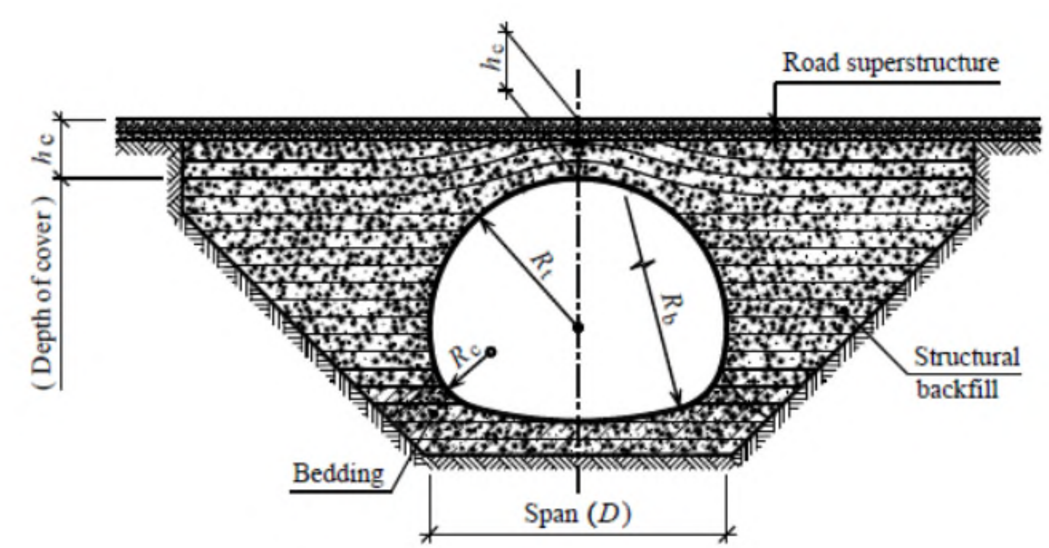
Impact: Low
Total Phosphorus Reduction: 0.18 kg/yr

Concept Rendering

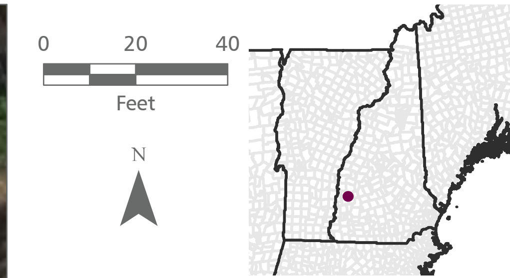
Photo Credit: https://infrasteel.com/what-are-the-primary-components-of-culverts/

Site Plan

Typical Detail/Cross Section



Pipe Arch Culvert
(Source: Application of FRP Materials for Construction of Culvert Bridges)



LEGEND

- Beach Area
- Infiltration Steps
- Coir Roll
- Grass Path
- Planting Area
- Stone Toe
- Bluestone Parking
- Check Dam
- New Culvert
- Sedimentation Basin
- Ditch
- Stream
- Existing Culvert
- Stormwater
- NH Contours (2 ft)
- Parcels

Sources: NH Granit 2021/2022 Imagery, Vermont Bioengineering Manual

Path: O:\PROJ-24\WRM\20241075-Crescent_Lake_Watershed_Assessment\Design\GIS_W24 - AOC 4 Exported: 6/27/2025 11:55 AM by ahuizenga

Near 70 Crescent Lake Road Culvert

Crescent Lake Watershed Management Plan

Crescent Lake Association

STONE ENVIRONMENTAL

Generic Shoreline Planting Plan

Site Description

This generic 100' shoreline is cleared along entire length. The shoreline shows some signs of erosion but does not require an engineering project to stabilize.

Proposed Improvement

Planting a minimum 15' buffer with a mixture of native, woody vegetation will stabilize the shoreline and provide some stormwater runoff treatment. Recommend a mixture of large trees, medium sized shrubs, and perennial plants. A 6' wide path down to the lake shore can remain for boat and recreation access.

Establishing a "No-Mow" area along the shoreline is also an acceptable and free practice that may work in some cases. Native seed beds in the soil will eventually re-establish native plants if selectively weeded and encouraged.

Sample Plant List

Trees:
- Alder
- Maple (Red, Silver, Sugar)
- Birch (White, Gray, Yellow)
- Black cherry
- Red oak
- Northern white cedar
- Eastern hemlock
- White pine

Shrubs:
- Red-osier dogwood
- Meadowsweet
- Serviceberry
- Bayberry
- Elderberry
- Arrowwood viburnum
- Chokeberry
- Hobblebush
- Highbush Blueberry/Cranberry

Perennials:
- Royal Fern
- Blue flag iris
- White turtlehead
- Black-eyed susan
- Joe Pye Weed
- Smooth blue aster
- Wild bergamot

For full list visit: https://www.des.nh.gov/sites/g/files/ehbemt341/files/documents/native-shoreland-plantings.pdf

Estimated Cost

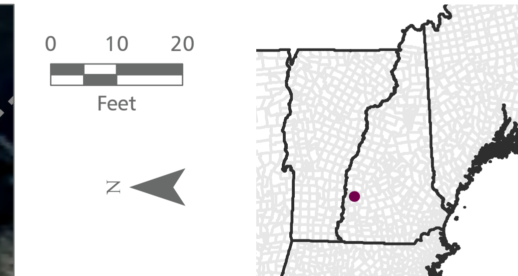
$5,000 - $10,000

Estimated Phosphorus Reduction

Impact: Medium

Total Phosphorus Reduction: 0.28 kg/yr

Site Plan



LEGEND

- NH Contours (2 ft)
- Parcels
- PERENNIAL
- SHRUB
- TREE

Concept Rendering

Plantings, Year 0

Plantings, Year 20

Sources: NH Granit 2021/2022 Imagery, Vermont Bioengineering Manual

Path: O:\PROJ-24\WRM\20241075-Crescent_Lake_Watershed_Assessment\Design\GIS_Generic Planting Layout Exported: 6/27/2025 11:58 AM by ahuizenga

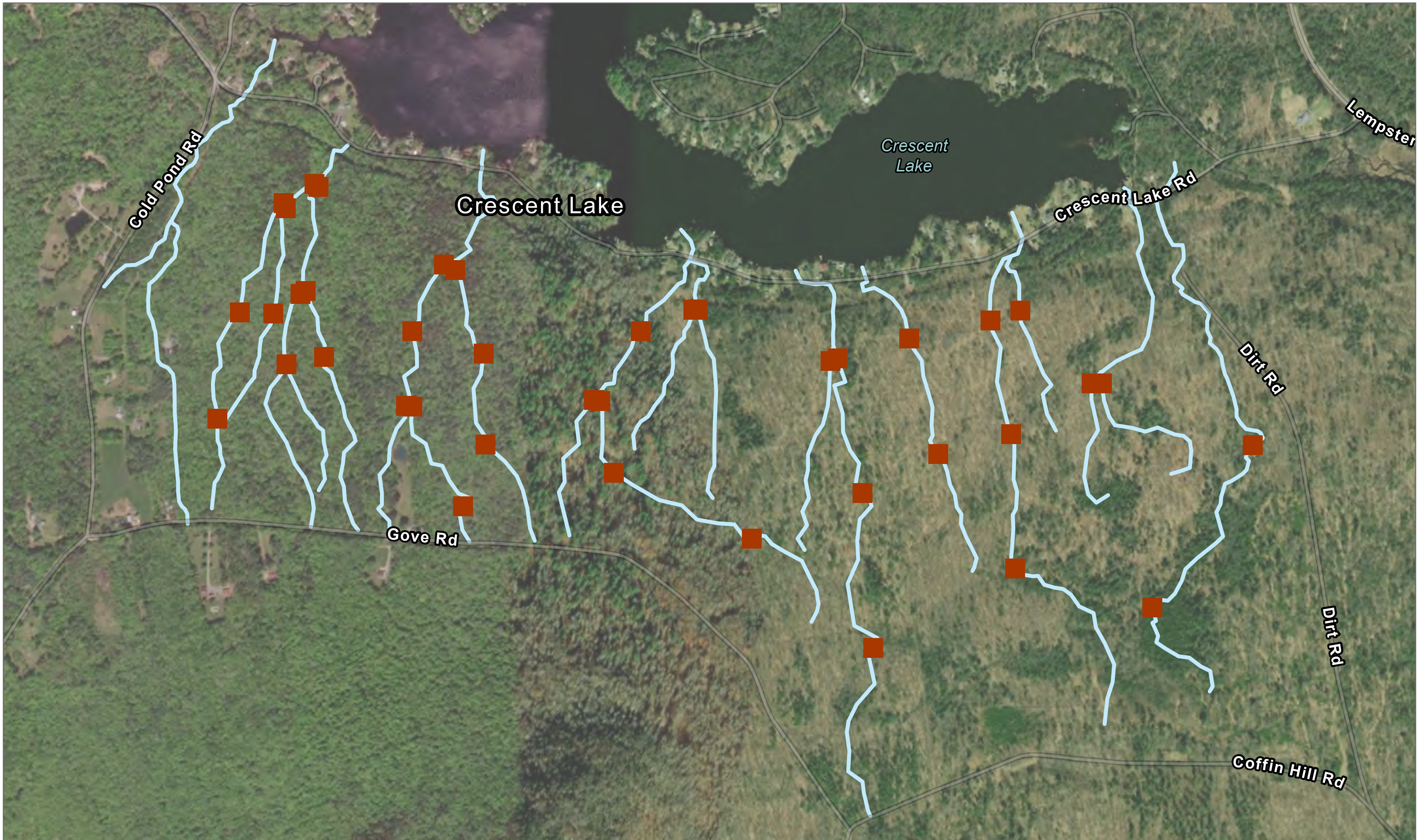
Generic Shoreline Planting Plan

Crescent Lake Watershed Management Plan

Crescent Lake Association

Stone Environmental

Appendix C – Wood Additions Map



LEGEND

WoodAdditions

StreamLine

N

0 250 500

Feet

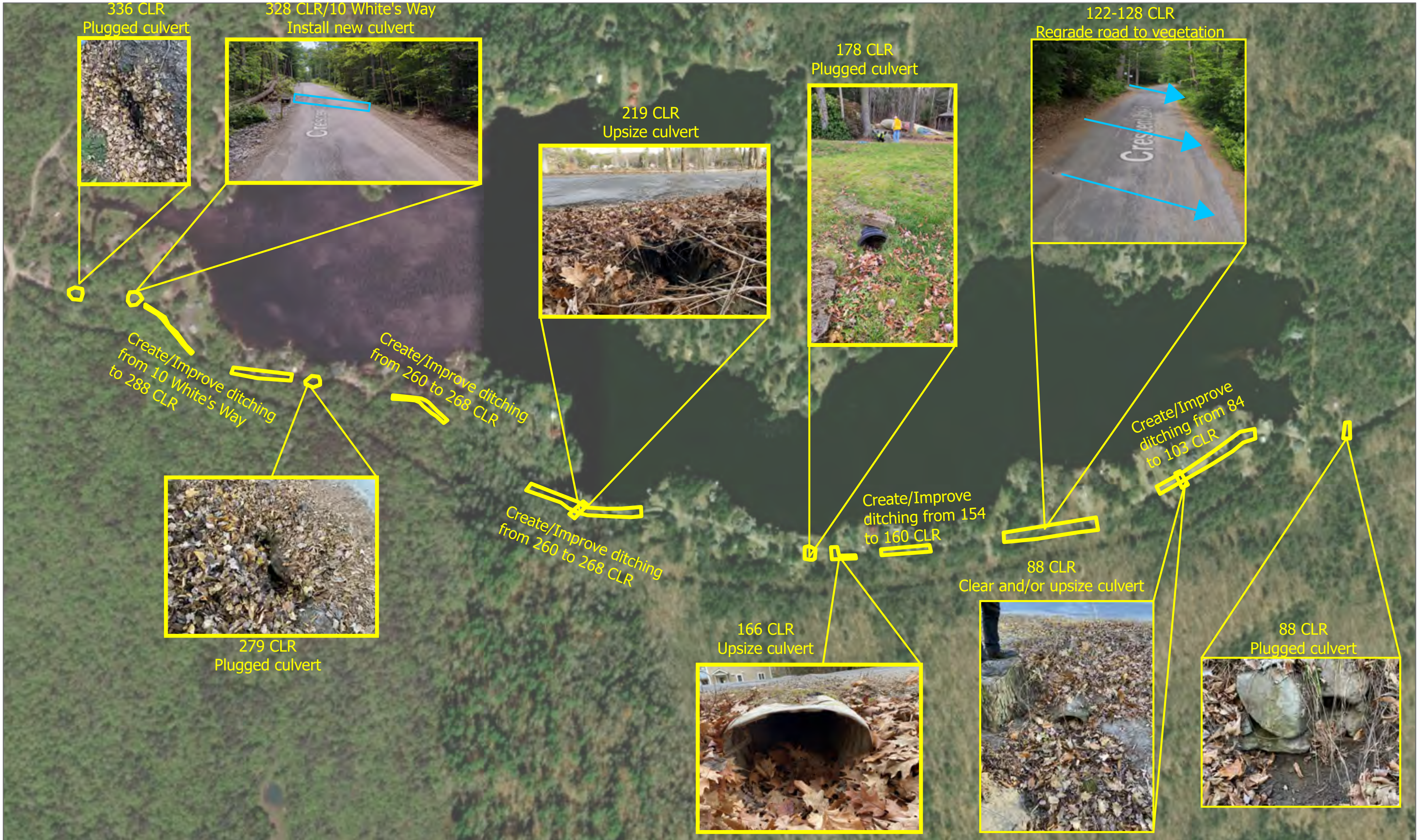
Appendix C. Wood Addition Locations

Crescent Lake Watershed Management Plan

Service Layer Credits: World Imagery: VCGI, Maxar
Hybrid Reference Layer: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Path: C:\Users\ahuizenga\OneDrive - Stone Environmental Inc\Documents\LocalWork\Crescent Lake NH\GIS_Feb2025\LocalCrescentLake\LocalCrescentLake.aprx Wood AdditionsExported: 2/7/2025 4:20 PM by ahuizenga

Appendix D – Crescent Lake Road Projects



LEGEND

Crescent Lake Road Improvements

N

0 250 500

Feet

Appendix D. Crescent Lake Road Upgrades

Crescent Lake Watershed Management Plan

Service Layer Credits: World Imagery: VCGI, Maxar

Path: C:\Users\ahuizenga\OneDrive - Stone Environmental Inc\Documents\LocalWork\Crescent Lake NH\GIS_Feb2025\LocalCrescentLake\LocalCrescentLake.aprx Crescent Lake Road ProjectsExported: 2/7/2025 4:20 PM by ahuizenga

Appendix E – Local Regulations

Town of Acworth Zoning Ordinance

- Article III.B.4, 5, 7, 8 – These sections in the General Provisions of the Acworth Zoning Ordinance state that no use shall be permitted in a manner which would:
  - result in the pollution of ground or surface waters
  - permit toxic or hazardous substances to enter ground or surface waters
  - result in soil erosion during or after construction
  - result in sedimentation of surface waters;
- Article III.C – This section states that sanitary systems shall be constructed and maintained in accordance with NHDES and enforced by the Board of Selectmen.
- Article V.5-6 – These sections create and manage Permanently Protected Areas in the Rural District where Lot Size Averaging for development occurs. Permanent protection shall be provided for an area equal to or exceeding the sum of the areas by which individual lots are reduced below the minimum normally required for the district.
- Article VI – This entire article covers the Crescent Lake District.
  - Setback requirements include language stating that buildings and structures should be sited to minimize impact on habitat and watershed and that new buildings shall be designed to prevent the release of surface runoff across exposed soils.
  - References the NH Comprehensive Shoreland Protection Act.
  - Limits the use of fertilizer within 25 feet of the high-water mark of Crescent Lake.
- Article VII – This section protects the town's surface waters by stating that the Conservation Zone is a 100 foot buffer around the high water mark of any streams or natural ponds, with the exception of the shores of Crescent Lake.
- Acworth Zoning Ordinance Supplement – This supplement covers floodplain management and requires permits and review procedures for proposed development in floodplain areas.

Town of Unity Land Use Ordinance

- Article 1.2 – This section states that one purpose of the ordinance is to "preserve and enhance the rural atmosphere, natural beauty, natural environment, and the overall quality of life in Unity…"
- Article 3.4 – This section states that "adequate provisions for water supply and sewage disposal for the accessory and primary dwelling units…"

Town of Unity Site Plan Regulations

- Section II states that one of the purposes of the Site Plan Regulations is to "avoid development which may result in negative environmental impacts"
- Section IX.I Storm Water Management and Erosion Control – This section states the need for a stormwater management and erosion control plan under certain conditions:
  - Total disturbance > 20,000 square feet
  - Construction of street or road
  - Subdivision involving three or more dwelling units
  - Disturbance of critical areas, such as steep slopes, wetlands, floodplains

Town of Unity Subdivision Regulations

- Section 4.2 Character of Property Proposed for Subdivision – This section states that subdivisions shall make every reasonable effort to protect ground and surface water resources, including:

- Environmentally sensitive areas such as steep slopes, flood prone areas, seasonally wet, marsh, much or peat areas and wetlands may not be altered, dredged drained, filled, or relocated, except for agricultural use.
    - Natural watercourses, ponds or lakes may not be altered, dredged, drained, filled or relocated and a 125-foot permanent natural greenbelt along water bodies and watercourses is strongly encouraged.
    - Specific requirements for stormwater drainage plans are required for sites with steep driveways
- Section 4.8 – This section states that the board will not approve a subdivision where the minimum standards and design requirements for on-site sewage disposal does not meet standards.
- Section 4.15 – This section sets the requirements for utilities and drainage for a subdivision setting minimum return intervals for culvert and drainage sizing.
- Section 4.16 – This section states the requirement of a sediment and erosion control plan.

Appendix F – Implementation Plan

CRESCENT LAKE IMPLEMENTATION PLAN					
Action Item		Responsible Party	Estimated Cost	Schedule	Funding Sources
	Shoreline SCMs				
1	Provide technical assistance and work to identify implementation cost sharing funding for property owners with more complex shoreline stabilization and erosion control projects. **Cost is the full price to construct the top 10 high impact shoreline properties. Achieves 24% of Objective 1 (4.6 kg/yr P of 19 kg/yr)**	CLA, private landowners	$135,000-$220,000	2026-2035	Grants, Landowners
2	Provide technical assistance and work to identify implementation cost sharing funding for property owners with less complex shoreline stabilization and erosion control projects. **Achieve a minimum of 36% of Objective 1 (6.9 kg/yr P of 19 kg/yr). Cost is based on an average price of $5,000 for 25 additional high and medium impact shoreline properties.**	CLA, private landowners	$125,000	2026-2035	Grants, Landowners
3	Continue to promote NH Lakes LakeSmart program evaluations and certifications through workshops and trainings. Cost assumes coordination of and materials for up to five workshops	CLA, NH Lakes, NHDES Soak Up the Rain NH, Municipalities	$5,000	2026-2035	Grants
4	Repeat the shoreline survey at 5 years and 10 years to update the plan and track progress/identify continued issues	CLA	$15,000	2030 and 2035	Grants, private landowners
	Watershed SCMs				
5	Complete design and construction of mitigation measures at top 5 ranked sites identified in watershed survey. **Achieves 10% (2 kg/yr P of 19 kg/yr P) of Objective 1.**	CLA, Municipalities	$35,000 - $60,000	2026-2027	CWSRF, Grants, Muncipalities, private landowners
6	Complete design and construction of Boat Launch Culvert. **Achieves 7% (1.4 kg/yr P of 19 kg/yr P) of Objective 1.**	CLA, Municipalities	$100,000 - $200,000	2026-2028	Town of Acworth, Grants
7	Complete design and construction of remaining mitigation measures identified in watershed survey (Except the major culvert replacements). **Achieves 17% (3.2 kg/yr P of 19 kg/yr P) of Objective 1.**	CLA, Municipalities	$150,000-$255,000	2029-2035	CWSRF, Grants, Muncipalities, private landowners
8	Complete design and construction of major culvert replacements. **Achieves 12% (2.2 kg/yr P of 19 kg/yr P) of Objective 1.**	CLA, Municipalities	$330,000-$880,000	2027-2030	Muncipalities, Grants
9	Engage a consultant with knowledge of Wood Addition to develop a plan for introducing more wood to streams in the conserved lands south of Crescent Lake.	CLA	$10,000-$25,000	2027	Grants
	Road Management and Municipal Operations				
10	Engage with public and private road and drainage maintenance providers and determine areas for improvement	Municipalities, CLA, Private Landowners	$3,000	2026	Municipalities, Grants
11	Provide education and training to nearby contractors, municipal staff, and private residents for road and driveway maintenance best practices. Assumes one workshop.	Municipalities, CLA	$1,500	2027	Municipalities, Grants
12	Engage with the town of Acworth on the rehabilitation of Crescent Lake Road. Share specific project locations identified in the WMBP that relate to success of the future project.	Municipalities, CLA	NA	2028-2030	Municipalities
13	Rehabilitation of Crescent Lake Road	Municipalities	TBD	2029-2030	Municipalities, Grants

	Action Item	Responsible Party	Estimated Cost	Schedule	Funding Sources
	Land Use Planning & Zoning				
14	Present WMBP report and recommendations to Select Boards in Unity and Acworth	CLA	$1,000	2026	Municipalities, Landowners, Grants
15	Meet with municipal staff to review WMBP recommendations to improve and/or develop ordinance provisions that protect lake water quality and update municipal master plans	CLA, Municipalities	$3,000	2026-2030	Municipalities, Landowners, Grants
16	Increase municipal staff capacity for inspections and enforcement of development and stormwater regulations on public and private lands	Municipalities	TBD	2026-2035	Municipalities
	Land Conservation				
17	Idenfity potential conservation properties and reach out to landowners who may be interested in easements within the watershed.	CLA, Conservation Commissions	NA	2026-2028	
	Septic System Management				
18	Distribute education materials about septic system function and maintenance to property owners using existing knowledge of older/noncompliant septic systems	CLA	$3,000	2026-2027	Grant, Landowners
19	Hold a septic system workshop for property owners. Cost assumes coordination and materials for up to five workshops	CLA, Municipalities	$5,000	2026-2035	Grant
20	Create a lake adjacent wastewater ordinance that: >Requires inspections for all home conversions from seasonal to permanent residences or property sales to ensure systems are sized and designed according to standards. Require updates if necessary. >Institutes a minimum pump-out/inspection interval for lake adjacent properties.	Municipalities	NA	2026-2030	Municipalities
	Education and Outreach				
21	Workshops for land owners with large lots (10+ acres) for assistance with land conservation. Assumes two workshops.	CLA	$5,000	2027	Grants
22	Develop an outreach campaign that covers many topics and modes of communication. Topics like stormwater controls, road maintenance, buffer improvements, fertilizer use, invasive species, and septic system maintenance could be included in mailers or presented at community gatherings. Hold 1 informational workshop per year to update public on progress in WMBP.	CLA, UVLSRPC	$10,000-$25,000	2026-2035	Grants
23	Hold "lake friendly" garden/lawn tours with participating LakeSmart properties.	CLA	NA	2026-2035	NA
	Research/Monitoring				
24	Flow weighted tributary monitoring to better understand inflows to Crescent Lake at Western and Northeast Inlets	CLA	$20,000-$30,000	2026-2030	Grants
25	Paired monitoring studies of wetland complexes to understand phosphorus dynamics in those systems.	CLA	$20,000-$30,000	2026-2030	Grants
26	Collect more fully mixed total phosphorus samples before or directly after ice-out	CLA, NHDES	$5,000	2026	NHDES, Grants
27	Sediment core sampling at 2-3 locations across Crescent Lake	CLA	$10,000-$15,000	2026-2027	Grants