# Monomonac Lake

## Watershed-Based Management Plan

**DRAFT** | September 2026

*Prepared by*
FB Environmental Associates

# MONOMONAC LAKE

## WATERSHED-BASED MANAGEMENT PLAN

September 2026 | **DRAFT**

Prepared by **FB Environmental Associates**

*in partnership with the Monomonac Lake Property Owners Association*

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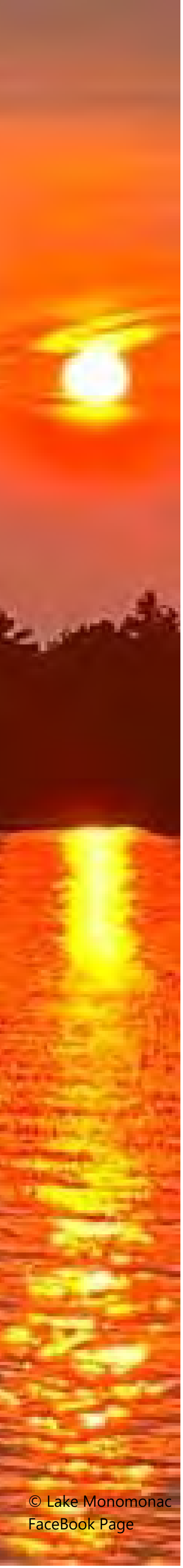
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# ACKNOWLEDGEMENTS


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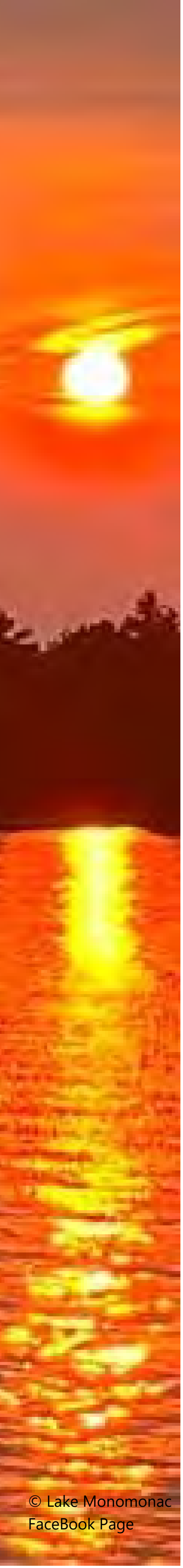


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**For questions, comments, or additional information related to the Monomonac Lake Watershed-Based Management Plan, please contact Jeff Eisenberg with the Monomonac Lake Property Owners Association at [jeffe603@outlook.com](mailto:jeffe603@outlook.com).**

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# ABBREVIATIONS

| ACRONYM | DEFINITION |
|---|---|
| **AIPC** | Aquatic Invasive Plant Control, Prevention and Research Grants |
| **ACEP** | Agricultural Conservation Easement Program |
| **CAGR** | Compound annual growth rate |
| **CCCD** | Carroll County Conservation District |
| **Chl-*a*** | Chlorophyll-*a* |
| **CLAPA** | Contoocook Lake Area Preservation Association |
| **CSP** | Conservation Stewardship Program |
| **CWSRF** | Clean Water State Revolving Fund |
| **DASH** | Diver assisted suction harvester |
| **EPA** | United States Environmental Protection Agency |
| **EQIP** | Environmental Quality Incentives Program |
| **FBE** | FB Environmental Associates |
| **kg/yr** | Kilograms per year |
| **LCHIP** | Land and Community Heritage Investment Program |
| **LLMP** | Lakes Lay Monitoring Program |
| **LLRM** | Lake Loading Response Model |
| **LWCF** | Land and Water Conservation Fund |
| **MLPOA** | Monomonac Lake Properties Owners Association |
| **MS4** | Municipal Separate Storm Sewer Systems |
| **NAWCA** | North American Wetlands Conservation Act |
| **NEFRF** | Northeast Forests and Rivers Fund |
| **NFWF** | National Fish and Wildlife Foundation |
| **NHDES** | New Hampshire Department of Environmental Services |
| **NRCS** | Natural Resources Conservation Service |
| **ppb, ppm** | parts per billion, parts per million |
| **PPPA** | Pool Pond Preservation Association |
| **RCPP** | Regional Conservation Partnership Program |
| **WCCD** | Worcester County Conservation District |
| **SCM** | Stormwater control measure |
| **UNH** | University of New Hampshire |
| **USDA** | United States Department of Agriculture |
| **WMP** | Watershed-Based Management Plan |
| **WSLA** | Winchendon Springs Lake Association |
| **µS/cm** | Microsiemens per centimeter |

# DEFINITIONS

**Adaptive management approach** recognizes that the entire watershed cannot be restored with a single restoration action or within a short time frame. The approach provides an iterative process to evaluate restoration successes and challenges to inform the next set of restoration actions.

**Anoxia** is a condition of low dissolved oxygen in water.

**Areal water load** is the total volume of water flowing into a lake per year normalized to the lake surface area and is expressed in units such as feet per year. It can be interpreted as the depth of inflowing water that would cover the lake surface each year.

**Assimilative capacity** is a lake's capacity to receive and process nutrients (phosphorus) without impairing water quality or harming aquatic life.

**Build-out analysis** combines projected population estimates, current zoning restrictions, and a host of additional development constraints (e.g., conservation lands, steep slope and wetland regulations, existing buildings, soils with low development suitability, and unbuildable parcels) to determine the extent of buildable area in the watershed.

**Chlorophyll-*a*** is a measurement of the green pigment found in all plants, including microscopic plants such as algae. Measured in parts per billion or ppb, it is used as an estimate of algal biomass.

**Clean Water Act** was enacted to protect the chemical, physical, and biological integrity of surface waters in the U.S. and requires states to establish water quality standards to ensure that surface waters can support human and ecological uses.

**Cyanobacteria** are photosynthetic bacteria that can grow prolifically as blooms when enough nutrients and light are available. Cyanobacteria can produce cyanotoxins, which can be highly toxic to humans and other life forms.

**Dissolved oxygen** is a measure of the amount of oxygen dissolved in water. Low oxygen can directly kill or stress organisms and stimulate release of phosphorus from bottom sediments.

**Epilimnion** is the top layer of lake water directly affected by seasonal air temperature and wind. This layer is well-oxygenated by wind and wave action.

**Eutrophication** is the process by which lakes become more productive over time (oligotrophic to mesotrophic to eutrophic). Lakes naturally become more productive or "age" over thousands of years. In recent geologic time, however, humans have enhanced the rate of enrichment and lake productivity, speeding up this natural process to tens or hundreds of years.

**Fall turnover** is the process of complete lake mixing when cooling surface waters become denser and sink, especially during high winds, forcing warmer, less-dense water to the surface. This process is critical for the natural exchange of oxygen and nutrients between surface and bottom layers in the lake.

**Flushing rate** (inverse of retention time) is the fraction of the lake volume that is replaced per year. It is calculated by dividing the flow in or out by the volume of the waterbody.

**Full build-out** refers to the time and circumstances in which, based on a set of restrictions (e.g., environmental constraints and current zoning), no more building growth can occur, or the point at which lots have been subdivided into the minimum size allowed.

**Hypolimnion** is the bottom-most layer of the lake that experiences periods of low oxygen during stratification and is typically devoid of sunlight for photosynthesis.

**Impervious surfaces or impervious cover** refer to any surface that will not allow water to soak into the ground. Examples include paved roads, driveways, parking lots, and roofs.

**Internal phosphorus loading** is the release of phosphorus bound to lake sediments into the water column. The phosphorus can be used as fuel for plant and algae growth.

**Low impact development** is an alternative approach to conventional site planning, design, and development that reduces the impacts of stormwater by working with natural hydrology and minimizing land disturbance by treating stormwater close to the source, and preserving natural drainage systems and open space, among other techniques.

**Metalimnion** is the markedly cooler, dynamic middle layer of rapidly changing water temperature. The top of this layer is distinguished by at least a degree Celsius drop per meter of depth, otherwise known as the **thermocline**.

**Nonpoint source pollution** comes from diffuse sources throughout a watershed, such as stormwater runoff, seepage from septic systems, and gravel road erosion. One of the major constituents of nonpoint source pollution is sediment, which contains a mixture of nutrients (like phosphorus) and inorganic and organic material that stimulate plant and algae growth.

**Oligotrophic** lakes are less productive or have fewer nutrients (i.e., low levels of phosphorus and chlorophyll-*a*), deep Secchi disk transparency readings (4.0 meters or greater), and high dissolved oxygen levels throughout the water column. **Eutrophic** lakes have more nutrients and are therefore more productive and exhibit algal blooms more frequently than oligotrophic lakes. **Mesotrophic** lakes fall in-between with an intermediate level of productivity.

**pH** is the standard measure of the acidity or alkalinity of a solution on a scale of 0 (acidic) to 14 (basic).

**Riparian** refers to wildlife habitat found along the banks of a lake, river, or stream. Not only are these areas ecologically diverse, but they are also critical to protecting water quality by preventing erosion and filtering polluted stormwater runoff.

**Secchi disk transparency** is a vertical measure of the transparency of water (ability of light to penetrate water) obtained by lowering a black and white disk into the water until it is no longer visible. It is an indirect measure of algal productivity and is measured in meters.

**Stormwater control measures (SCMs)** are practices designed to minimize discharge of nonpoint source pollution from developed land to lakes and streams. Watershed-based management plans should include both **non-structural** (non-engineered) and **structural** (engineered) SCMs for existing and new development to ensure long-term restoration success. Best Management Practices (BMPs) is a term used interchangeably with SCMs.

**Thermal stratification** is the process whereby warming surface temperatures in summer create a temperature and density differential that separates the water column into distinct, non-mixable layers.

**Total phosphorus** is one of the major nutrients needed for algae and plant growth. It is generally present in small amounts (measured in parts per billion or ppb) and limits growth in lakes. In general, as the concentration of phosphorus increases, the amount of algae and plant biomass also increases.

**Trophic state** is the degree of eutrophication of a lake and is designated as oligotrophic, mesotrophic, or eutrophic.

**Watershed-based management plan** is holistic, data-driven planning framework that integrates land use, water quality, and community priorities to address nonpoint source pollution within a defined watershed. It combines technical analysis with targeted management strategies, funding mechanisms, and long-term monitoring to satisfy state and federal water quality standards.

# EXECUTIVE SUMMARY

**The challenges facing Monomonac Lake and how we can address them together.**

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The Monomonac Lake watershed spans 11,993 acres in southern New Hampshire region, with the upper lake and watershed in the towns of Rindge and New Ipswich, NH, and the lower lake and watershed in Winchendon, MA (Figure 1). The watershed is characterized by forested uplands, extensive wetlands, and a network of nine major tributary streams and over ten small ponds that drain to or from Monomonac Lake. The lake outlets to Whites Mills Pond, which is often grouped with Monomonac Lake for watershed management purposes. Combined, the two waterbodies have a watershed area of 12,446 acres. The long-term health of the lake depends on how communities manage land use, development, and changing environmental conditions. Fortunately, the lake is supported by the Monomonac Lake Property Owners Association (MLPOA) and the Winchendon Springs Lake Association (WSLA), which have dedicated leadership and an outstanding network of volunteers to lead protection efforts in the watershed.

## THE PROBLEM

Monomonac Lake has historically maintained good water quality, but recent cyanobacteria blooms signal growing threats. While blooms have been recorded since 2006, blooms of potentially toxic species (*Dolichospermum*) have become more common recently.

Key stressors include:

- Phosphorus inputs from stormwater runoff, shoreline erosion, septic failures, roads, fertilizers, and agricultural activities.
- Climate variability, with larger storms and longer ice-free periods.

Because phosphorus is the limiting nutrient in these freshwater systems, reducing phosphorus loading remains the central water quality objective for Monomonac Lake.

Surveys identified over 200 impacted shorefront properties, aging septic systems, and 21 problem sites with runoff from development contributing 65% of watershed phosphorus load to Monomonac Lake. Without action, development and climate pressures will accelerate water quality decline.

## THE GOAL

The goal is to protect water quality and recreation in Monomonac Lake. The Monomonac Lake Watershed-Based Management Plan sets a five-year and ten-year goal to meet New Hampshire water quality standards for the designated uses of aquatic life integrity and primary contact recreation and substantially reduce the likelihood of harmful cyanobacteria blooms. This goal can be accomplished through the following objectives:

> **OBJECTIVE 1:** Reduce phosphorus loading from existing development by 13.4% (88.9 kilograms per year) to Monomonac Lake by 2036, with an interim five-year goal of 5% (30 kg/yr).
>
> **OBJECTIVE 2:** Offset phosphorus loading from future development by a total of 107 kg/yr by 2036 to Monomonac Lake.

## THE SOLUTION

The MLPOA and partners have developed the action plan, which includes:

- **Structural Stormwater Control Measures:** runoff capture, shoreline buffers, and erosion control.
- **Septic System Maintenance and Upgrades:** inspect septic systems that may be failing and replace systems that fail inspections. Additional planning may reveal which systems use outdated designs.
- **Education and Outreach:** strengthening community education on septic care, fertilizer use, stormwater, and shoreline protection can improve water quality and bring in new members.
- **Policy and Land Use Tools:** promotion of land conservation and land protection through low impact development and resilient development standards through revision of ordinances.

The cost of implementation is estimated at over a million dollars over the next ten years, funded through state and federal grants, private support, and municipal commitments in addition to the dedication and commitment of volunteer time and support to manage plan implementation. Many costs were unknown or roughly estimated and should be updated as information becomes available. Cost estimates are provided in the action plan where possible (Section 5).

## THE KEY TO SUCCESS

This watershed management plan meets the nine key planning elements required by the United States Environmental Protection Agency and makes Monomonac Lake eligible for federal watershed assistance grants. The success of this plan will depend on continued strong coordination by the MLPOA, WSLA, active engagement from shoreline landowners, and sustained financial and volunteer support. Because phosphorus reductions are complex and influenced by both local and region-wide conditions, adaptive management will be essential to track progress and adjust strategies over time. With collaboration, commitment, and long-term investment, the community can protect Monomonac Lake and ensure a healthy future for these valuable natural resources.

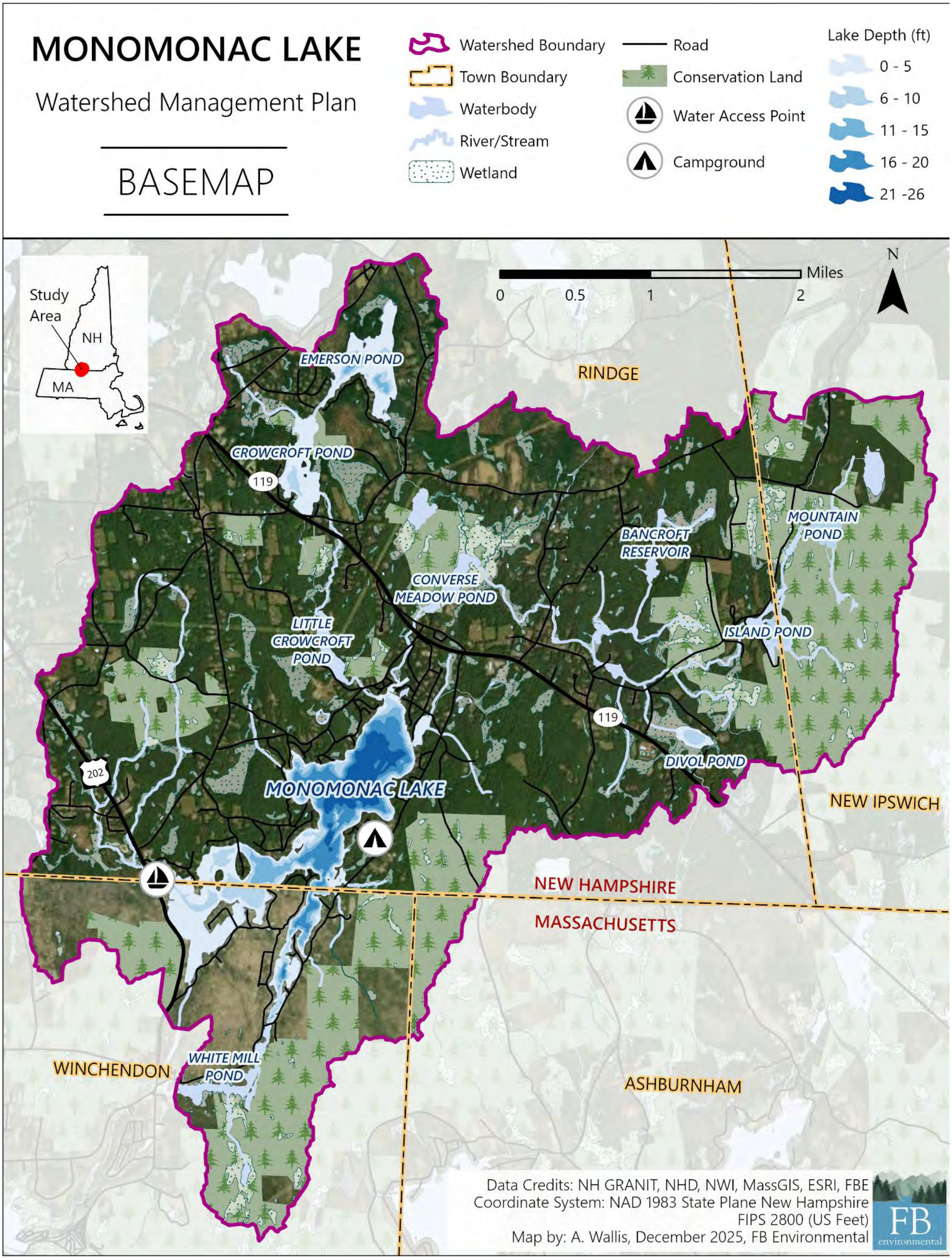



**Figure 1.** Monomonac Lake watershed basemap.

# 1 INTRODUCTION

## 1.1 WATERBODY DESCRIPTION AND LOCATION

### Watershed Overview and Hydrology

Monomonac Lake, located in Rindge, NH and Winchendon, MA, spans approximately 614 acres with a watershed area of 11,993 acres (Figure 1). Formed from the expansion of a small pond when the lake's dams were created, the lake has a maximum depth of 22 feet (6.7 meters) and an average depth of 10 feet (3.0 meters). The lake has two outlets, one of which flows over the Great Dam into Whites Mill Pond in Winchendon. This pond is often included in watershed protection efforts and was included in the study area for many components of this watershed management plan. Adding Whites Mill Pond to the lake area of Monomonac Lake gives a lake surface area of 662 acres and a total watershed area of 12,654 acres (Figure 1).

The watershed is characterized by forested uplands, extensive wetlands, and a network of nine major tributary streams and small ponds, including Crowcroft Pond, Emerson Pond, Converse Meadow Pond, Bancroft Reservoir, Mountain Pond, Island Pond, and Divol Pond that drain to Monomonac Lake via various tributaries. There are two outlets of the lake: North Branch Millers River and through White Mill Pond which drains to North Branch Millers River. The North Branch Millers River joins with the Connecticut River and eventually drains into the Atlantic Ocean. The lake level is controlled via dams at each outlet – the spillway to the west and the Great Dam to the east. Dam operations and water level are dictated by the U.S. Army Corps of Engineers.

Monomonac Lake contains many islands, few of which are inhabited. Paradise Island in Rindge and Blueberry Island in Winchendon are the largest of the two and contain numerous homes.

Wetlands, **riparian** corridors, and forested headwaters play a critical role in moderating runoff, retaining sediment and nutrients, and supporting aquatic and terrestrial habitat throughout the watershed.

### Climate

The watershed experiences a temperate climate with cold winters, warm summers, and seasonally variable precipitation. Average annual precipitation for the last ten years in the area is 50.4 inches. Recent regional trends toward more intense precipitation events and longer summer dry periods have increased the importance of stormwater management and watershed resilience. High-intensity precipitation can accelerate erosion, mobilize nutrient-rich sediments, and overwhelm roadside and shoreline drainage systems, while prolonged warm periods strengthen **thermal stratification**, **hypolimnion** oxygen depletion, and **internal phosphorus loading** in surface waters. These climatic factors heighten the sensitivity of the lake to land use practices in the watershed.

## Land Cover and Development

Land cover in the watershed is dominated by mixed forest, wetlands, and low-density residential development, with more concentrated development occurring along major road corridors and lake shoreline. Major road corridors around Monomonac include Route 202 and Route 119 (General James Reed Highway), along with many local roads. Commercial businesses are concentrated in downtown Rindge in the northeast watershed. Agricultural areas are scattered throughout the watershed, particularly in the northern portion of the watershed. Shoreline development, road networks, aging septic systems, and increasing impervious surfaces represent the primary features influencing runoff quantity and quality. Even at relatively low development densities, cumulative impacts from small sources, such as driveways, lawn areas, and unpaved roads can contribute substantial sediment and nutrient loads to surface waters.

## Ecological Value

The watershed's forests comprise a mix of conifers, such as white pine and eastern hemlock, and deciduous species such as beech, red oak, and sugar maple. There are 1,053 acres of wetlands dispersed throughout the watershed (1,120 if including Whites Mill Pond), typically nearby to waterbodies. These diverse habitats provide critical refuge for a wide range of wildlife. Large mammals such as moose, deer, black bear, coyote, and bobcat roam the upland areas, while smaller species like fox, raccoon, porcupine, fisher cats, mink, and snowshoe hare thrive in mixed habitats. Aquatic environments support otter, muskrat, and beaver populations, and wetlands provide habitat for reptiles and amphibians such as turtles, snakes, frogs, and salamanders. The lake also supports a warm water fishery.

The watershed also hosts a rich bird community, from common species like wild turkeys, ruffed grouse, and songbirds to key water-associated species such as herons, loons, ducks, geese, and bald eagles. Fish and insect populations support both aquatic and terrestrial food webs. Of special note, Monomonac Lake is home to threatened and endangered species, including reproducing populations of common loons.

## Human Use and Water Access

The lake supports a range of recreational uses, with many shoreline homes in both New Hampshire and Massachusetts, private beaches, and a summer camp. The only public boat access to the lake is located off Route 202 next to the North of the Border Food Mart, right on the New Hampshire-Massachusetts border. There are no marinas or sources of boat gas on the lake nor public beaches.

There are several preserves throughout the watershed, including the Miriam Hunt Memorial Forest, Converse Meadow, Ford Family Nature Preserve, Fosket Wildlife Refuge, Mountain Pond Forest, and many more. Over twenty preserves and conservation areas totaling 2,718 acres, or 3,140 if including the Whites Mill Pond watershed are owned and maintained by municipal, private, and state entities and provide opportunities for passive outdoor recreation and scenic enjoyment by the public. There is a children's camp – Camp Starfish – located on the eastern side of the lake. Camp Starfish began as church camp in the late 1880s. Today it offers a safe, fun, structured therapeutic experience for kids aged six to

22 who are experiencing social, emotional, behavioral or learning challenges. It is one of only a few summer camps to offer one-to-one camper-to-counselor enrollment (MLPOA, n.d.).

## 1.2 WATERSHED PROTECTION GROUPS

The **Monomonac Lake Property Owners Association** (MLPOA) serves as the non-profit lake association for Monomonac Lake with the goal of encouraging the protection and preservation of the lake and its valuable natural resources with a focus on New Hampshire specific needs. The MLPOA is made up of residents and landowners in the watershed and is led by a volunteer Board of Directors, and several volunteer committees. The MLPOA participates in the New Hampshire Department of Environmental Services Volunteer Lake Assessment Program (NHDES VLAP) water testing program to monitor the lake and track long-term protection efforts. The MLPOA currently has 73 members.

The **Winchendon Springs Lake Association** (WSLA) is the non-profit association for the Massachusetts residents of Monomonac Lake. The association was established in 1982 to protect water quality for future generations. The association collaborates with MLPOA on issues impacting the entire lake.

The **Cheshire County Conservation District** (CCCD) in New Hampshire and **Worcester County Conservation District** (WCCD) in Massachusetts are two county conservation districts that operate as resource management agencies and subdivisions of local governments. CCCD focuses on water quality, erosion and sedimentation, wildlife habitat, forest and wetland health, nonpoint source pollution, and stormwater and flooding. These organizations work with farmers, landowners, schools, and municipalities to protect natural resources through projects such as stream restoration, invasive species management, and pollinator plantings.

The **New Hampshire Association of Conservation Commissions** works to provide educational assistance to conservation commissions throughout New Hampshire (216 in total). As a non-profit organization, the New Hampshire Association of Conservation Commissions' mission is to instill responsible use of the available natural resources by promoting conservation and serving as the communication link between conservation commissions, while providing technical support on the logistics of conservation commission meetings and document language. Both watershed towns in New Hampshire - Rindge and New Ipswich – have conservation commissions.

The **Massachusetts Association of Conservation Commissions** supports Conservation Commissions throughout Massachusetts through education and advocacy. They provide environmental education, training, and assistance to over 2,000 individuals each year in conservation commissions, municipal and state staff, engineers, consultants, attorneys, and more. They also participate in government advisory committees on environmental issues and comment on proposed laws and regulations. The Town of Winchendon, MA has a conservation commission.

Covering 34 communities, in New Hampshire the **Southwest Region Planning Commission** is a valuable resource to the region. The **Montachusett Regional Planning Commission** in Massachusetts covers 22 municipalities. The commissions aid communities with their local planning services in a targeted approach to protect the environment, while supporting local economies and cultural values.

**NH LAKES** is a statewide, publicly-supported, non-profit organization working to restore and preserve the health of New Hampshire's lakes. NH Lakes facilitates the Lake Host and LakeSmart programs along with other outreach and education campaigns and provides funding to towns and watershed associations for lake restoration and protection efforts.

The **New Hampshire Department of Environmental Services** (NHDES) partners with local organizations to improve watershed-level water quality by supporting communities in setting goals, developing management plans, and addressing contamination through financial and technical assistance.

The **Massachusetts Department of Environmental Protection** (MassDEP) partners with local organizations to protect public health and natural resources by supporting communities in managing watersheds, mitigating pollution, and improving water quality through financial and technical assistance.

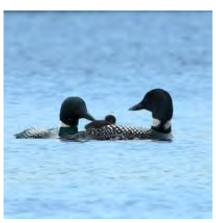
The **Monadnock Conservancy** in New Hampshire is a non-profit land trust that works to conserve and connect important natural resource areas across thirty-nine communities in the southwestern region of New Hampshire. The organization partners with landowners, municipalities, and conservation groups to permanently protect forests, farms, wildlife habitat, water resources, and scenic landscapes, while also supporting recreation and community access to open space. The land trust has conserved over 24,000 acres of land in New Hampshire, including numerous large parcels in Rindge.

The **Mount Grace Land Trust** in Massachusetts conserves forests and farms to provide recreational opportunities and protect biodiversity. The land trust promotes the protection of undisturbed habitat while also supporting working landscapes. Mount Grace has already conserved numerous parcels in Winchendon.

The **Northeast Wilderness Trust** has protected over 100,000 acres of land across New York and New England with the goal of protecting undisturbed lands and storing carbon. The trust has already conserved numerous parcels in New Hampshire, including few in the Rindge area.

The **Society for the Protection of New Hampshire Forests** is a statewide non-profit land conservation organization that works to protect forests, water resources, wildlife habitat, and scenic landscapes across New Hampshire. Through land conservation, sustainable forest management, advocacy, and education, the organization promotes long-term stewardship and public access to the state’s natural resources.

The **Contoocook Lake Area Preservation Association** (CLAPA) is the non-profit association that protects the nearby Contoocook Lake and its watershed. Contoocook Lake is partially in Rindge, NH, and its watershed is adjacent to the Monomonac Lake watershed. The association conducts many similar activities to MLPOA and WSLA.



The Pool Pond Protection Association (PPPA) is a community organization in Rindge that aims to protect Pool Pond. The Pool Pond watershed is adjacent to the Monomonac Lake watershed. The association does not have a website but instead uses a small FaceBook group to communicate to its members.

## 1.3 PURPOSE AND SCOPE

**The purpose of the Monomonac Lake Watershed-Based Management Plan (WMP) is to prioritize implementation efforts over the next ten years (2026-2035) to continue to improve the water quality of Monomonac Lake. The plan aims to meet state water quality standards for the designated uses of aquatic life integrity and primary contact recreation for mesotrophic waterbodies and to reduce the likelihood of harmful cyanobacteria blooms in the lakes**.

As part of this plan, a **build-out analysis**, land-use model, water quality and **assimilative capacity** analysis, and shoreline and watershed surveys were conducted to better understand the sources of phosphorus and other pollutants to the lake (Sections 2 and 3). Results from these analyses were used to establish the water quality goal and objectives (Section 2.4), prioritize recommended management strategies for the identified pollutant sources (Section 4), and establish estimated pollutant load reductions and costs needed for remediation (Sections 5 and 6). Recommended management strategies involve using a combination of **structural and non-structural stormwater control measures (SCMs)**, as well as an **adaptive management approach** that allows for regular updates to the plan (Section 4). An action plan (Section 5) with associated timeframes, responsible parties, and estimated costs was created in collaboration with the Advisory Committee and public during a public meeting (Section 1.4). This plan meets the nine key planning elements required by the United States Environmental Protection Agency (EPA) so that communities become eligible for federal watershed assistance grants administered by NHDES and MassDEP (Section 1.5).

## 1.4 COMMUNITY INVOLVEMENT AND PLANNING

The plan was through collaborative efforts, including several meetings, public presentations, and conference calls. Participants included FB Environmental Associates (FBE) and MLPOA (see Acknowledgments).

### 1.4.1 Plan Development Meetings

Several meetings were held over the duration of the plan. The following list does not include check ins that did not involve the entire committee nor routine annual meetings conducted separately by the MLPOA, except as they relate to the plan.

| | |
|---|---|
| **October 20, 2025** | FBE meets in-person with MLPOA at a public forum to kick-off the project and review the draft action plan. |
| **February 5, 2025** | FBE and the Advisory Committee meet to review the watershed survey results. |
| **June 23, 2026** | FBE and the Advisory Committee meet to review the water quality analysis, modeling, and water quality goal. |
| **July 18, 2026** | FBE presents an overview of the WMP process at the MLPOA annual meeting. |
| **September 14, 2026** | FBE presents the draft WMP at the Rindge Conservation Commission meeting and opens the public feedback period. |

### 1.4.2 Draft WMP Public Presentation and Review Period

A final public presentation was held in-person on September 14, 2026, to summarize the analyses and recommendations detailed in the plan. The presentation was attended by members of the MLPOA board and the community and was hosted by the Rindge Conservation Commission. A portion of the presentation was dedicated to receiving public feedback on the plan. The presentation was followed by a 30-day review period where the public had additional time to digest the material, read the draft WMP, and provide comments and recommendations for edits. Written comments were received and incorporated into the final plan.

## 1.5 INCORPORATING EPA'S NINE ELEMENTS

EPA guidance lists nine key planning elements that highlight important steps in restoring and protecting water quality for any waterbody affected by nonpoint source pollution. The nine key planning elements found within this plan are as follows:

**A.** IDENTIFICATION OF THE CAUSES AND SOURCES OF NONPOINT SOURCE POLLUTION

Sections 2 and 3 highlight known sources of nonpoint source pollution to Monomonac Lake and describe the results of the watershed survey and other assessments. These sources of pollutants must be controlled to achieve the load reductions estimated in this plan, as discussed in item (B) below.

**B.** ESTIMATION OF POLLUTANT LOADING AND LOAD REDUCTIONS EXPECTED FROM MANAGEMENT MEASURES

Sections 2 and 5 describe the calculation of pollutant loading to Monomonac Lake and the amount of reduction needed to meet the water quality goal, respectively.

**C.** DESCRIPTION OF NONPOINT SOURCE MANAGEMENT MEASURES

Sections 4 and 5 identify ways to achieve the estimated phosphorus load reduction and reach water quality targets. The action plan focuses on several major topic areas categorizing action items that address nonpoint source pollution.

**D.** ESTIMATION OF TECHNICAL AND FINANCIAL ASSISTANCE

Sections 5 and 6 include a description of the associated costs, sources of funding, and primary authorities responsible for implementation. Funding sources should be diverse, including local, state, and federal grants, local organizations, private donations, and landowner contributions to support action plan implementation.

**E.** DEVELOPMENT OF EDUCATION AND OUTREACH COMPONENT

Section 4 describes how the educational component of the plan is already being or will be implemented.

**F.** SCHEDULE FOR IMPLEMENTING THE NONPOINT SOURCE MANAGEMENT MEASURES

Section 5 provides a list of action items and recommendations to reduce the phosphorus load to Monomonac Lake. Each item has a set schedule that defines when the action should begin and/or end or run through if an ongoing activity. The schedule should be adjusted by the MLPOA and the WSLA regularly (see Section 4.4 on Adaptive Management and Section 6.1 on Plan Oversight). While phosphorus is the primary nutrient driving this plan, the MLPOA, WSLA, and municipalities should also consider reductions in sediment, nitrogen, and bacteria, where applicable, to support overall water quality improvements and align with broader reporting expectations.

**G.** DESCRIPTION OF INTERIM MEASURABLE MILESTONES FOR MEASURING PROGRESS

Section 6 outlines indicators along with milestones for implementation success that should be tracked annually.

**H.** SET OF CRITERIA

Sections 2 and 6 can be used to determine whether phosphorus loading reductions are being achieved over time and whether progress meets water quality targets. If targets are not met, these sections provide criteria to determine whether the plan should be revised.

**I.** DEVELOPMENT OF MONITORING COMPONENT

Section 6 describes the long-term water quality monitoring strategy for Monomonac Lake, which allows for evaluation of implementation effectiveness over time against the criteria in (H) above. The success of this plan cannot be evaluated without ongoing monitoring and assessment and careful tracking of load reductions following implementation of action items.

# 2 WATER QUALITY ASSESSMENT

This section provides an overview of the past, current, and predicted future state of water quality based on water quality assessment and watershed modeling. These analyses identified pollutants of concern and helped provide the basis to set water quality goals and objectives for Monomonac Lake.

## 2.1 WATER QUALITY SUMMARY

Water quality assessment can be complex. Here are the key points to know about each lake:

- **Monomonac Lake has historically good water quality.**

  Monomonac Lake is legislatively classified as Class B, which represents waters that are considered good quality and are the most common, intended to be suitable for swimming, fishing, and supporting aquatic life. The lake is mesotrophic because water quality has consistently met the standards for a productive but healthy lake that may be in transition to a less biodiverse trophic state.

- **The water quality of the lake is threatened by enhanced nutrient loading from human activities and extreme weather events.**

  Monomonac Lake experiences anoxia (low dissolved oxygen) at the lake bottom during the summer and shows worsening water transparency and **chlorophyll-*a*** at the deep spot. Monomonac Lake has generally high nutrient concentrations, high algal biomass, and shallow transparency compared to other lakes in New Hampshire. Cyanobacteria blooms have emerged as a concern in recent years.

- **Monomonac Lake is well managed for invasive aquatic species.**

  The lake has been infested with invasive aquatic species, namely variable milfoil. Diligent, volunteer-based Weed Watcher and Lake Host programs have kept these invaders at bay.

### 2.1.1 Water Quality Standards and Impairment Status

The federal **Clean Water Act** requires states to determine designated uses for all surface waters within their jurisdiction, develop water quality criteria to protect those designated uses, and establish antidegradation provisions (Env-Wq 1708) that set limits on impacts to water quality from development.

Designated uses define activities and services that surface waters should support. For surface waters in New Hampshire, the six designated uses are as follows, and those applicable to this plan are **bolded**:

- **Aquatic life integrity** (i.e., supporting a balanced, integrated, and adaptive community of organisms having species composition, diversity, and functional organization comparable to similar natural habitats)
- **Primary contact recreation** (i.e., swimming)
- Secondary contact recreation (i.e., boating, fishing)
- Fish consumption
- Shellfish consumption
- Potential drinking water supply

In New Hampshire, all surface waters are legislatively classified as either Class A or Class B, most of which are Class B (Env-Wq 1700). Class A waters are the highest quality and are protected for designated uses like drinking water (with treatment). Class B waters are still considered good quality and are the most common, intended to be suitable for swimming, fishing, and supporting aquatic life. Monomonac Lake is Class B.

NHDES biologists survey New Hampshire lakes to determine their **trophic state** – a way of describing overall lake health based on water clarity, nutrients, and plant and algae growth. Lakes are placed into one of three categories:

**Oligotrophic** *low nutrients and algae biomass, good clarity, and healthy habitat for cold water fish*

**Mesotrophic** *moderate nutrients and algae biomass, still good for recreation and aquatic life*

**Eutrophic** *higher nutrients and algae biomass, reduced water clarity, limited uses*

Monomonac Lake was classified as mesotrophic in surveys conducted in 1976, 1991, and 2008. This means the water quality consistently meets the standards for a moderately-productive lake that supports aquatic life and recreation.

Water quality criteria serve as a "yardstick" for measuring whether a lake is healthy enough to support its designated uses (like swimming or aquatic life) based on whether it is Class A or B or oligotrophic, mesotrophic, or eutrophic. These criteria include parameters such as nutrient levels (e.g., phosphorus), algae levels (chlorophyll-*a* and prevalence of cyanobacteria), dissolved oxygen, and pH. If water quality measurements do not meet the criteria for designated uses according to the NHDES Consolidated Assessment and Listing Methodology, the lake is assessed as impaired. Water quality criteria for each classification and designated use in New Hampshire are legislatively enabled in RSA 485 A:8, IV and detailed in administrative rules Env-Wq 1700.

Every other year to meet requirements under the Clean Water Act, state agencies such as NHDES produce an Integrated Report that assesses the quality of surface waters across the state. This Integrated Report combines the 305(b) Surface Water Quality Report that provides a general overview of state surface water quality and the 303(d) List of Impaired Waters that identifies surface waters not supporting one or more designated uses and requiring a Total Maximum Daily Load. A Total Maximum Daily Load is a limit on how much pollution a waterbody (like a river, lake, or stream) can safely handle while still supporting its designated uses.

The Monomonac Lake watershed contains six lake/pond assessment units, all except for one of which are formally assessed as impaired for at least one designated use on the 303(d) List of Impaired Waters for the 2024 reporting cycle (NHDES, 2024a) (Table 1). Of the four impoundment assessment units, none are assessed as impaired for any designated use. NHDES' rating of water quality, presented in Table 1, is based on the most severe impairment of any parameter for which the assessment unit was evaluated. A waterbody may receive a "severe" or "poor" rating due to the potential impact of low dissolved oxygen or pH on aquatic life yet still have excellent water quality with regard to parameters related to lake trophic status, cyanobacteria growth, and/or recreational uses.

- Monomonac Lake is assessed as impaired for aquatic life integrity, with a "poor" rating for both chlorophyll-*a*, pH, total phosphorus, and non-native aquatic plants. It is also impaired for primary contact recreation and rated "poor" for cyanobacteria hepatoxic microcystins. Cyanobacteria blooms have emerged as a concern for Monomonac Lake, especially in recent years. Monomonac Lake is sampled at the deepest spot of the lake, with the site referred to as MONRINAD (Figure 2).
- Emerson Pond, which feeds into Monomonac Lake through Crowcroft Pond and Emerson Pond Brook, is assessed as impaired for aquatic life integrity based on high total phosphorus and chlorophyll-*a*, and low pH. Crowcroft Pond is assessed as impaired due to low pH.
- Mountain Pond and Island Pond, which feed into Monomonac Lake through the North Branch of Miller's River, are assessed as impaired due to low pH.
- Divol Pond is not assessed as impaired for any designated uses, nor are the four impoundment assessment units. These include the Van Dyke Dam (Little Crowcroft Pond), the Bancroft Reservoir Dam, Mill Pond, and an impoundment along the Miller River.
- The Camp Monomonac Beach, the only assessed beach on Monomonac Lake, is assessed as impaired for primary contact recreation due to the presence of cyanobacteria hepatotoxic microcystins. The beach is rated "likely good" for primary contact recreation due to low to *E. coli* levels.
- Of the thirty-one tributary assessment units to Monomonac Lake and its upstream ponds, five are assessed as impaired for aquatic life integrity due low pH. These are the North Branch Millers River, which has two assessment units, Emerson Pond Brook, Goddard Inlet Brook, Lord Brook, the Colburn Lane Inlet to Monomonac Lake, and the State Line Inlet to Monomonac Lake.

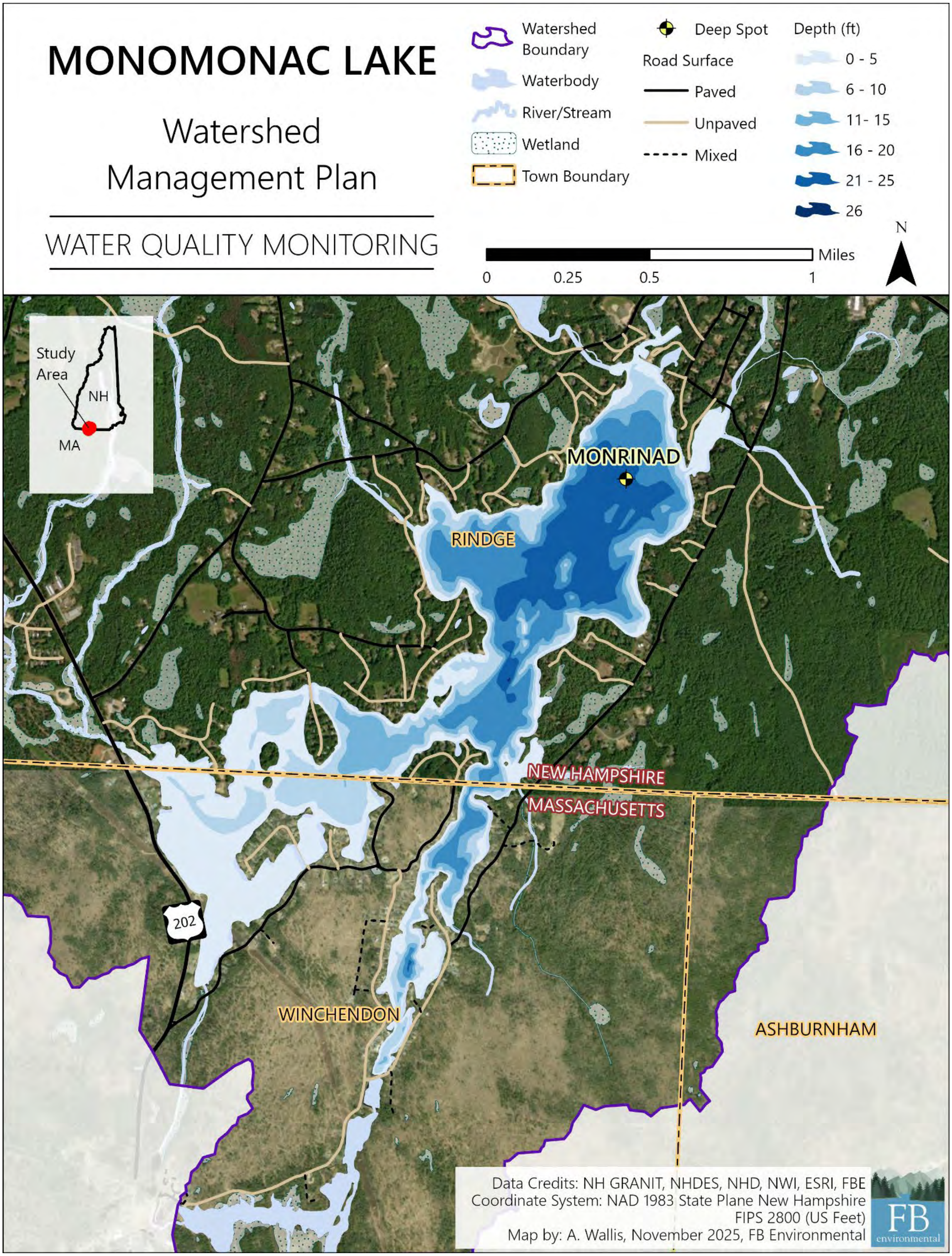


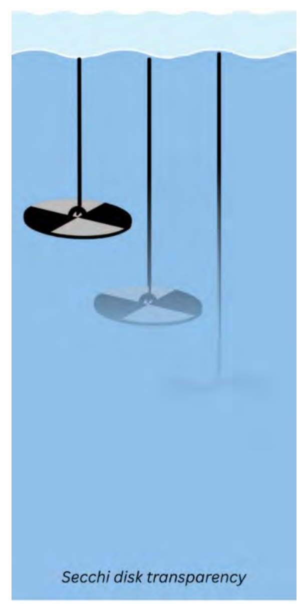

**Figure 2.** The Monomonac Lake deep spot (MONRINAD).

**Table 1.** NHDES assessment units covering lakes/ponds in the Monomonac Lake watershed and their associated water quality rating as reported on the NHDES 2024 Watershed Report Cards. The Monomonac Lake assessment unit area only includes the New Hampshire portion of the lake.

| Assessment Unit Name | AUID | Area *(acres)* | Water Quality |
|---|---|---|---|
| Lake Monomonac | NHLAK802020103-06 | 409.85 | Poor |
| Emerson Pond | NHLAK802020103-04 | 95.49 | Poor |
| Island Pond | NHLAK802020103-05 | 31.94 | Poor |
| Mountain Pond | NHLAK802020103-07 | 21.68 | Poor |
| Crowcroft Pond | NHLAK802020103-11 | 63.30 | Poor |
| Lake Monomonac – Camp Monomonac Beach | NHLAK802020103-06-02 | 1.38 | Poor |

### 2.1.2 Trophic State Indicators

Total phosphorus, chlorophyll-*a*, and Secchi disk transparency are trophic state indicators, reflecting biological productivity in lake ecosystems. The combination of these parameters helps determine the extent of **eutrophication** in lakes and helps signal changes in lake water quality over time. For example, if the water becomes less clear (lower Secchi disk transparency), it may be because more algae are growing – often fueled by higher phosphorus levels – or because other materials are suspended in the water. These changes usually point to impacts from human activity or other disturbances in the surrounding watershed.




A significant decreasing (improving) trend in surface total phosphorus was observed in the historical dataset (1976–2015; $p = 0.045$, slope = –0.083) (Figure 3). No other significant trends—improving or worsening—were found for phosphorus in surface or bottom waters across any time period. This is consistent with the 2024 NHDES VLAP report, which noted stable phosphorus levels at all depths since 1987.

Higher total phosphorus concentrations were most often measured in the bottom water compared to the surface from 2016-2025, indicating some amount of internal phosphorus loading is occurring (Figure 4). Phosphorus concentrations were slightly more variable in the bottom than the surface, which could be caused by variability in internal loading across sampling months and years.

A significant increasing (worsening) trend in chlorophyll-*a* was detected in the historical dataset (1976–2015; p = 0.037, slope = 0.064) (Figure 3), though no trend was found for other periods. NHDES VLAP similarly reports stable chlorophyll-*a* conditions since 1987.

Secchi disk transparency measured without a scope showed a significant decreasing (worsening) trend across all years (2007–2025; p = 0.0034, slope = –0.022) (Figure 3). However, no trend was observed for scope-based measurements, which could be attributed to having fewer data points. This decline in transparency aligns with the 2024 NHDES VLAP report, which also identified worsening transparency since 1987 at Monomonac Lake.

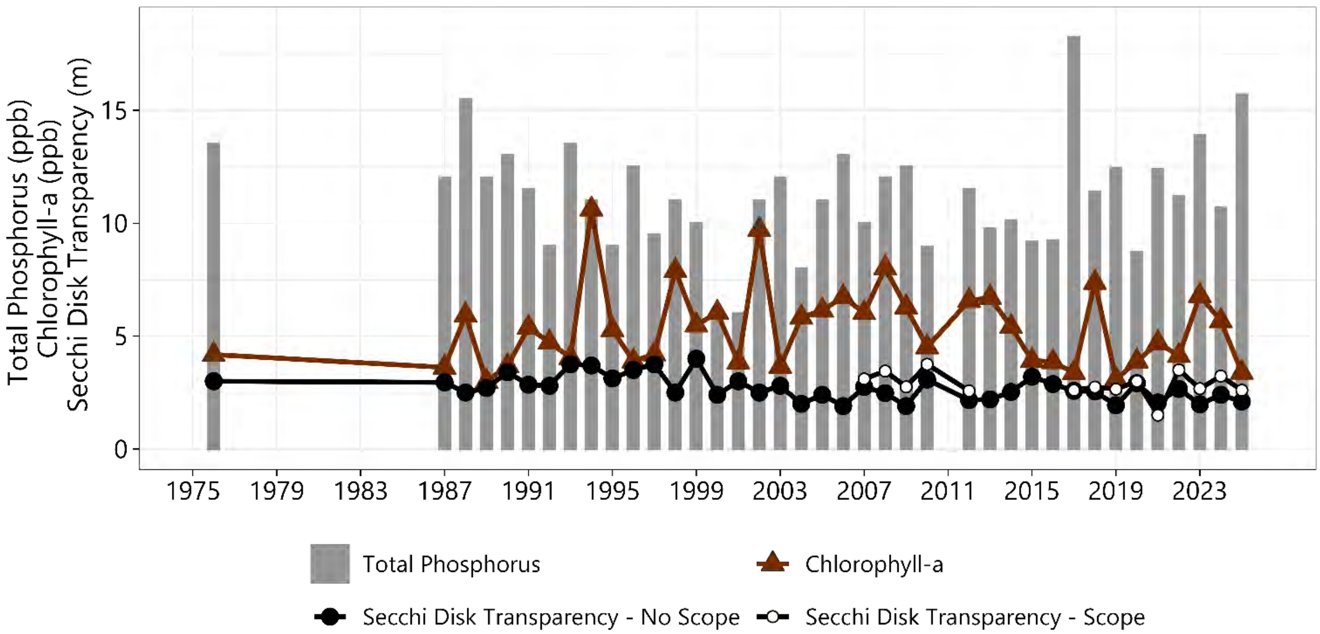



**Figure 3.** Median surface total phosphorus, median surface chlorophyll-*a*, and median water clarity (Secchi disk depth for scope and no scope methods) measured at Monomonac Lake largely in June-September from 1976-2025 for the deep spot station (MONRINAD). Multiple worsening statistically significant trends were detected and total phosphorus was improving based on the Mann-Kendall nonparametric trend test using *rkt* package in R. ppb = parts per billion. m = meters.

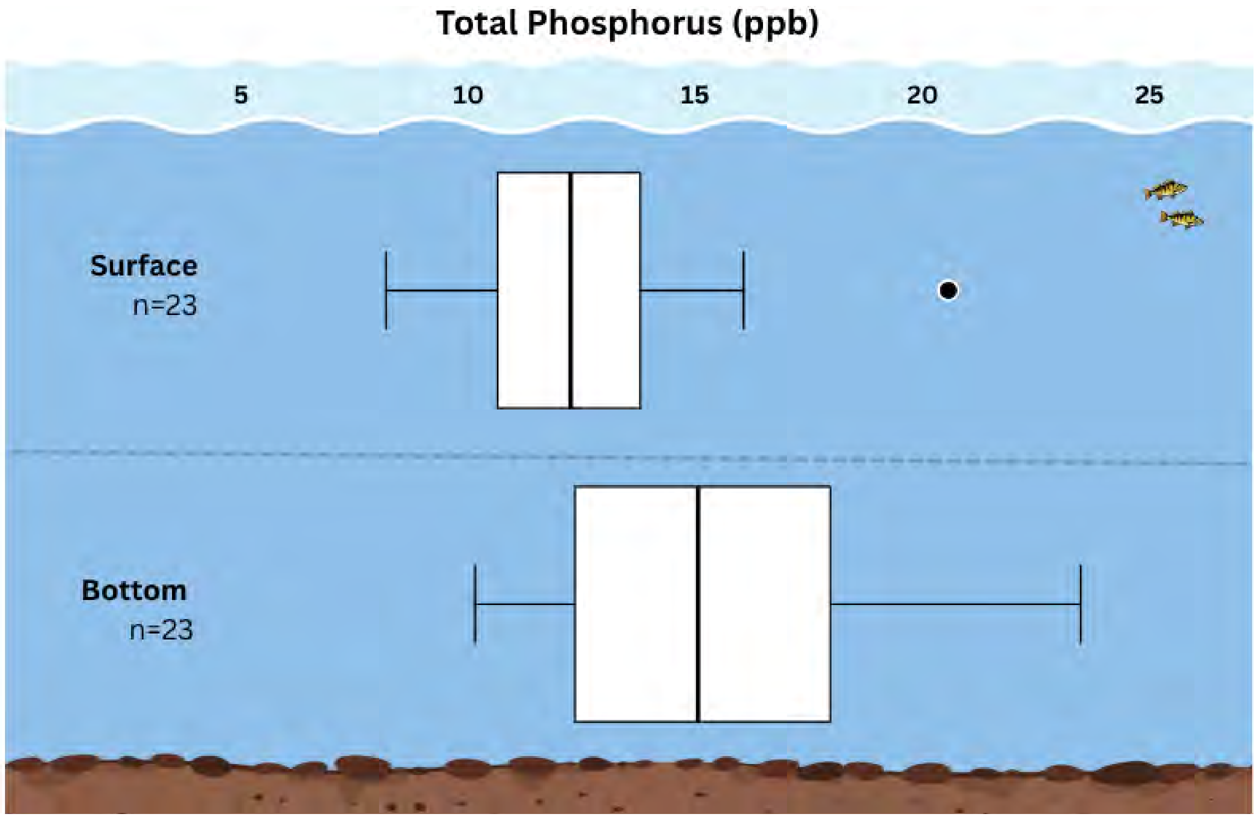



**Figure 4.** Boxplots showing median total phosphorus concentration in the surface and bottom layers of the deep spot of Monomonac Lake (MONRINAD) from the past ten years, 2016-2025. The boxes show the 25th, 50th (median), and 75th percentiles of the data. The whiskers show 1.5 times the interquartile range (the range from the 25th to 75th percentiles). Points are outlier observations.

### 2.1.3 Dissolved Oxygen and Water Temperature

A common occurrence in lakes is the depletion of dissolved oxygen in the deepest waters throughout the summer months. This occurs when thermal stratification (the separation of distinct temperature layers) prevents warmer, less dense, oxygen-rich surface waters from mixing with cooler, denser, oxygen-depleted bottom waters in the lake. As summer progresses, chemical and biological activity in the bottom layer consumes oxygen, but that oxygen cannot be replenished because mixing with the surface is blocked by stratification.

Dissolved oxygen levels below 5 parts per million (ppm) and water temperature above 24 degrees Celsius can stress and reduce habitat for cold water fish and other sensitive aquatic organisms. In addition, very low dissolved oxygen (called anoxia) at the lake bottom can result in the release of sediment-bound phosphorus, a process known as internal phosphorus loading. This phosphorus then becomes available to fuel algae and cyanobacteria growth.

Thermal stratification and depletion of oxygen in bottom waters is a natural phenomenon in lakes like Monomonac Lake because the lake is dimictic, meaning it mixes fully in the spring and fall and stratifies in the summer.

***Lake Stratification and Mixing***

Most lakes in New England are classified as **dimictic**, meaning they fully mix twice a year—during spring and fall "**turnover**"—when the water temperature becomes uniform throughout the lake. During summer stratification, warm surface water sits above cooler, denser bottom water, forming a thermal barrier that prevents mixing. In winter, colder water remains near the surface under ice cover, while warmer water stays at the bottom, until turnover occurs again in spring and fall. The deep area of Monomonac Lake weakly stratifies in summer (Figure 5) and is considered dimictic. Shallow areas may mix during cooler or windy summer periods.

However, due to its relatively shallow depth, Monomonac Lake only weakly stratifies in the summertime. (Figure 5) shows average temperature and dissolved oxygen profiles for Monomonac Lake during summer stratification between spring and fall turnover (1976–2024). A change in temperature between 3- and 4-meters depth marks the weak stratification zone. Profiles for Monomonac Lake were typically only collected once per sampling season. From these, there is no average dissolved oxygen below 2 ppm, though some individual samples at 6-7 meters have fallen below that threshold, indicating the possibility of internal phosphorus loading. Tracking oxygen and temperature over time is important to detect whether conditions are worsening due to human impacts, such as an earlier onset of summer stratification due to an earlier ice out. Collecting multiple profiles each year would measure seasonal changes in the lake. Profiles collected in the early autumn months (September and October) can provide more insight into internal loading in Monomonac Lake when stratification is typically the strongest and oxygen depletion would highest.

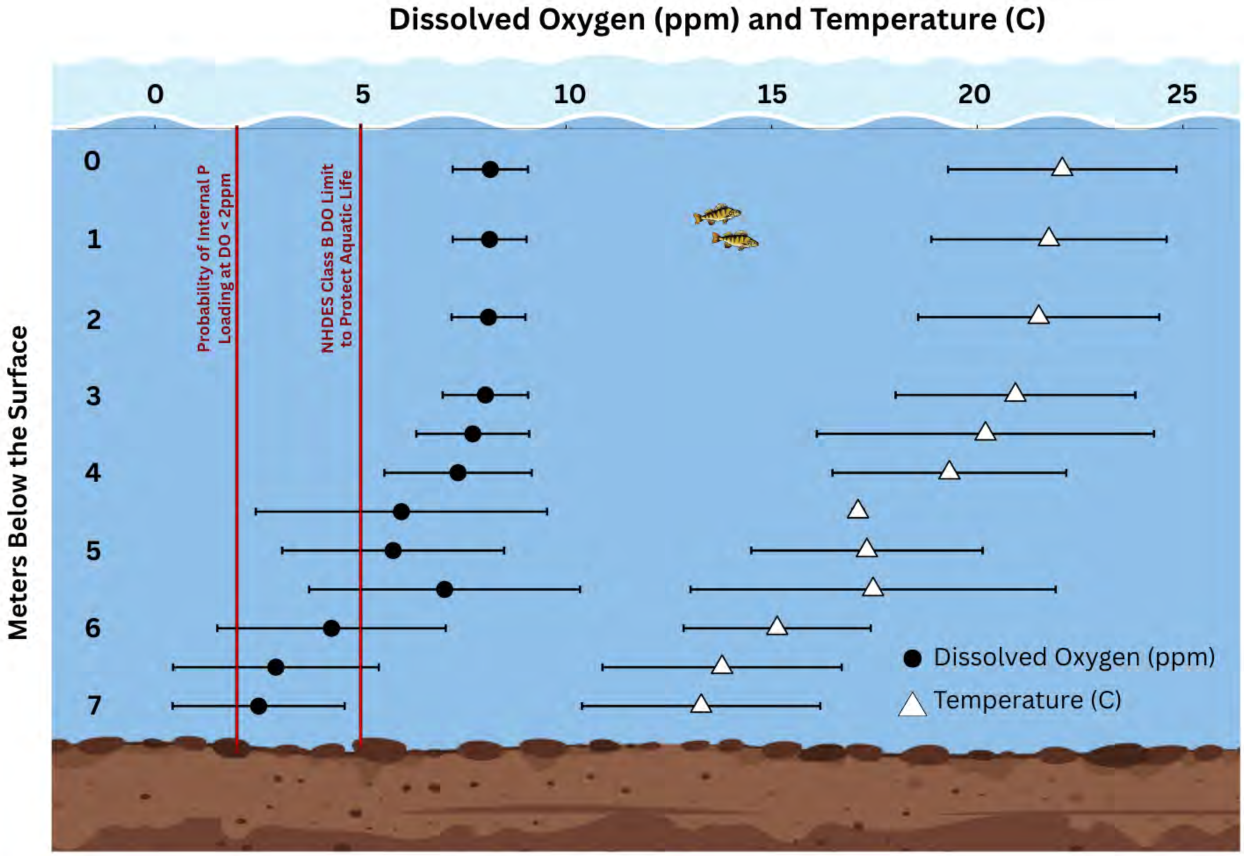


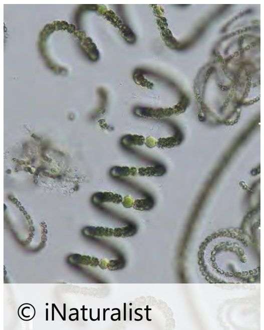

**Figure 5.** Average depth profiles for dissolved oxygen (black circles) and water temperature (white triangles) for the deep spot of Monomonac Lake (MONRINAD). Dots represent average values across sampling dates for each respective depth. Error bars represent standard deviation. Data represent profiles collected from 1976 to 2024 (n=31 for temperature and n=33 for dissolved oxygen).

### 2.1.4 Phytoplankton (Cyanobacteria) and Zooplankton

Algae and cyanobacteria naturally occur in the environment and are essential for lake health. Algae and cyanobacteria biomass are primarily regulated by nutrient inputs and lake mixing processes, although other factors such as light availability and temperature also influence their growth. Human disturbances, such as erosion, overapplied fertilizers, polluted stormwater, excess animal waste, and inadequately treated wastewater can increase nutrient inputs to lakes and tributaries. Excess nonpoint source pollution in the form of nutrient loading in human-impacted lakes, combined with rising air temperatures, has increased the prevalence of harmful algal (cyanobacteria) blooms in lakes across the U.S.

Cyanobacteria are single-celled bacteria that can photosynthesize. They often grow in colonies and, under bloom conditions, can sometimes produce dangerous toxins such as microcystins. These toxins may cause a wide range of health effects in humans, pets, livestock, and wildlife, including neurological, liver, kidney, and reproductive organ damage, gastrointestinal pain or illness, vomiting, eye, ear, and skin irritation, mouth blistering, tumor growth, seizure, or, in rare cases, death. Blooms can form dense mats or surface scum that can occur within the water column, attached to bottom sediments, or along the shoreline.

There are several common cyanobacteria in New Hampshire and Massachusetts lakes, such as: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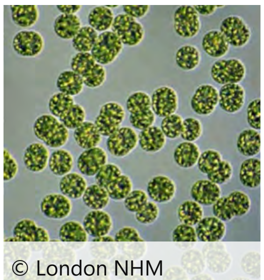
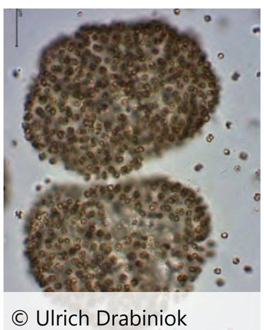
***Dolichospermum***

Formally *Anabaena*, typically observed as filaments, can produce microcystin, anatoxins, saxitoxin, and cylindrospermopsin.


© London NHM

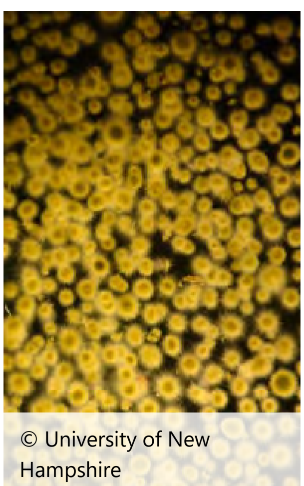
***Microcystis***

Typically observed as variations of small-celled colonies, can produce microcystin and anatoxin.


© Ulrich Drabiniok

***Woronichinia***

Typically forms dense colonies, can produce microcystin.


© University of New Hampshire

***Gloeotrichia***

Typically observed as radiating colonies forming spherical aggregates, can produce microcystin and cylindrospermopsin, and can regulate buoyancy to access nutrients from sediments before rising to the surface to form blooms.


© Loyola University Chicago

***Planktothrix***

Formally *Oscillatoria*, typically observed as filaments, can produce microcystin and cylindrospermopsin, can maintain high growth rate at relatively low light intensities when it forms blooms deeper in the water column (NHDES, 2020).

Cyanobacteria are becoming more common even in low-nutrient lakes, likely because of a warming climate. Warmer water, longer periods of stratification, greater water column stability, less mixing, and reduced flushing during low-flow periods all create conditions that allow cyanobacteria to thrive and outcompete other phytoplankton species (Przytulska, Bartosiewicz, & Vincent, 2017; Paerl, 2018; Favot, et al., 2019). Many cyanobacteria can regulate their buoyancy and move up and down in the water column to capture sunlight near the surface and access phosphorus near the bottom, even during stratification or under low oxygen conditions. Some cyanobacteria can become dormant in sediment and jump-start cell reproduction once conditions are favorable (i.e., warm water temperatures and plenty of sunlight and nutrients). Some species can also obtain atmospheric nitrogen when sufficient light and nutrients such as phosphorus, iron, and molybdenum (a mineral that is essential for life in small amounts and is found in soils and water) are available. Others can store excess nitrogen and phosphorus within their cells for later use when conditions improve.

Because of these traits, and with climate warming favoring their dominance, cyanobacteria play a central role in reinforcing lake eutrophication. They can accelerate nutrient enrichment in low-nutrient systems and hinder the recovery of lakes already in a eutrophic state (Dolman, et al., 2012; Cottingham, Ewing, Greer, Carey, & Weathers, 2015). Understanding these feedbacks will be critical for developing more effective lake management and restoration strategies.

It is likely that the prevalence of cyanobacteria will increase and possibly accelerate in lakes affected by extreme weather changes, though year-to-year variability in weather may determine the timing, extent, and severity of cyanobacteria blooms in any given season. However, conditions favorable for cyanobacteria blooms can be substantially minimized by reducing nutrient-rich runoff from the landscape. Water level and flow influence bloom dynamics by either flushing cyanobacteria and nutrients downstream during high-flow events or, conversely, by limiting upstream nutrient inputs during lower-flow conditions, which can reduce the nutrient availability needed to sustain bloom growth.

***Cyanobacteria Bloom History***

Through 2024, NHDES issued a warning when cyanobacteria densities exceeded 70,000 cells/mL, advising people, pets, and livestock to avoid contact with potentially toxic waters. Watches were issued when blooms might pose a risk or were approaching that threshold and remained active for up to one week. Watches were also issued when a bloom occurred outside the reporting season (May-October) or when a bloom was identified via photograph and not officially enumerated from a sample. NHDES' system for issuing warnings and watches changed in 2025. NHDES now issues a warning if cyanobacteria cell counts exceed 70,000 cells per milliliter at multiple locations, indicating that the bloom is a more widespread, lake-wide concern. Otherwise, NHDES issues a watch if reports are only for one location or for shoreline accumulations. More detailed information on the NHDES Cyanobacteria Harmful Algal Bloom Program can be found online.

Monomonac Lake is assessed by NHDES as impaired for primary contact recreation due to cyanobacteria hepatotoxic microcystins, as defined under the 305(b) and 303(d) Consolidated Assessment and Listing Methodology (CALM) because cyanobacteria blooms within the past ten years have significantly interfered with primary contact recreation (NHDES, 2024b). Under CALM regulations, surface waters must be free of foam, debris, scum, odor, discoloration, turbidity, nuisance species, or any other conditions that interfere with recreation. Monomonac Lake has had ten officially reported NHDES cyanobacteria bloom warnings, as displayed in Table 2, the first of which was issued in 2006 (NHDES, 2025). The longest warning was issued in 2008, lasting 48 days and was dominated by *Dolichospermum* (formerly *Anabaena*). Most blooms in Monomonac Lake have been dominated by *Dolichospermum*, except for a bloom of *Microcystis* in 2015 and the first observation of *Woronichinia* in 2024. Two of the three blooms in 2024 contained both *Dolichospermum* and *Woronichinia*—one in August lasting six days and another in September lasting 20 days. The third bloom, in May, consisted only of *Dolichospermum*. The highest cell count observed in Monomonac Lake was during the 2023 bloom in June, with a *Dolichospermum* count of 3,095,000 cells/mL. All three cyanobacteria taxa observed in Monomonac Lake, *Dolichospermum*, *Microcystis*, and *Woronichinia*, are potentially toxin producing species of cyanobacteria. The State of Massachusetts has a different protocol in reporting cyanobacteria blooms, and does not have a public record of historical blooms. No data on cyanobacteria blooms in Monomonac Lake was found on the Massachusetts DEP website.

A recent cyanobacteria bloom occurred in June of 2026. According to MLPOA, the bloom accumulated in the narrows and was one of the largest blooms in recent years.

**Table 2.** Cyanobacteria advisories (warnings) issued by NHDES for Monomonac Lake (NHDES, 2025)

| Advisory Year | Duration (days) | Dominant Taxa | Total Cell Concentration (cells/mL) |
|---|---|---|---|
| 2006 | 19 | *Dolichospermum/Anabaena* | >70,000 or >50% |
| 2008 | 48 | *Dolichospermum/Anabaena* | >70,000 or >50% |
| 2009 | 12 | *Dolichospermum/Anabaena* | >70,000 or >50% |
| 2010 | 10 | *Dolichospermum/Anabaena* | 500,000 |
| 2015 | 8 | *Microcystis* | 507,858 |
| 2017 | 13 | *Dolichospermum/Anabaena* | 695,700 |
| 2023 | 7 | *Dolichospermum/Anabaena* | 3,095,000 |
| 2024 | 7 | *Dolichospermum/Anabaena* | 631,000 |
| 2024 | 6 | *Dolichospermum/Anabaena, Woronichinia* | 509,000 |
| 2024 | 20 | *Dolichospermum/Anabaena, Woronichinia* | 76,600 |

***Dominant Phytoplankton and Zooplankton***

Phytoplankton and zooplankton samples were first collected and analyzed during the 1976, 1991, and 2008 NHDES Trophic Surveys of Monomonac Lake. Each survey includes two biological sampling events: first in summer and then in the following winter. The dominant phytoplankton species in the 1976, 1991, and 2008 trophic surveys were *Asterionella* (diatom) and *Chrysosphaerella* (golden-brown) in the summers, and *Asterionella* (diatom) and *Peridnium* (dinoflagellates) in the winters. The 2024 Data Summary of the NHDES VLAP Individual Lake Report for Monomonac Lake shows phytoplankton population (relative percent cell count per taxa) for 2012, 2013, 2015, 2017, 2019, 2022, and 2024. Both

2015 and 2017 had high relative percentages of cyanobacteria, with low percentages in 2012, 2013, and 2024. Diatoms were dominant in 2013, 2019, and 2022, with golden browns dominant in 2012 and 2024 (NHDES VLAP, 2024).

The dominant zooplankton species in the 1976, 1991, and 2008 trophic surveys were *Keratella* (rotifer) and *Kellicottia* (rotifer) in the summers, and *Synchaeta* (rotifer), *Nauplius* larvae (copepod), and *Polyarthra* (rotifer) in the winters. Rotifers are small zooplankton whose populations can respond quickly to environmental changes. Copepods are small crustaceans that eat phytoplankton and provide an important food source for fish. *Daphnia* are among the most efficient grazers of phytoplankton but were not shown to be a dominant zooplankton group in Monomonac Lake. Maintaining a balance and sustainable food web of phytoplankton and zooplankton are necessary components of a healthy lake ecosystem.

| | |
|---|---|
| **Rotifers** | *small zooplankton whose population can respond quickly to environmental changes* |
| **Copepods** | *small crustaceans that eat phytoplankton and provide an important food source to fish* |
| **Cladocerans** | *include Daphnia, which are among the most efficient grazers of phytoplankton* |

*Cyanobacteria bloom in Monomonac Lake in June 2026. © MLPOA*

### 2.1.5 Chloride and Specific Conductivity

Chloride pollution can cause harm to aquatic organisms and disrupt internal mixing processes when chloride concentrations reach toxic levels. The State of New Hampshire sets a chronic water quality threshold of 230 ppm for chloride (which roughly equates to 835 microsiemens per centimeter (µS/cm) for specific conductivity). Chloride concentrations in Monomonac Lake are below the chronic impairment threshold. However, both chloride and specific conductivity have consistently exceeded the median value for New Hampshire lakes (5 mg/L for chloride and 42.3 uS/cm for conductivity).

Both chloride and specific conductivity in the surface and bottom waters show statistically significant increasing (worsening) trends over the data record (1976-2025) across all depth zones (Figure 6). The increasing trends suggest that chloride inputs from road salt used for winter deicing may be contaminating the lake. Additional contributors may include erosion and sediment runoff from unpaved roads (especially on steep slopes), as well as inputs from water softeners, septic systems, and fertilizers.

Although current levels do not pose an immediate threat, concentrations are reaching concerning levels and continued increases could eventually push the lake toward chronic chloride toxicity. Proactively reducing salt use and addressing erosion in the watershed will help protect Monomonac Lake from future impacts.

Salt application in the watershed comes from multiple sources, largely from the salting of local, state, and privately-owned paved roads. In addition, residential practices may also contribute to salt loading, as homeowners around the lake are likely using de-icing agents on driveways and walkways. Other potential contributors to high chloride and specific conductivity include wastewater inputs from failing or underperforming septic systems, leaky sewer lines, and greywater inputs from water softeners.

The chloride concentration in Monomonac Lake may be a concern for the health of the lake and may be impacting zooplankton populations that would otherwise help control the growth of cyanobacteria and other phytoplankton. A proactive reduction in salt use in the watershed is needed. Note that deicing salt can enter groundwater and cause high salinity in lakes and tributary streams throughout the year. Chloride concentrations in surface waters are often highest during the summer months, when lower water levels reduce dilution and concentrate existing salts.

Encouraging commercial salt applicators to obtain NH Green SnowPro certification could help ensure that professional de-icing is applied efficiently, while outreach to homeowners with guidance on proper salt use could reduce over-application and limit unnecessary salt input to the lake. Collectively, these applications may be significant contributors of salt runoff to the lake.

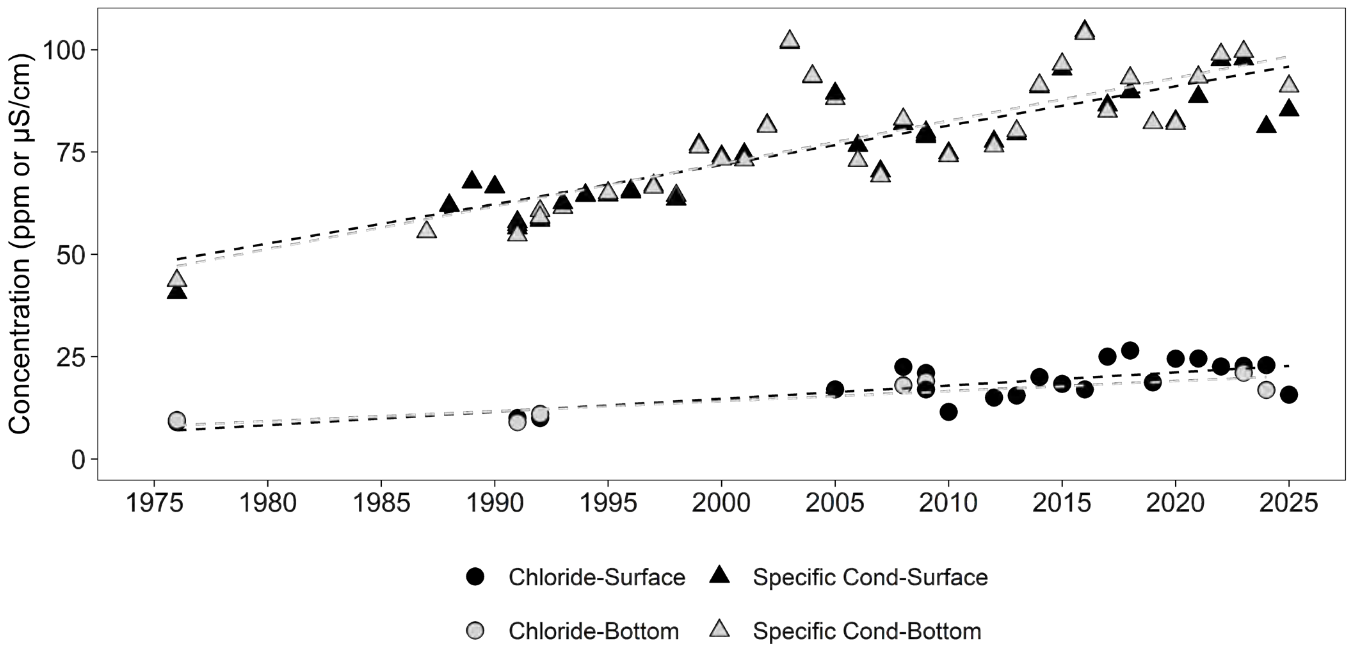



**Figure 6.** Yearly median of monthly medians for chloride and specific conductivity in the deep spot of Monomonac Lake (MONRINAD). Dashed lines indicate a statistically significant increasing (worsening) trend for both chloride and specific conductivity in the surface and bottom waters.

### 2.1.6 Turbidity

Turbidity is a measure of how clear or cloudy water is, caused by particles in the water scattering or absorbing light. In lakes and streams, turbidity can be influenced by algae and cyanobacteria, organic matter, and sediment. High turbidity reduces water clarity, limits photosynthesis and aquatic plant growth, stresses filter-feeding organisms, and can damage fish gills. Because suspended particles absorb sunlight, turbid waters also tend to be warmer and hold less dissolved oxygen.

At the deep spot of Monomonac Lake, turbidity values are low, with a median of 0.87 and 1.54 NTU in the surface and bottom waters, respectively, from the most recent ten years of data (2016-2025). For comparison, New Hampshire's water quality standard for Class B waters is no more than 10 NTU above natural background conditions. While NHDES has not set a numeric value for "natural" turbidity, values below 1 NTU are generally considered natural and low.[1]

Monomonac Lake's surface and bottom waters remain well below this threshold, though slightly elevated turbidity can be seen periodically in the bottom water (Figure 7). This is likely due to disturbance of the bottom sediment or the ability of cyanobacteria to regulate their buoyancy using gas-vesicles. Cyanobacteria may descend into the bottom waters during high light intensity conditions, or to take advantage of bio-available phosphorus at these depths.

[1] In the 2024 Consolidated Assessment and Listing Methodology (CALM), NHDES provides reference values aimed to represent natural turbidity that differ based on the month, derived from other streams. The reference values for streams in June, July, August, and September are 0.875, 0.831, 0.813, and 0.800 NTU, respectively.

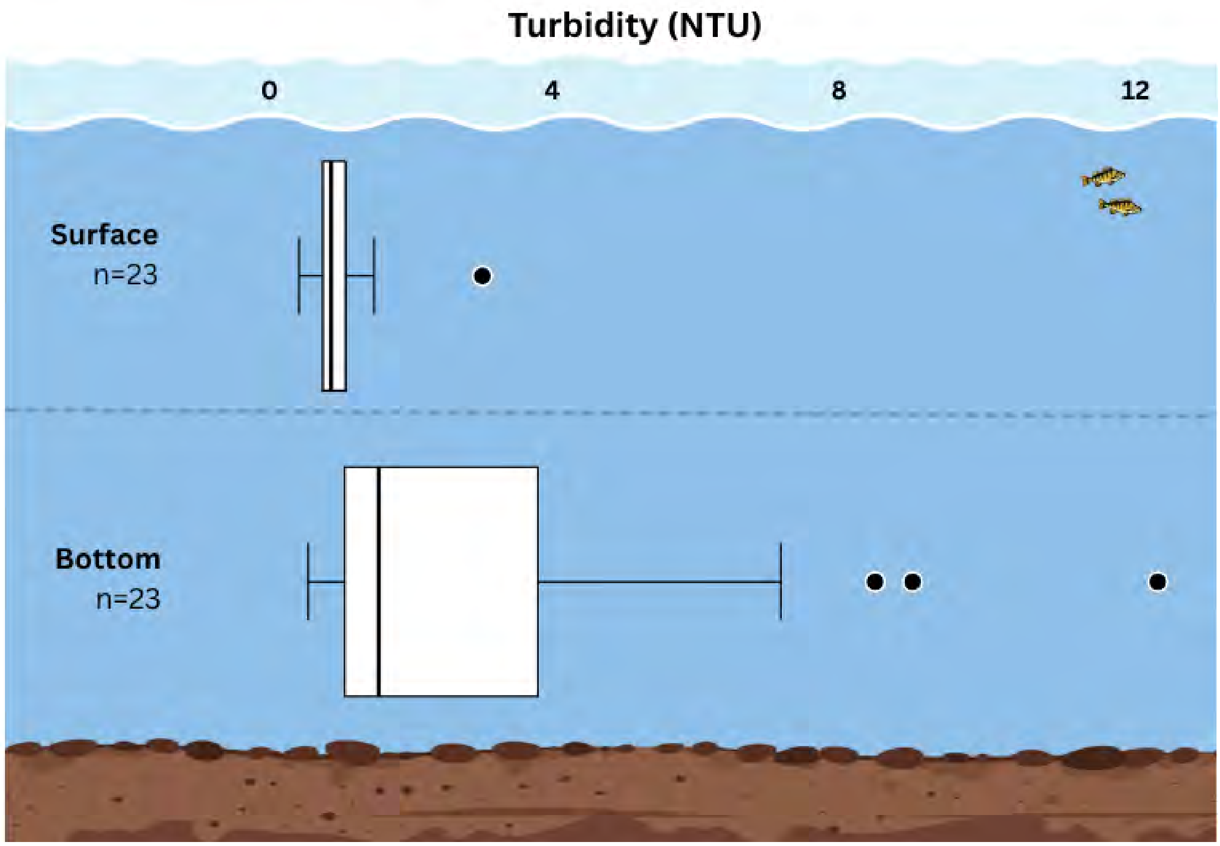



**Figure 7.** Boxplots showing median turbidity (NTU) in the surface and bottom water of the deep spot of Monomonac Lake (MONRINAD) for the past 10 years (2016-2025).

### 2.1.7 pH

The pH of a water body describes how acidic or basic the water is, with 7 representing neutral. Lower values indicate more acidic conditions, while higher values indicate more basic conditions. The habitable range of pH for aquatic organisms is near neutral, with NHDES setting the standard for Class B waterbodies to have a pH between 6.5 and 8.0 to protect aquatic life (Figure 8). Monitoring the pH of Monomonac Lake is especially important as multiple inflows to the lake are assessed as impaired due to low pH and those inflows may affect the water quality of the lake itself.


**Figure 8.** Graphic of the pH scale, indicating the zone that supports aquatic life.

The majority of the median pH values in the surface water at the deep spot of Monomonac Lake (MONRINAD) from 1987-2025, fall below a pH of 6.5, which is the lower (more acidic) end of the acceptable range set by NHDES (Figure 9). Only three yearly pH medians in the surface water exceed this acceptable range (2016, 2020, and 2024). There was no observed improving or worsening trend from 1987-2025.

Across the depth zones from 2016-2025, pH has generally been higher (less acidic) in the surface than in the bottom. This pattern is expected as photosynthesis in the surface's photic zone consumes carbon dioxide and raises pH, while respiration at greater depths has the opposite, acidifying effect. The pH may be lowest in the bottom water due to organic matter settling and decomposing, increasing respiration and acidity. Both the surface and the bottom have median pH values below the NHDES guideline range for supporting aquatic life (Figure 9). Low pH can stress aquatic organisms, and when pH falls below ~5.5, it can also mobilize iron and aluminum-bound phosphorus from lake sediments, further degrading water quality.

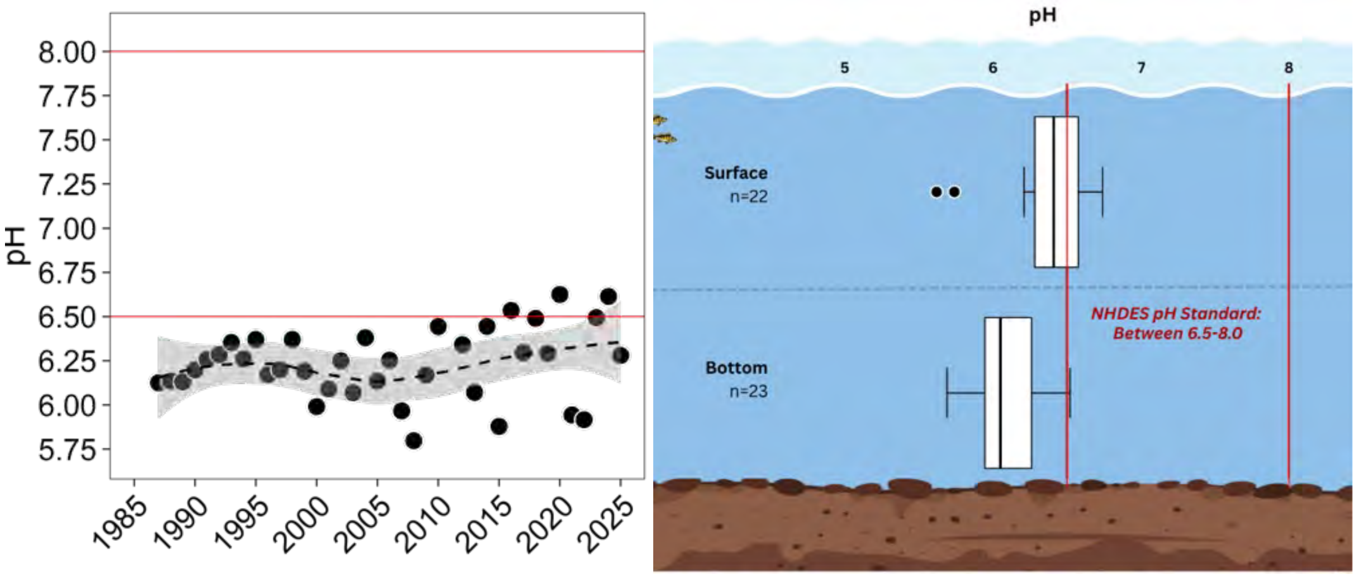
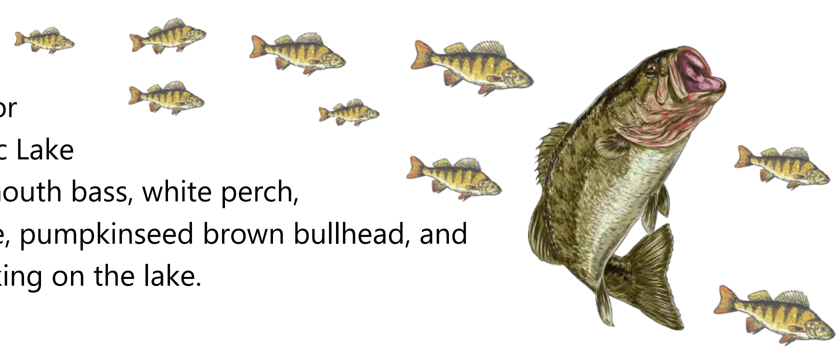



**Figure 9.** (Left) Yearly median of monthly medians for surface pH in the deep spot of Monomonac Lake (MONRINAD). (Right) Boxplots showing median pH in the surface and bottom of the deep spot of Monomonac Lake (MONRINAD) for the past 10 years, 2016-2025.

### 2.1.8 Fish



Fish are important in ecosystem food webs and for providing recreational opportunities. Monomonac Lake support warm water fish species including largemouth bass, white perch, yellow perch, eastern chain pickerel, black crappie, pumpkinseed brown bullhead, and bluegill. There is no historical or current fish stocking on the lake.

### 2.1.9 Invasive Species


The introduction of non-indigenous invasive aquatic plant species to New Hampshire's waterbodies has been on the rise. These invasive aquatic plants are responsible for habitat disruption, loss of native plant and animal communities, reduced property values, impaired fishing and degraded recreational experiences, and high removal costs. Once established, invasive species are difficult and costly to remove. There are multiple programs that help prevent the introduction of invasive species and monitor the lakes, including the Lake Host Program and the Weed Watcher Program.

Variable milfoil (*Myriophyllum heterophyllum*) arrived in Monomonac Lake in 1999. NHDES produced a Long-Term Variable Milfoil Management Plan for Monomonac Lake in 2020, which outlines historical and future actions to control milfoil. Nine areas of the lake are known to host milfoil plants, mostly along the western shoreline of the southern bay of the lake. Beginning in 1999, Monomonac Lake has been treated yearly in June with chemical herbicides, namely Diquat and 2, 4-D to control milfoil. In 2022, MLPOA and NHDES used ProcellaCOR to treat the lake. Weed watchers monitor the lake monthly to track infestations and mats throughout the season. Hand pulling was used as a control method in 2008 and 2009 only by local divers.

Weed watchers patrol the lakes and ponds throughout the summer in areas they use and report sightings to the program coordinator. Volunteer and paid Lake Hosts at the boat launch provide voluntary boat and trailer inspections and inform the public about invasive species. The MLPOA coordinates these Lake Hosts with grant support from NH Lakes. Continuing to monitor and control variable milfoil and other invasive species will help preserve the water quality of Monomonac Lake for the future.

## 2.2 ASSIMILATIVE CAPACITY

The assimilative capacity of a lake describes the amount of a pollutant that can be added to a waterbody without causing a violation of the anti-degradation tiers based on a lake's trophic designation as detailed in the NHDES Consolidated Assessment and Listing Methodology. The three tiers include: Tier 2, high quality waters where water quality is better than 10% of the difference between the best possible water quality (next lower trophic condition) and the criteria; Tier 1, where water quality is within 10% of the difference between the best possible water quality (next lower trophic condition) and the criteria; and Impaired, where water quality exceeds the criteria. Support determinations are based on the nutrient stressor (total phosphorus) and response indicator (chlorophyll-*a*), with chlorophyll-*a* dictating the assessment if both chlorophyll-*a* and total phosphorus data are available and the assessments differ.

For mesotrophic lakes such as Monomonac Lake, water quality criteria are set at 12.0 ppb for total phosphorus and 5.0 ppb for chlorophyll-*a* (Table 3; Table 4). Assessment results show that Monomonac Lake achieves Tier 1 standards for chlorophyll-*a*, meaning the lake is within 10% reserve capacity (Table 5). The lake exceeds the total phosphorus standard for mesotrophic lakes, meaning Monomonac Lake is potentially non-supporting for aquatic life integrity based on Table 4. For Monomonac Lake, reductions in phosphorus inputs will be necessary to lower total phosphorus below the threshold of 12.0 ppb and decrease the risk of cyanobacteria blooms. Reducing total phosphorus concentrations beyond the Tier 2 standard of 11.6 ppb would likely be beneficial to reducing chlorophyll-*a* concentrations below to Tier 1 or Tier 2 thresholds.

**Table 3.** Aquatic life integrity designated use nutrient criteria ranges by trophic state in New Hampshire. Chlorophyll-*a* is a surrogate measure for algae.

| Trophic State | Total Phosphorus *(ppb)* | Chlorophyll-*a* *(ppb)* |
|---|---|---|
| Oligotrophic | < 8.0 | < 3.3 |
| Mesotrophic | > 8.0 - 12.0 | > 3.3 - 5.0 |
| Eutrophic | > 12.0 - 28.0 | > 5.0 - 11.0 |

**Table 4.** Decision matrix for aquatic life integrity designated use assessment in New Hampshire. Chlorophyll-*a* is a surrogate measure for algae. Monomonac Lake is shown in the bolded, highlighted box based on the water quality analysis presented in Table 5.

| Nutrient Assessments | Total phosphorus criterion exceeded | Total phosphorus criterion NOT exceeded | Insufficient info for total phosphorus |
|---|---|---|---|
| **Chlorophyll-*a* criterion exceeded** | Impaired | Impaired | Impaired |
| **Chlorophyll-*a* criterion NOT exceeded** | **Potential non-support (Tier 2)** | Fully supporting (Tier 2) | Potential support (Tier 2) |
| **Insufficient info for chlorophyll-*a*** | Insufficient info | Insufficient info | Insufficient info |

**Table 5.** Assimilative capacity analysis results for Monomonac Lake using mesotrophic water quality criteria. Chlorophyll-*a* dictates the assessment results. ppb = parts per billion.

| Site | Parameter | Tier 2 Threshold *(ppb)* | Existing Median Water Quality* *(ppb)* | Remaining Assimilative Capacity *(ppb)* | Assessment Results |
|---|---|---|---|---|---|
| **Deep Spot (MONRINAD)** | Total phosphorus | 11.6 | 12.2 | 1.5 | Tier 1: Within Reserve |
| | Chlorophyll-*a* | 4.8 | 4.9 | 1.4 | |

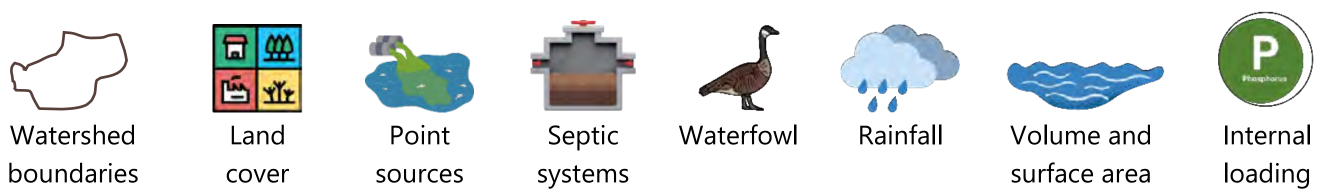
** Existing water quality data truncated to May 24-September 15 in the previous 10 years (2015-2024) for composite, epilimnion, or upper samples (in order of priority on a given day). Data were summarized by day, then month, then all years using median statistics.*

# 2.3 WATERSHED MODELING

## 2.3.1 Lake Loading Response Model

Environmental modeling is the process of using mathematics to represent the natural world. Models can help explain how a system works, study cause and effect, or predict future conditions. Environmental models range from simple equations that can be solved with pen and paper, to complex computer programs requiring teams of people to operate.

For lakes, one common tool is the Lake Loading Response Model (LLRM). This model can make predictions about phosphorus concentrations, chlorophyll-*a* concentrations, and water clarity under different pollutant loading scenarios. These types of models play a key role in the watershed planning process, as pollutant load estimates are a required component of EPA's nine key planning elements. The LLRM is an Excel-based model that uses environmental data to develop a water and phosphorus loading budget for lakes and their tributaries (AECOM, 2009). Water and phosphorus loads (in the form of mass and concentration) are traced from various sources in the watershed through tributary basins and into the lake. The model incorporates the following data:




These data are combined with coefficients that quantify nutrient inputs from different sources, attenuation factors that account for nutrient loss, and equations from scientific literature on lakes, rivers, and nutrient cycles to generate annual average predictions of total phosphorus, chlorophyll-*a*, Secchi disk transparency, and algal bloom probability. The model can be used to identify current and future pollutant sources, estimate pollutant limits, establish water quality goals, and guide watershed improvement projects. A detailed description of the methodology employed for the Monomonac Lake LLRM is provided in the Monomonac Lake: Lake Loading Response Model Report (FBE, 2026a).

### 2.3.1.1 Lake Morphology and Flow Characteristics

The morphology (shape) and bathymetry (depth) of lakes and ponds are considered reliable predictors of water clarity and lake ecology. Large, deep lakes are typically clearer than small, shallow lakes as the differences in lake area, number and volume of upstream lakes, and flushing rate affect lake function and health. The **areal water load** is the depth of all inflowing water that would cover the entire lake surface area. The flushing rate is the number of times that the lake's volume is replaced per year.

***Stats for Monomonac Lake***

| | | |
|---|---|---|
| **Surface area** | = | 614 acres |
| **Shoreline** | = | 15.0 miles |
| **Maximum depth** | = | 25.6 feet (7.8 meters) |
| **Volume** | = | 7,340,275 cubic meters |
| **Areal water load** | = | 38.2 feet per year<br>(11.636 meters per year) |
| **Flushing rate** | = | 4.244 times per year |

There are two dams in the watershed currently controlling water flow (NHDES, 2022). The main dam, called the Great Dam, controls the flow out of Monomonac Lake. The Great Dam is located at the eastern outlet of the lake. The emergency spillway, located at the western outlet of the lake, is used for flood control (refer to Section 3.1.3.3). While Monomonac Lake flushes 4.2 times per year, flushing is not consistent throughout the year, and the lake may flush less frequently in the dry, summer months when there are low water levels from limited rainfall and high evaporation. Changes in flushing rate throughout the year and from year to year can impact lake water quality response.

#### 2.3.1.2 Land Cover

Characterizing land cover within a watershed on a spatial scale can highlight potential sources of nonpoint source pollution that would otherwise go unnoticed in a field survey of the watershed. For instance, a watershed with large areas of developed land (i.e., impervious cover) and minimal forestland will likely be more at risk for nonpoint source pollution than a watershed with well-managed development and large tracts of undisturbed forest and/or protected forest, particularly along headwater streams. Land cover is also the essential element in determining how much phosphorus is contributed to surface water via stormwater runoff and baseflow.

Current land cover in the Monomonac Lake watershed was determined by FBE using NH Geographically Referenced Analysis and Information Transfer System datasets, Environmental Systems Research Institute World Imagery, and Google Earth imagery. See Monomonac Lake: Lake Loading Response Model Report (FBE, 2026a) for more details on methodology. The Monomonac Lake watershed is 73% forested/natural (8,288 acres); 11% developed (1,252 acres); 2% agricultural (255 acres); and 14% wetlands/open water (1,585 acres, excluding the lake).

Figure 10 shows the breakdown of land cover by major category and the corresponding total phosphorus load. Although developed areas for Monomonac Lake make up only 11% of the watershed, developed areas contribute 65% of the total phosphorus load. These areas are characterized by impervious surfaces (asphalt, concrete, rooftops, and compacted gravel) that prevent infiltration and channel stormwater which may lead directly to the lake. Runoff from these surfaces carries sediments, nutrients, pathogens, pesticides, hydrocarbons, and metals that can harm aquatic life. See Figure 11 for a map of land cover in the watershed.

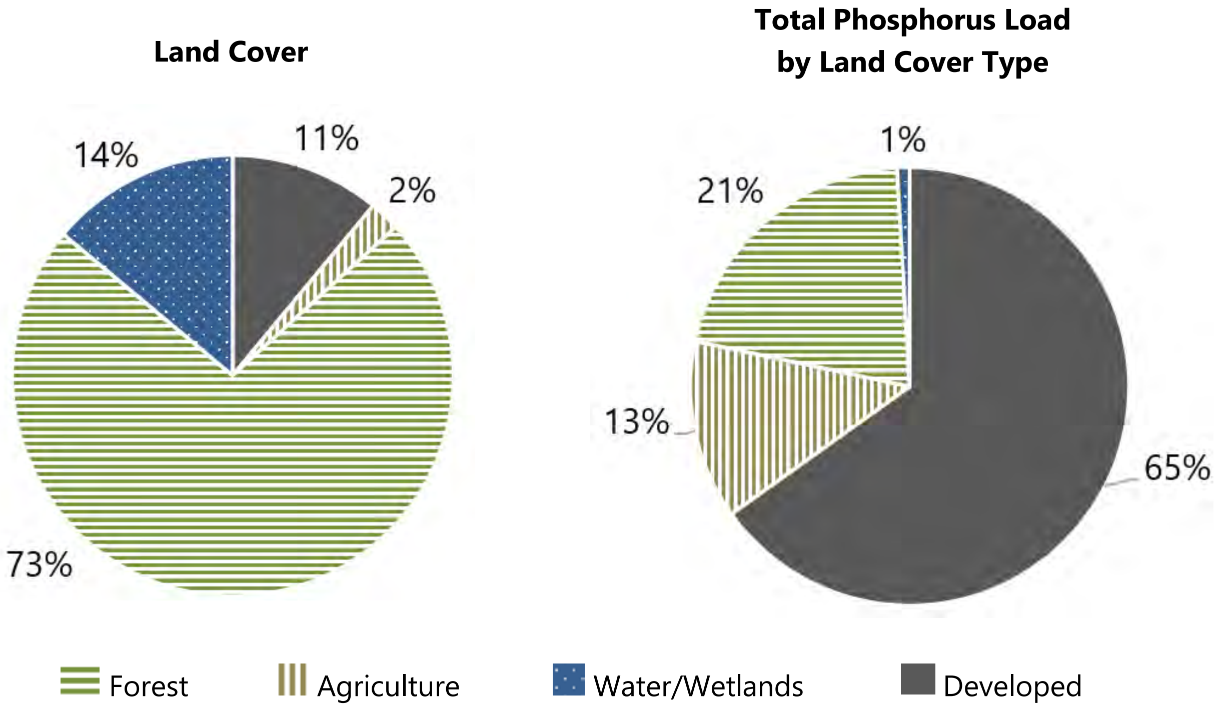



**Figure 10.** Land cover area by major category (left) and total phosphorus watershed load by major land cover category (right) for Monomonac Lake. The water/wetlands category does not include the lake areas.

*Depiction of lake loading. © FBE*

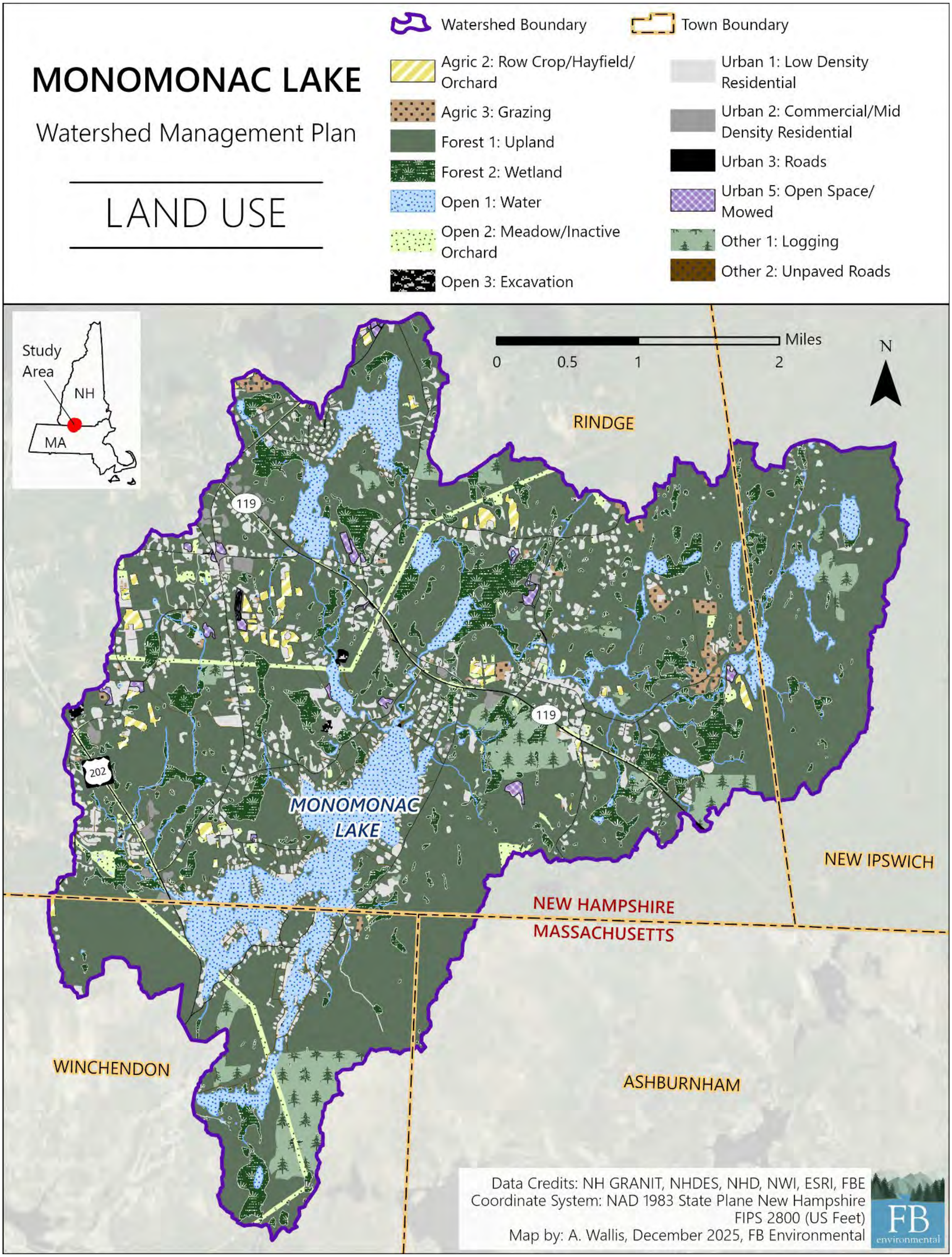



**Figure 11.** Land cover in the Monomonac Lake watershed.

#### 2.3.1.3 Internal Phosphorus Loading

Phosphorus that enters the lake and settles to the bottom can be re-released from sediment when chemical bonds between iron and phosphorus are broken under anoxic conditions, thus providing a nutrient source for algae, cyanobacteria, and plants. Internal phosphorus loading can also result from wind-driven wave action or physical disturbance of the sediment (boat propellers, aquatic macrophyte management activities).

Internal loading estimates were derived from a combination of data collected at the deep spot of the lake. Dissolved oxygen and temperature profiles taken at the deep spot were used to determine average annual duration and depth of anoxia, defined as less than 2 ppm of dissolved oxygen. Total phosphorus data taken at the deep spot, along with anoxic volume and area, were used to determine the rate of release and mass of the annual internal phosphorus load. The internal load estimate in any given year is highly variable and warrants further investigation.

Based on current data, internal loading represents 5% of the total phosphorus load to Monomonac Lake, indicating that it is a minor source at an annual scale. It may be functionally more relevant at critical times of year during the peak growing and recreational season.

#### 2.3.1.4 Lake Loading Response Model Results

Overall, model predictions for Monomonac Lake were in good agreement with observed data for total phosphorus (<1% difference) (Table 6). The model predictions were in fair agreement with observed data for chlorophyll-*a* (14% difference) and Secchi disk transparency (23% difference). It is important to note that the LLRM does not capture all biogeochemical processes affecting water quality and is less accurate for predicting chlorophyll-*a* and Secchi disk transparency. For example, chlorophyll-*a* estimates are based solely on nutrient loading, while algae growth is also influenced by sediment resuspension, zooplankton grazing, heterotrophic algae, light limitation, and flushing from high flows. Limited data prevented evaluation of these additional factors. The model predicted 18 cyanobacteria bloom days for the lake.

Watershed runoff combined with baseflow (74%) was the largest phosphorus loading contribution across all sources to Monomonac Lake (Figure 12; Table 7). Septic systems are the next largest load at 14%. Atmospheric deposition (4%), waterfowl (2%), and internal loading (5%) were relatively minor sources but may be seasonally important during low flow summer conditions (Figure 12; Table 7). Note that 1) the septic system load estimate applies only to systems located directly along the shoreline, which have the potential to short-circuit minimally treated effluent to the lake; and 2) contributions from septic systems elsewhere in the watershed are accounted for in the coefficients used to calculate the watershed load.

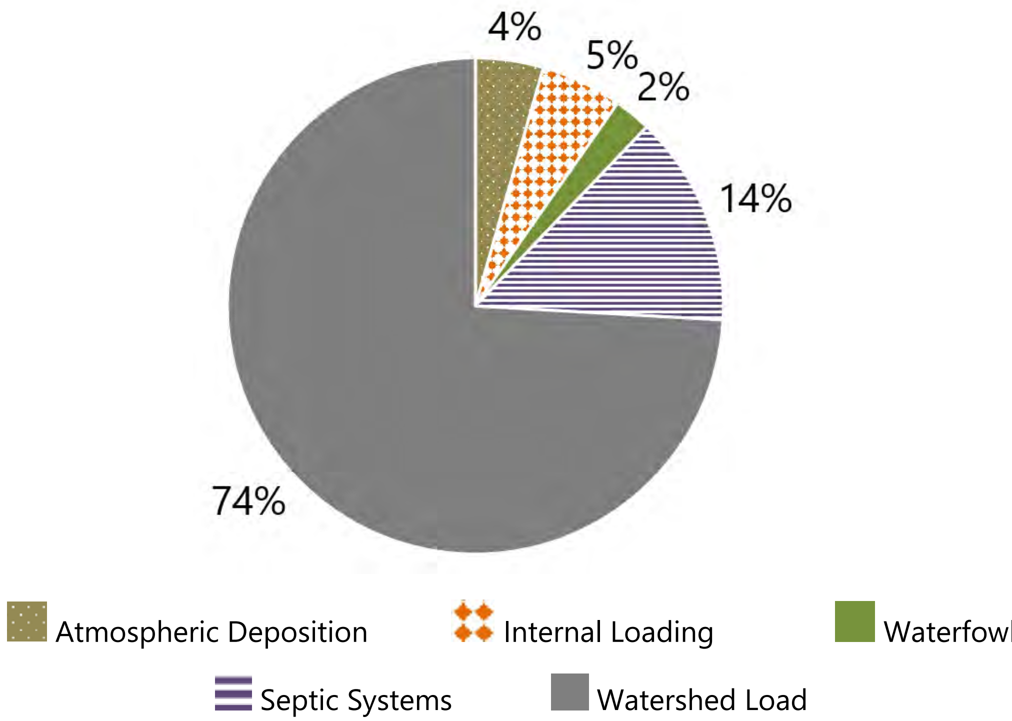



**Figure 12.** Summary of total phosphorus loading by major source for Monomonac Lake.

Normalizing phosphorus export by sub-watershed area highlights areas with elevated per-area loading (greater than 0.20 kilograms per hectare per year), which generally correspond to higher development or agricultural intensity, particularly along direct shoreline areas and inflows (Table 8; Figure 13). Even agricultural areas distant from the lake can contribute to phosphorus export due to fertilizer use, soil disturbance, animal waste, and landscape alterations.

Once the model was calibrated for current in-lake phosphorus concentration, we manipulated land cover and other sources of phosphorus to estimate the pre-development loading scenario (i.e., what in-lake phosphorus concentration was prior to human development or the best possible water quality for the lake). Pre-development loading estimation showed that total phosphorus loading to Monomonac Lake increased by 129% from 142.8 kilograms per year (kg/yr) prior to development to 665.1 kg/yr under current conditions (Table 7). These additional phosphorus sources come from development in the watershed, septic systems, atmospheric dust, and internal loading. Water quality prior to development is estimated to have been excellent with extremely low phosphorus and chlorophyll-*a* concentrations and high water clarity (Table 6).

We also manipulated land cover and other factors to estimate future loading scenario (i.e., what in-lake phosphorus concentration might be at full build-out under current zoning or the worst possible water quality for the lake). Refer to the *Monomonac Lake Build-Out Analysis Report* (FBE, 2026b) for details on methodology. Though not accounted for in the future model, projected increases in the frequency and intensity of storms and runoff events, along with longer dry periods and warming trends, may exacerbate erosion of phosphorus-laden sediment to surface waters and increase in-lake phosphorus concentrations (despite dilution and flushing assumed by the model). Future loading estimation showed that total phosphorus loading to Monomonac Lake may increase by 99% from 665.1 kg/yr to 1,977.4 kg/yr at full build-out (projected year: 2148) under current zoning (Table 7). Additional phosphorus will be generated from more development in the watershed, greater atmospheric dust, more septic systems, and enhanced internal loading. The model predicted higher (worse) phosphorus (36.2 micrograms per liter), higher (worse) chlorophyll-*a* (15.6 micrograms per liter) with 314 bloom days, and lower (worse) water clarity (1.5 meters) compared to current conditions (Table 6).

**Table 6.** In-lake water quality predictions for Monomonac Lake. TP = total phosphorus. Chl-*a* = chlorophyll-*a*. SDT = Secchi disk transparency. Bloom Days represents average annual probability of chlorophyll-*a* exceeding 8 ppb.

| Model Scenario | Measured Median TP *(µg/L)* | Modeled Median TP *(µg/L)* | Measured Mean Chl-*a* *(µg/L)* | Modeled Mean Chl-*a* *(µg/L)* | Measured Mean SDT *(meters)* | Modeled Mean SDT *(meters)* | Modeled Bloom Days |
|---|---|---|---|---|---|---|---|
| Pre-Development | not measured | 2.6 | not measured | 0.3 | not measured | 11.1* | 0 |
| Current (2025) | 12.1 | 12.0 | 4.6 | 4.0 | 2.7 | 3.4 | 18 |
| Future (2148) | not measured | 36.2 | not measured | 15.6 | not measured | 1.5 | 314 |

**Value exceeds the maximum depth of the waterbody. Modeled Secchi depth for the pre-development scenario of Monomonac Lake would hit the bottom as the lake is only 6.5-7.5 meters deep.*

**Table 7.** Total phosphorus (TP) and water loading summary by source for Monomonac Lake. kg/yr = kilograms per year.

| Development State | Measurement | Atmospheric | Internal | Waterfowl | Shoreline Septic System | Watershed Load | Total Load To Lake |
|---|---|---|---|---|---|---|---|
| **Pre-Development** | TP (kg/yr) | 18.7 | 0 | 16.1 | 0 | 108.0 | **142.8** |
| | Percent | 13% | 0% | 11% | 0% | 76% | **100%** |
| | Water (cubic meters per year) | 3,425,003 | 0 | 0 | 0 | 27,832,138 | **31,257,141** |
| **Current (2025)** | TP (kg/yr) | 29.4 | 35.3 | 16.1 | 91.4 | 492.8 | **665.1** |
| | Percent | 4% | 5% | 2% | 14% | 74% | **100%** |
| | Water (cubic meters per year) | 3,425,003 | 0 | 0 | 67,266 | 27,661,384 | **31,153,653** |
| **Future (2148)** | TP (kg/yr) | 66.9 | 106.0 | 16.1 | 110.9 | 1,678.5 | **1,977.4** |
| | Percent | 3% | 5% | 1% | 5% | 85% | **100%** |
| | Water (cubic meters per year) | 3,425,003 | 0 | 0 | 91,584 | 27,000,715 | **30,517,302** |

**Table 8.** Summary of current land area, water flow, and total phosphorus concentration and loading by sub-watershed for Monomonac Lake. Land area does not include the area of the lake. ha = hectares. $m^3$/yr = cubic meters per year. kg/ha/yr = kilograms per hectare per year.

| **Development State** | **Measurements** | **Bancroft Reservoir** *(720 ha)* | **Bush Hill** *(120 ha)* | **Colburn Lane** *(151 ha)* | **Converse Meadow Pond** *(595 ha)* | **Crowcroft Pond** *(333 ha)* | **Direct Drainage** *(666 ha)* | **Emerson Pond** *(192 ha)* | **Little Crowcroft Pond** *(213 ha)* | **Lord Brook** *(674 ha)* | **Mountain Pond** *(621 ha)* | **Rocky Hill** *(106 ha)* | **Swan Point** *(213 ha)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pre-Development Watershed Loads** | Water flow *($m^3$/yr)* | 5,277,570 | 904,142 | 1,110,559 | 4,346,619 | 2,421,674 | 5,049,244 | 1,380,780 | 1,576,143 | 5,050,551 | 4,610,654 | 809,279 | 1,579,397 |
| | Phosphorus mass *(kg/yr)* | 21.2 | 3.9 | 4.5 | 17.3 | 9.6 | 21.8 | 5.5 | 6.5 | 21.2 | 19.3 | 3.5 | 6.4 |
| | Phosphorus mass by area *(kg/ha/yr)* | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| **Current (2025) Watershed Loads** | Water flow *($m^3$/yr)* | 5,257,270 | 901,580 | 1,095,237 | 4,308,624 | 2,386,714 | 5,027,053 | 1,371,480 | 1,570,661 | 5,004,239 | 4,611,687 | 808,929 | 1,564,208 |
| | Phosphorus mass *(kg/yr)* | 91.7 | 8.7 | 28.0 | 86.7 | 70.6 | 108.1 | 22.3 | 34.4 | 119.1 | 34.0 | 5.3 | 31.2 |
| | Phosphorus mass by area *(kg/ha/yr)* | 0.13 | 0.07 | 0.19 | 0.15 | 0.21 | 0.16 | 0.12 | 0.16 | 0.18 | 0.05 | 0.05 | 0.15 |
| **Future (2148) Watershed Loads** | Water flow *($m^3$/yr)* | 5,105,828 | 897,543 | 1,062,248 | 4,181,679 | 2,325,190 | 4,930,453 | 1,330,000 | 1,520,830 | 4,853,771 | 4,591,086 | 792,365 | 1,505,329 |
| | Phosphorus mass *(kg/yr)* | 381.2 | 16.4 | 91.1 | 329.4 | 188.2 | 292.8 | 101.6 | 129.7 | 406.8 | 73.4 | 36.9 | 143.8 |
| | Phosphorus mass by area *(kg/ha/yr)* | 0.53 | 0.14 | 0.60 | 0.55 | 0.56 | 0.44 | 0.53 | 0.61 | 0.60 | 0.12 | 0.35 | 0.67 |

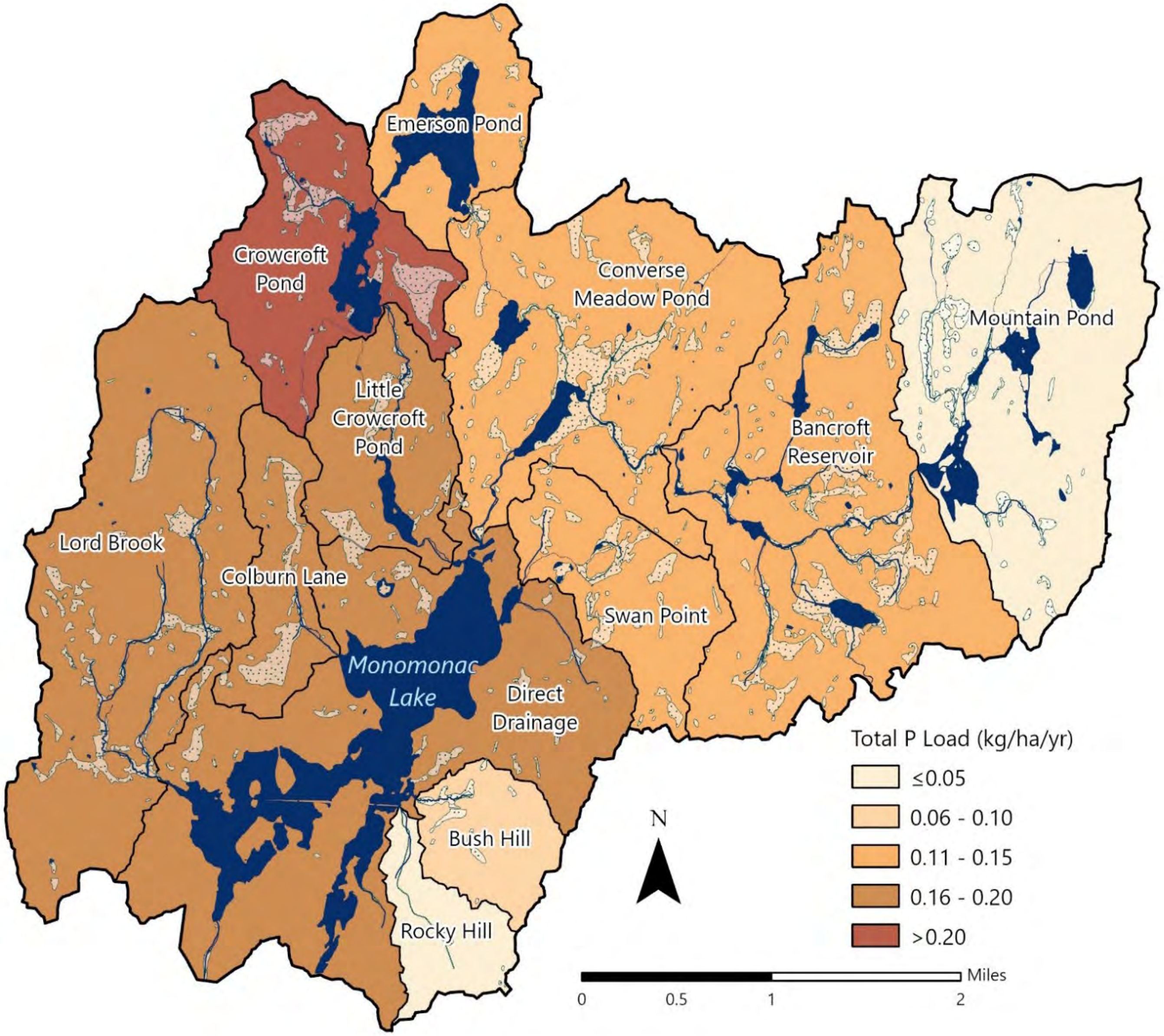



**Figure 13.** Map of current total phosphorus load per unit area (kilograms per hectare per year = kg/ha/yr) for each sub-watershed in the Monomonac Lake watershed. Higher phosphorus loads per unit area are concentrated in the more developed direct shoreline areas.

### 2.3.2 Build-out Analysis

A full build-out analysis was completed for the Monomonac Lake watershed as part of the Monomonac Lake Build-Out Analysis Report (FBE, 2026b). A build-out analysis identifies areas with development potential and projects future development based on a set of conditions (e.g., zoning regulations, environmental constraints) and assumptions (e.g., population growth rate). A build-out analysis shows what land is available for development, how much development can occur, and at what densities. "**Full build-out**" is a theoretical condition representing the moment in time when all available land suitable for residential, commercial, and industrial uses has been developed to the maximum capacity permitted by local ordinances and zoning standards. Local ordinances and zoning standards are subject to change, and the analysis requires simplifying assumptions; therefore, the results of the build-out analysis should be viewed as planning-level estimates only for potential future outcomes from development trends.

**FULL BUILD-OUT** is a theoretical condition representing the moment in time when all available land suitable for residential, commercial, and industrial uses has been developed to the maximum capacity permitted by current local ordinances and current zoning standards.

To determine where development may occur within the study area, the build-out analysis first subtracts land unavailable for development due to physical constraints, including environmental restrictions (e.g., wetlands, conserved lands, hydric soils), zoning restrictions (e.g., shoreland zoning, street right-of-ways, and building setbacks), and practical design considerations (e.g., lot layout inefficiencies) (Figure 14). Note that 194 acres of conservation land was added to Winchendon in 2025 near the southern end of the lake; however, this conservation parcel was incorporated into the data prior to the build-out analysis. Existing buildings also reduce the capacity for new development.

The build-out analysis showed that 48% (5,354 acres) of the Monomonac Lake watershed is still considered buildable under current zoning regulations (Table 9; Figure 15). FBE identified 1,516 existing principal buildings within the watershed, and the build-out analysis projected that an additional 5,961 buildings could be constructed in the future, resulting in a total of 7,477 buildings in the watershed (Table 10; Figure 16).

**Table 9.** Amount of buildable land by town and zone in the Monomonac Lake watershed in Rindge and New Ipswich, NH and Winchendon, MA.

| Zone | Total Area *(acres)* | Buildable Area *(acres)* | Percent Buildable Area |
|---|---|---|---|
| **New Ipswich** | **1360** | **36** | **3%** |
| Rural District (RD) | 1360 | 36 | 3% |
| **Rindge** | **8072** | **4709** | **58%** |
| Residential District (RD) | 1951 | 897 | 46% |
| Residential Agricultural District (RAD) | 5533 | 3429 | 62% |
| Village District (VD) | 315 | 198 | 63% |
| Business-Light Industry District - Same Zone Abutting (BLID_1) | 31 | 25 | 82% |
| Business-Light Industry District - Different Zone Abutting (BLID_2) | 199 | 122 | 61% |
| Gateway East District - Same Zone Abutting (GED_1) | 7 | 7 | 97% |
| Gateway East District - Different Zone Abutting (GED_2) | 37 | 32 | 87% |
| **Winchendon** | **1734** | **609** | **35%** |
| Rural Residential (R80) | 1134 | 333 | 29% |
| Suburban Residential (R40) | 308 | 156 | 51% |
| Planned Dev – 1 & 2 Family Res (PD_1&2FAM) | 32 | 23 | 70% |
| Lake Monomonac Overlay District (R40_LMOD) | 259 | 97 | 38% |
| **Total** | **11,166** | **5,354** | **48%** |

**Table 10.** Number of existing and projected buildings by town and zone in the Monomonac Lake watershed in Rindge and New Ipswich, NH and Winchendon, MA.

| Zone | Number Existing Buildings | Number Projected Buildings | Total Number Buildings | Percent Increase |
|---|---|---|---|---|
| **New Ipswich** | **27** | **45** | **72** | **167%** |
| *Rural District (RD)* | 27 | 45 | 72 | 167% |
| **Rindge** | **1,195** | **5,271** | **6,466** | **441%** |
| *Residential District (RD)* | 439 | 1057 | 1,496 | 241% |
| *Residential Agricultural District (RAD)* | 604 | 3811 | 4,415 | 631% |
| *Village District (VD)* | 125 | 194 | 319 | 155% |
| *Business-Light Industry District - Same Zone Abutting (BLID_1)* | 10 | 20 | 30 | 200% |
| *Business-Light Industry District - Different Zone Abutting (BLID_2)* | 9 | 150 | 159 | 1,667% |
| *Gateway East District - Same Zone Abutting (GED_1)* | 3 | 4 | 7 | 133% |
| *Gateway East District - Different Zone Abutting (GED_2)* | 5 | 35 | 40 | 700% |
| **Winchendon** | **294** | **645** | **939** | **219%** |
| Rural Residential (R80) | 5 | 392 | 397 | 7,840% |
| Suburban Residential (R40) | 10 | 110 | 120 | 1,100% |
| Planned Dev – 1 & 2 Family Res (PD_1&2FAM) | 3 | none | 3 | 0% |
| Lake Monomonac Overlay District (R40_LMOD) | 276 | 143 | 419 | 52% |
| **Total** | **1,516** | **5,961** | **7,477** | **393%** |

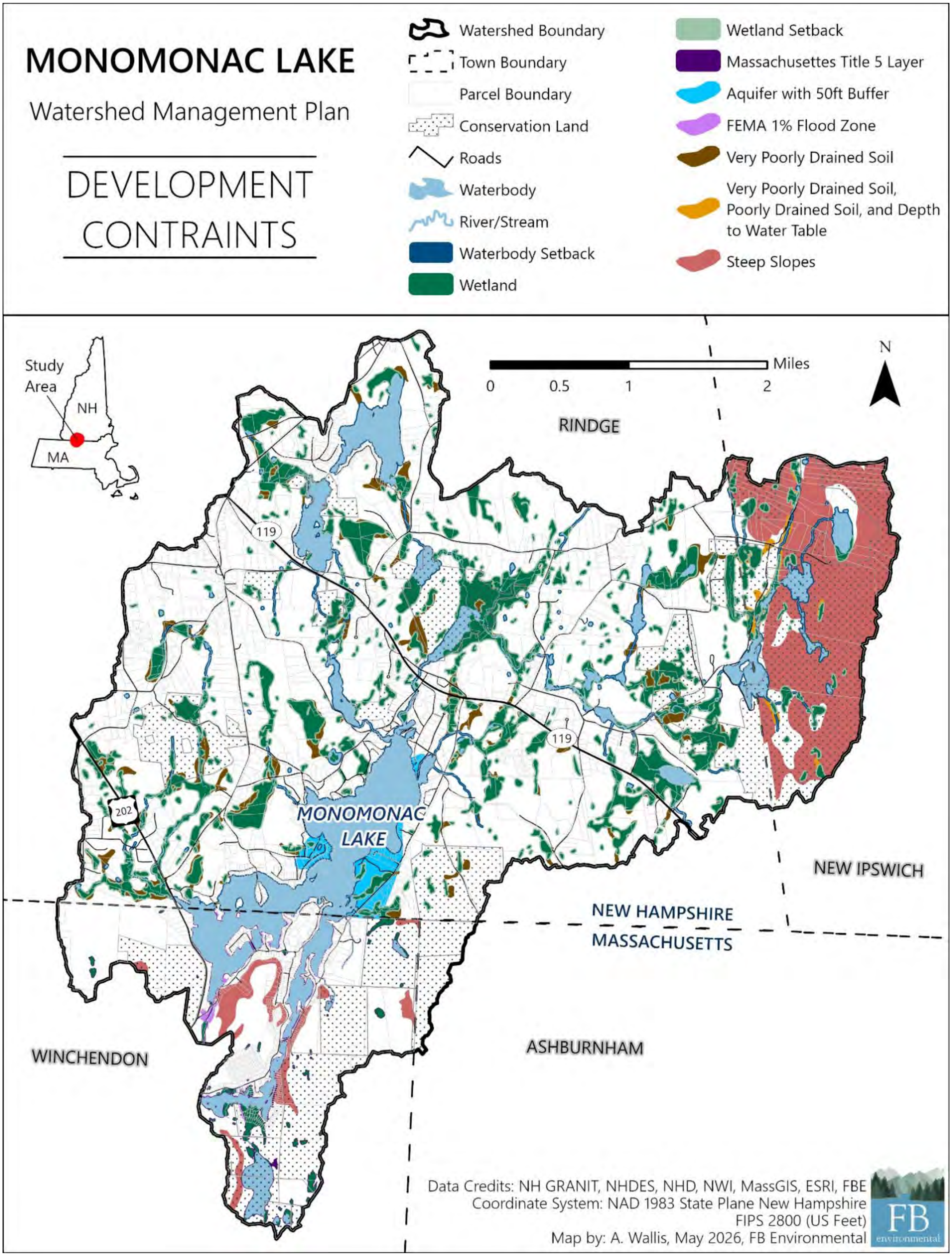



**Figure 14.** Development constraints in the Monomonac Lake watershed in Rindge and New Ipswich, NH and Winchendon, MA. Developed as part of the *Monomonac Lake Build-Out Analysis Report*.

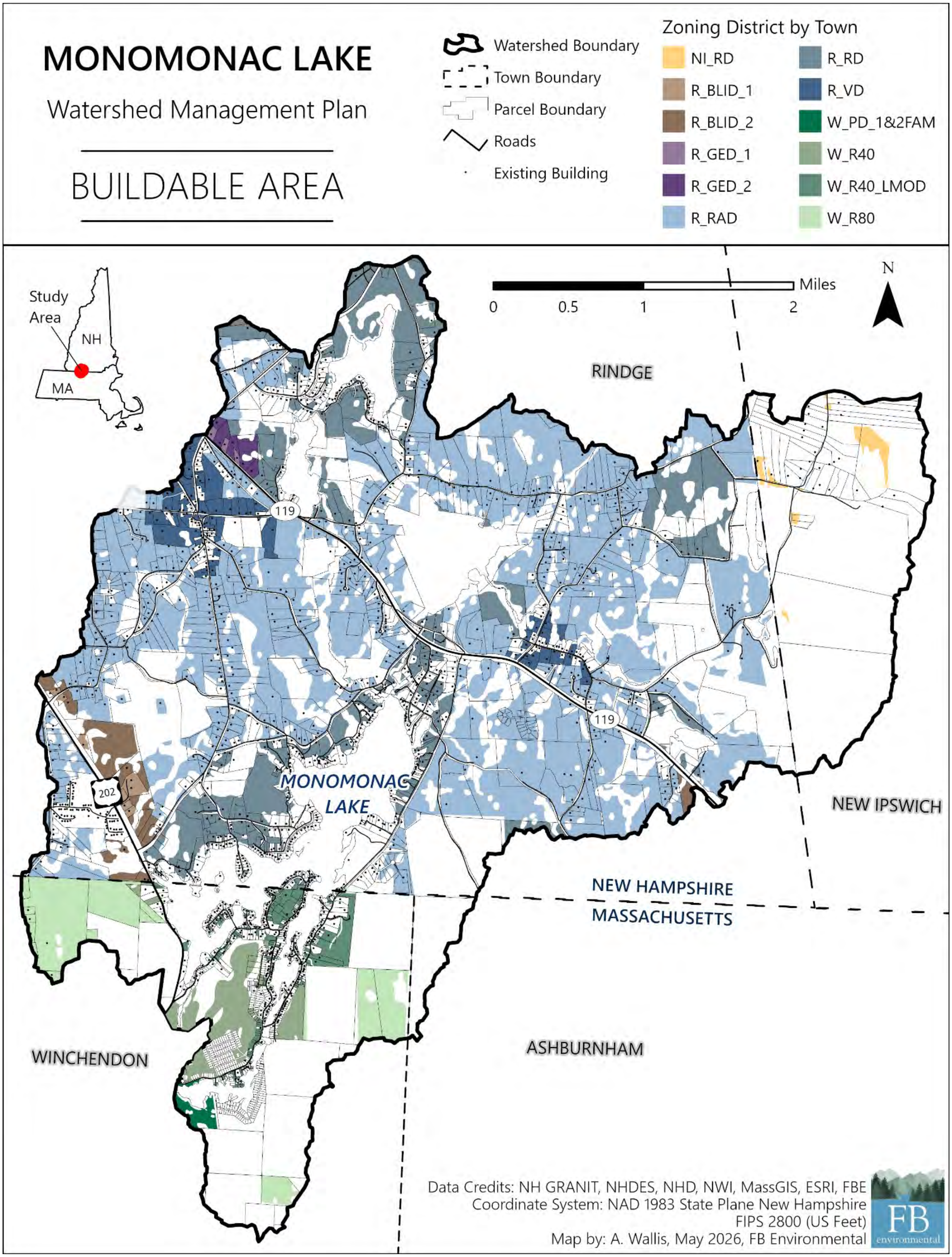



**Figure 15.** Buildable area by municipal zone in the Monomonac Lake watershed in Rindge and New Ipswich, NH and Winchendon, MA. Developed as part of the *Monomonac Lake Build-Out Analysis Report*.

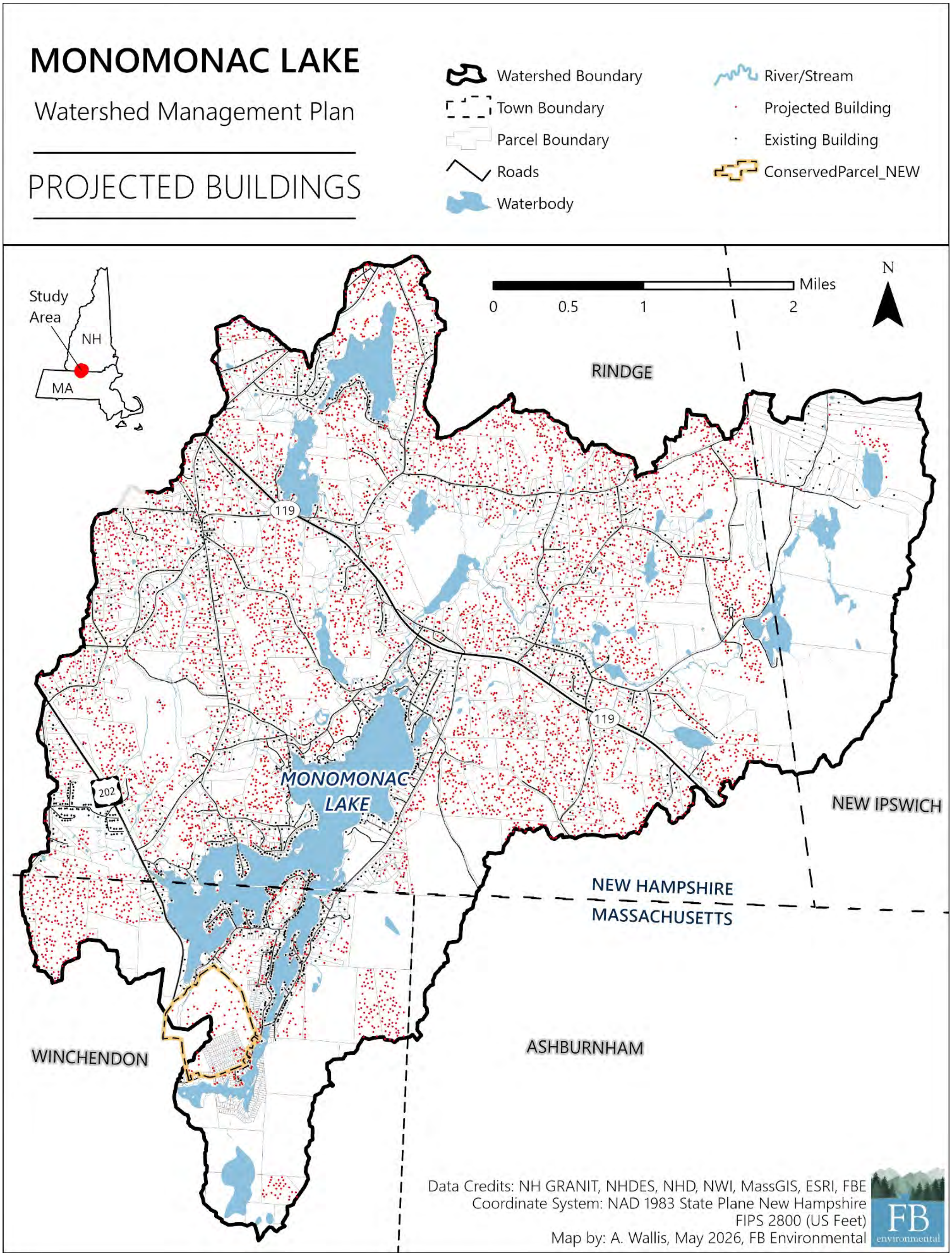



**Figure 16.** Projected buildings in the Monomonac Lake watershed in Rindge and New Ipswich, NH and Winchendon, MA. Developed as part of the *Monomonac Lake Build-Out Analysis Report*.

A TimeScope Analysis applies historical compound annual growth rates (CAGR) to the number of projected buildings to project the rate of new development into the future. The TimeScope Analysis presented here projects three different growth rates for the watershed towns, representing the past 10 years (2010-2020), 20 years (2000-2020), and 40 years (1980-2020) of decadal census data (Table 11). It is important to note that future growth rates may vary from historical growth rates.

**Table 11**. Compound annual growth rates (CAGR) for the towns in the Monomonac Lake watershed, used for the TimeScope Analysis. Data from the U.S. Census Bureau.

| Town Populations | 1980 | 2000 | 2010 | 2020 | 40 Year CAGR (1980-2020) | 20 Year CAGR (2000-2020) | 10 Year CAGR (2010-2020) |
|---|---|---|---|---|---|---|---|
| *New Hampshire (for reference)* | *920,610* | *1,235,786* | *1,316,470* | *1,377,529* | 1.01% | 0.54% | 0.45% |
| Rindge | 3,375 | 5,451 | 6,014 | 6,476 | 1.64% | 0.87% | 0.37% |
| Winchendon | 7,019 | 9,611 | 10,300 | 10,364 | 0.98% | 0.38% | 0.03% |
| New Ipswich | 2,433 | 4,289 | 5,099 | 5,204 | 1.92% | 0.97% | 0.10% |
| **Towns Combined** | **12,827** | **19,351** | **21,413** | **22,044** | **1.82%** | **1.31%** | **0.29%** |

For the Monomonac Lake watershed, full build-out is projected to occur in 2114 at the 10-year CAGR, 2148 at the 20-year CAGR, and 2575 for the 40-year CAGR for the watershed towns (Figure 17).

Note that the growth rates used in the TimeScope Analysis are based on town-wide census statistics but have been applied here to a portion of the towns. If areas closer to the lake within each town develop faster than more upland areas, watershed full build-out conditions may occur sooner. Also note that the population growth rate in these towns is slowing, so the growth rate estimates that are more recent, such as the 10- or 20-year estimates, are likely more accurate than the 40-year estimate. Using census data to project population increase and/or development has inherent limitations. For instance, the building rate may increase at a different rate than population, due to factors such as commercial versus residential development and number of people per household. As such, the TimeScope Analysis might over or underestimate the time required for the study area to reach full build-out. Numerous social and economic factors influence population change and development rates, including policies adopted by federal, state, and local governments. The relationships among the various factors may be complex and therefore difficult to model.

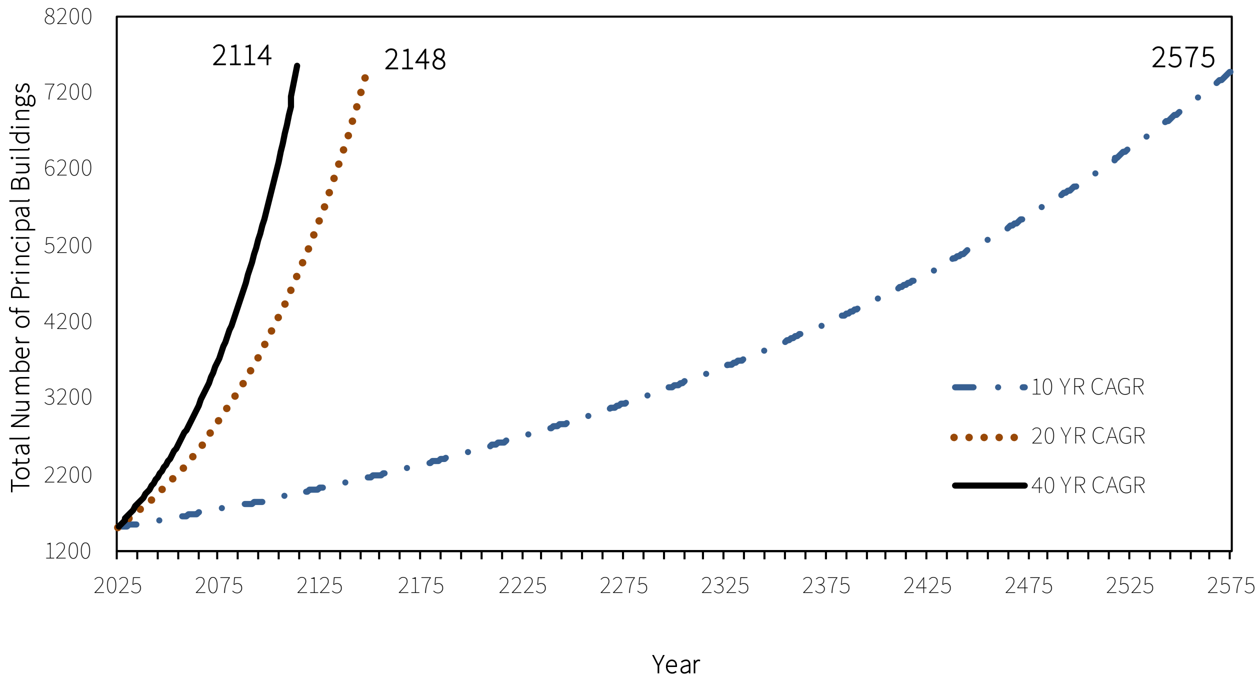



**Figure 17**. Full build-out projections for the Monomonac Lake watershed (based on compound annual growth rates; CAGR).

## 2.4 WATER QUALITY GOAL AND OBJECTIVES

A water quality goal was developed based on the data and modeling described in previous sections. The model results identify the largest contributing sources of phosphorus to the lake and the subsequent in-lake total phosphorus concentrations for a current condition scenario and a future conditions scenario. This indicates that Monomonac Lake is currently being affected by existing development in the watershed and will likely be impacted by continued growth. These results provide a foundation for informed management decisions and establishing an appropriate water quality goal for Monomonac Lake.

Reducing sources of phosphorus throughout the watershed will be necessary to protect water quality in the long-term by preventing the accumulation of phosphorus that can feed cyanobacteria blooms. Given that the lake is experiencing cyanobacteria blooms and is threatened by new development, it is highly recommended that strong objectives be established to protect the water quality of the lake.

Based on discussions with the Advisory Committee, the following water quality goal and objectives were set for the Monomonac Lake WMP. It is important to note that meeting this goal for the lake may not be enough to prevent cyanobacteria blooms caused by other stressors such as a longer growing season and warming lake water. More data and evaluation of changes in the lake's water quality response to these stressors would be needed to adjust the goal.

**The goal of the Monomonac Lake WMP is to improve water quality of Monomonac Lake such that the likelihood of harmful cyanobacteria blooms is reduced, assimilative capacity for chlorophyll-*a* is restored, and the lake's resiliency is increased moving into the future.** This goal will be achieved through the implementation of the following objectives. More detailed action items to achieve these objectives will be provided in the action plan as part of the WMP.

***Objective 1***

Reduce phosphorus loading from existing development by 13.4% (88.9 kg/yr) to Monomonac Lake to decrease the predicted annual average total phosphorus concentration from 12.0 to 10.4 micrograms per liter. An interim five year goal of 30 kg/yr was set which would reduce in-lake predicted annual average total phosphorus concentration to from 12.0 to 11.6 micrograms per liter.

***Objective 2***

Mitigate (prevent or offset) phosphorus loading from future development by a total of 107 kg/yr by 2036 to Monomonac Lake to maintain the current predicted annual average total phosphorus concentration.

***Reality Check***

The watershed survey identified 21 sites impacting the lake. Remediating these sites could prevent up to 4.4 kg/yr of phosphorus from entering the lake. In addition, the shoreline survey identified 231 properties with medium to high shoreline disturbance scores. Treating these shoreline sites could reduce the phosphorus load to the lake by 55.3 kg/yr. Finally, upgrading the 292 shoreline septic systems older than 25 years is estimated to reduce the phosphorus load to the lake by 29.2 kg/yr.

**In sum, treating existing pollutant sources identified as coming from the external watershed load could reduce the phosphorus load to Monomonac Lake by 88.9 kg/yr, which meets 100% of Objective 1 and 296% of the interim five year goal of 30 kg/yr.** There may be additional structural stormwater control measures that can reduce phosphorus loading, such as routine road ditch maintenance, property-level stormwater management, improved agricultural practices, and shoreline improvements on a small portion of parcels that were inaccessible during the shoreline survey. Shoreline properties on Emerson Pond may also lead to downstream improvements. Non-structural SCMs such as educating homeowners about residential stormwater management, fertilizer use, shoreline vegetated buffers, and septic system maintenance are essential tools for meeting Monomonac Lake's water quality goals. These initiatives reduce phosphorus loading by preventing limiting nutrient runoff from lawns, and encouraging property-scale stormwater mitigation, and reducing undetected septic system failures.

Objective 2 may be achieved through town ordinance revisions that implement low impact development strategies, encourage cluster development, or increase minimum lot size requirements, which helps protect forested space and maintains the watershed's natural character. Additionally, seeking opportunities to protect the vegetated shoreland zone and increase the conservation of forested areas can further safeguard the natural filtration processes that Monomonac Lake relies on.

Establishing interim benchmarks for each water quality objective provides the necessary flexibility to reassess goals as new data becomes available and as development pressures evolve over the next decade (Table 12). By comparing modeled water quality trends against 'no-action' predictions, stakeholders can use an adaptive management approach to determine if current strategies are succeeding or falling short. This distinction is vital; for instance, if benchmarks are missed due to funding constraints rather than development outstripping mitigation efforts, the path for adjustment will differ. At each milestone, stakeholders should evaluate the latest water quality data alongside implementation progress, allowing them to recalibrate future benchmarks to reflect both environmental conditions and practical logistical limitations. The final watershed management plan for Monomonac Lake will establish indicators of progress to track implementation efforts and break the goal into actionable and achievable milestones.

**Table 12.** Summary of interim benchmarks for tracking progress towards achieving the water quality objectives for Monomonac Lake. Interim benchmarks are cumulative.

| Interim Goals / Benchmarks | 2029 | 2032 | 2036 |
|---|---|---|---|
| **Objective 1**<br>Reduce phosphorus loading from existing development by 13.4% (88.9 kg/yr) to Monomonac Lake. | Achieve **2.3%** (15.0 kg/yr) reduction in total phosphorus loading to Monomonac Lake. | Achieve **4.5%** (30.0 kg/yr) reduction in total phosphorus loading to Monomonac Lake; re-evaluate water quality and track progress. | Achieve **13.4%** (88.9 kg/yr) reduction in total phosphorus loading to Monomonac Lake; re-evaluate water quality and track progress. |
| **Objective 2**<br>Mitigate (prevent or offset) phosphorus loading from future development by 106.3 kg/yr to Monomonac Lake. | Prevent or offset **27 kg/yr** in total phosphorus loading from new development to Monomonac Lake. | Prevent or offset **53 kg/yr** in total phosphorus loading from new development to Monomonac Lake; re-evaluate water quality and track progress. | Prevent or offset **107 kg/yr** in total phosphorus loading from new development to Monomonac Lake; re-evaluate water quality and track progress. |

# 3 POLLUTANT SOURCE IDENTIFICATION

This section describes sources of excess phosphorus to Monomonac Lake. Sources of phosphorus to lakes include stormwater runoff, shoreline erosion, construction activities, illicit connections such as sanitary pipes and sump pumps, failed or improperly functioning septic systems, boat discharges, fabric softeners and detergents in greywater, fertilizers, and pet, livestock, and wildlife waste. The externally loaded phosphorus can then circulate within the lake, contributing to internal phosphorus loading over time. Additional phosphorus sources can enter the lake from atmospheric deposition but are not addressed here because of limited local management options. Wildlife is mentioned as a potential source but largely for nuisance waterfowl such as geese or ducks, which may congregate in large groups because of human-related actions, such as feeding or having easy shoreline access (i.e., lawns). More frequent and intense rainfall events with associated peaks in stormwater runoff is also not a direct source but can exacerbate the impact of the other phosphorus sources identified in this section and should be considered when striving to achieve the water quality objectives.

## 3.1 WATERSHED DEVELOPMENT

Nonpoint source pollution comes from many diffuse sources on the landscape and is more difficult to identify and control than point source pollution. Nonpoint source pollution can result from contaminants transported by overland runoff (e.g., runoff from suburban and rural areas and agricultural runoff), groundwater flow, or direct deposition of pollutants to receiving waters. Examples of nonpoint source pollution that can contribute nutrients to surface waters via runoff, groundwater, and direct deposition include erosion from disturbed ground or along roads, stormwater runoff from developed areas, malfunctioning septic systems, excessive fertilizer application, unmitigated agricultural activities, washing vehicles on driveways, pet waste, and wildlife waste.

### 3.1.1 Shoreline Survey

In 2025, two FBE technical staff along with MLPOA volunteers conducted a shoreline survey for Monomonac Lake. Each of the six teams documented the condition of the shoreline for each parcel using a rapid scoring method which assessed each parcel with lake frontage for vegetated buffer, bare soil, shoreline erosion, slope, and distance of structures from the lake. Scores were combined into a Shoreline Disturbance Score and a Shoreline Vulnerability Score, with higher values indicating poorer or more vulnerable shoreline conditions. Photos were taken at each parcel and were cataloged by tax map-lot number. Due to the shallow nature of Monomonac Lake, certain parcels could not be accurately assessed, as they were inaccessible by either boat or car. A mid-summer survey every five years is recommended to monitor evolving conditions.

A total of 444 parcels were evaluated along the shoreline of Monomonac Lake. The average Shoreline Disturbance Score for the lake is 6.7, with 51% of parcels (231) scoring 7 or higher, indicating potentially detrimental shoreline conditions such as inadequate buffers, exposed soil, and erosion. The average Shoreline Vulnerability Score was 4.2, with 79% of parcels (357) scoring 4 or higher, indicating most homes were built within 150 ft of the shoreline on moderate to steep slopes, which are more prone to erosion regardless of buffer quality (Table 13; Figure 18).

**Table 13.** Average scores for each evaluated condition criterion comprising the average Shoreline Disturbance Score and the average Shoreline Vulnerability Score for Monomonac Lake. Lower values indicate shoreline conditions that are effective at reducing erosion and excess nutrient input to the lake.

| Evaluated Condition | Average Score |
|---:|---|
| Buffer (1-5) | 3 |
| Bare Soil (1-4) | 2.3 |
| Shoreline Erosion (1-3) | 1.4 |
| **Shoreline Disturbance Score (3-12)** | **6.7** |
| Distance (0-3) | 2.3 |
| Slope (1-3) | 1.9 |
| **Shoreline Vulnerability Score (1-6)** | **4.2** |

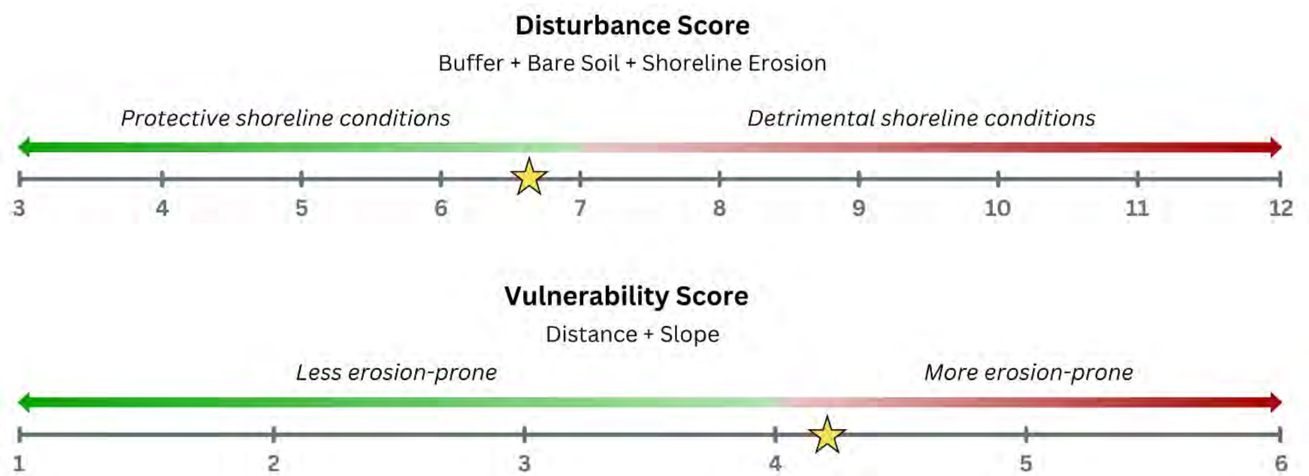



**Figure 18.** Monomonac Lake average shoreline survey disturbance and vulnerability scores, indicated by yellow stars.

Pollutant loading estimates are based on Shoreline Disturbance Scores. The 231 parcels with scores 7-12 (medium to high) contribute an estimated 110.6 kilograms of phosphorus annually. Implementing SCMs at 50% efficiency on these properties could reduce phosphorus by 55.3 kilograms per year.

Some site characteristics, such as slope, naturally increase erosion risk, while others, such as the distance of structures from the lake, reflect historic development and are difficult to change. Shoreline buffers and exposed soil are more easily modified to improve shoreline resilience.

Overall, Monomonac Lake is at risk for erosion issues (average disturbance score close to 7), with 231 properties (51%) that need to address shorelines that are likely impacting the lake. Many homes are close to shore on moderate to steep slopes, increasing erosion potential. Scores should guide remediation priorities, with recommendations focusing on establishing or maintaining vegetated buffers to reduce erosion and phosphorus and sediment inputs to the lake.

### 3.1.2 Watershed Survey

***Overview***

FBE partnered with Rindge Director of Public Works, Michael Sr. Cloutier, to conduct a watershed survey in October 2025 to identify areas contributing to pollutant loads. Before fieldwork, input on areas of concern was gathered from MLPOA, and aerial imagery and GIS data were analyzed to target likely problem sites such as unpaved roads, beaches, and impervious areas.

Twenty-one problem sites were identified, primarily involving road and ditch erosion and buffer clearing (Figure 19). Three additional sites were identified as points of interest.

***Priority Sites***

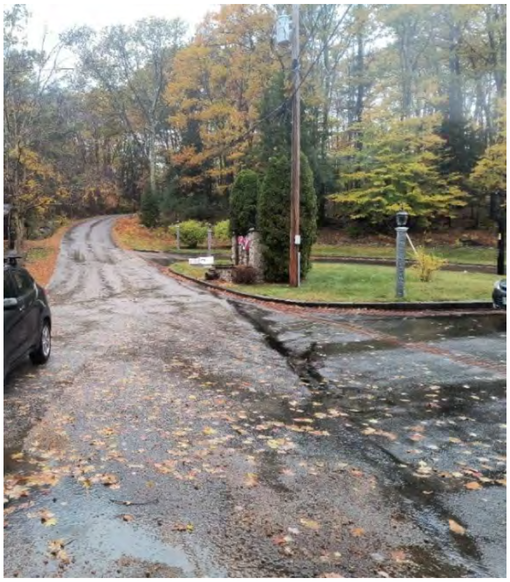
The five highest-priority sites, based on cost-effectiveness, are shown below. In addition, both public and private road managers should apply best practices for installation and maintenance to protect water quality. More details on these and other sites, including pollutant load reductions and cost estimates for all recommended fixes, are summarized in the Watershed Survey Memo (FBE, 2026c) (Appendix A).

## Priority Site #1 DPW-4: Coot Bay Drive

*Location (latitude, longitude): 42.7273, -71.9979*

**Observations:** Coot Bay on the west side of Lake Monomonac has elevated chloride levels from road salt. Coot Bay Drive is a very steep road leading from Wellington Road to the lake. It is a residential road with relatively low traffic and deicing salt applied in the winter. The portion of the road closest to the lake is privately owned, which limits the Town's ability to install stormwater runoff treatment measures and ensure well calibrated salt application along this critical lakeside section of the road. Because the road is steep and largely impervious, it is a priority concern area, as sand, sediment, and road salt are readily washed downhill toward the lake.

**Recommendations:** Contact private property owners at the end of Coot Bay Road and work with them to identify options to treat stormwater and reduce chloride pollution to the lake. Opportunities may include enhancing shoreline buffers or installing compact stormwater control measures. Additionally, coordinate with NHDOT and MassDOT to review their road salting practices in the watershed and ensure they align with their respective states' guidance. The Town of Rindge should also evaluate how salt and sand are applied at the top of the hill on Coot Bay Road, as materials readily travel downslope, and adjust downward where feasible the application rates and timing while still maintaining winter road safety. Consider having Town of Rindge staff participate in Green SnowPro training, which educates and certifies winter maintenance professionals in salt reduction practices which improve water quality while protecting public safety.



*Looking up Coot Bay Drive, where runoff (with high road salt concentrations in winter) flows down the road surface.*

*Water pools in a low point in the road before flowing to the lake through a small, steep wooded area with limited ground cover and minimal pollutant attenuation.*

*Small roadside gully that transitions into a gully (left), leading to a pool of water.*

## Priority Site #2 **M-5: East Monomonac Road**

*Location (latitude, longitude): 42.7129, -71.9918*

**Observations:** A small road shoulder gully runs from 255 East Monomonac Road to a stream crossing that discharges to the lake approximately 200 feet downstream. Some pooling of water was observed on the shoulder. The final part of the gully is a narrow ditch/gutter. The crossing is just south of the MA/NH border. East Monomonac Road is a town owned road of Winchendon, MA.

**Recommendations:** Install riprap in the final part of the gully to capture sediment before it reaches the stream crossing.

*Large erosion gully alongside New Hampshire Route 119. Gully leads to catch basin and stream at the bottom of the hill.*

## Priority Site #3 **B-11: Route 119**

*Location (latitude, longitude): 42.7412, -71.9845*

**Observations**: Large gully runs next to New Hampshire Route 119, flanked by a road shoulder consisting of a large and poorly vegetated slope. The gully travels down-hill to a catch basin, which outlets near a stream.

**Recommendations:** Install riprap and vegetate the gully with salt-tolerant plant species. Road salt can inhibit or kill typical grasses, which may explain the lack of vegetation at this location. Add an infiltration basin before the water reaches the catch basin.

***Note:*** *MLPOA has made progress toward remediating this site by engaging local residents and engineers who have produced a concept design plan for the site. Together, MLPOA and residents have connected with the State of New Hampshire about remediation efforts here.*

*Deep erosion gully that flows into a grassed area along the shoreline of Little Crowcroft Pond with minimal vegetation between the two.*

### Priority Site #4 **B-14: Goddard Road Private Driveway**

*Location (latitude, longitude): 42.7364, -71.9944*

**Observations:** A deep gully has formed downstream of a large, paved driveway on a property with a lush green lawn and lots of impervious surface. The gully has deeply eroded part of the road shoulder and leads into a grassy area towards Little Crowcroft Pond which is a small waterbody that drains to Lake Monomonac. This gully is directly in-line with the paved driveway and is the only gully of its type in the area.

**Recommendations:** Conduct outreach and education to property owners on driveway best management practices. Add a plunge pool to the base of the gully before the water reaches Little Crowcroft Pond, and enhance the buffer in this area. Consider working with the property owner to re-pitch the driveway to re-direct stormwater into a catch basin uphill of the dirt road, combined with a plunge pool or setting basin at the outlet before reaching the lake.

*Large gully on side of road.*

### Priority Site #5 **B-12: Lord Hill Road**

*Location (latitude, longitude): 42.7422, -72.0156*

**Observations:** A moderately large gully runs along the entirety of the hill down the dirt road of Lord Way. There is no established road ditch on this side of the road, so the water runs on the road instead. While multiple turnouts are present upstream, they are slightly clogged and poorly pitched so the water does not flow into them. Additional gullies are located on other portions of the road. The majority of the stormwater outlets into the woods at the bottom of the hill attenuating sediment transport, though stormwater under high flow likely reaches the stream. Lord Hill Road is a town owned road of Rindge, NH.

**Recommendations:** Re-dig turnouts so the water flows into them rather than down the hill and add sandbags to help control flow direction. Install an established plunge pool or infiltration basin at the bottom of the hill.

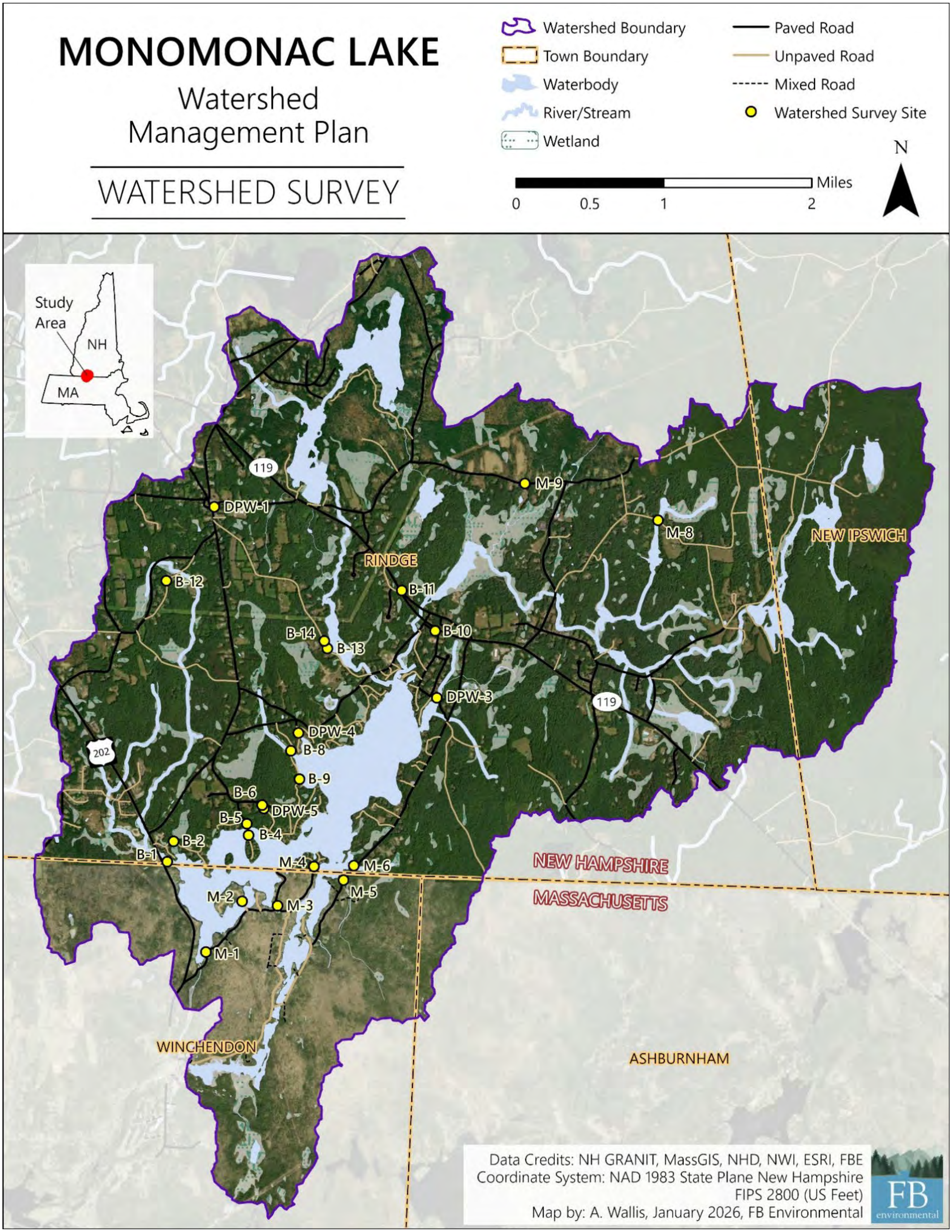
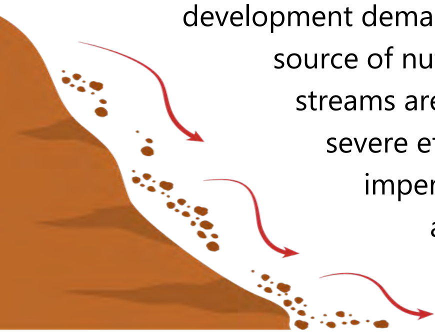



**Figure 19.** Location of identified nonpoint source pollution sites in the Monomonac Lake watershed.

### 3.1.3 Soil and Shoreline Erosion

Erosion can occur when the ground or shoreline is disturbed by digging, construction, plowing, foot or vehicle traffic, or wildlife. Rain and associated runoff are the primary pathways by which eroded soil reaches lakes and streams. Once in surface waters, nutrients are released from the soil particles into the water column, causing excess nutrient loading to surface waters. This is termed cultural eutrophication, where accelerated lake aging is caused by human activities and stressors in the watershed. Since development demand near lakes is high, construction activities in lake watersheds can be a large source of nutrients. Unpaved roads and trails used by motorized vehicles near lakes and streams are especially vulnerable to erosion. Stream bank erosion can also have a rapid and severe effect on lake water quality and can be triggered or worsened by upstream impervious surfaces like buildings, parking lots, and roads, which can send large amounts of high velocity runoff to surface waters. Maintaining natural vegetative buffers around lakes and streams and employing strict erosion and sedimentation controls for construction can minimize these effects.



#### 3.1.3.1 Surficial Geology

The soils and rocks in the area tell a story millions of years in the making. Between 300–400 million years ago, the northeastern U.S. was covered by a shallow sea, leaving sedimentary layers of shale, sandstone, and limestone (Goldthwait, Goldthwait, & Goldthwait, 1951). Over time, the Earth's crust folded under high heat and pressure to change the sedimentary rocks into metamorphic rocks (quartzite, schist, and gneiss parent material). This metamorphic parent material has since been modified by bursts of molten material intrusions to form igneous rock, including granite for which New Hampshire is famous (Goldthwait, Goldthwait, & Goldthwait, 1951). Erosion has further modified and shaped this parent material over the last 200 million years.

The current landscape formed 12,000 years ago at the end of the Great Ice Age, as the mile-thick glacier over half of North America melted and retreated, scouring bedrock and depositing glacial till to create the deeply scoured basin of the region's lakes. The retreating action also eroded mountains and left behind remnants of drumlins and eskers from ancient stream deposits. The glacier deposited a layer of glacial till more than three feet deep. Glacial till is composed of unsorted material, with particle sizes ranging from loose and sandy to compact silts and gravels. This material laid the foundation for vegetation and streams as the depression basins throughout the region began to fill with water (Goldthwait, Goldthwait, & Goldthwait, 1951).

#### 3.1.3.2 Soils and Erosion Hazard

The Monomonac Lake watershed is composed of 35 different soil series (excluding soils beneath waterbodies), with the four most prevalent being the following:

1. Marlow fine sandy loam (18% of watershed area) – this is a well-drained soil formed in glacial till, commonly found on hills and summits and are very deep to bedrock. Rock fragments are dominantly gravel with some cobbles and stones, and range from 5 to 35 percent throughout the solum and up to 40 percent in the substratum.

**2** Tunbridge-Berkshire complex (11%) – this is well-drained soil that formed in glacial till. The soils have a depth to bedrock ranging 20 inches to greater than 60 inches. Rock fragments range from 5 to 35 percent throughout the mineral soil. They are mostly gravel, channers, and cobbles, but the range includes stones.

**3** Monadnock fine sandy loam (11%) – this is a moderately well-drained soil formed in firm, compact, platy glacial till of sandy texture. Soils are often gravelly and cobbly. Monadnock soils occur on hills and mountains and have a depth to bedrock of greater than 60 inches.

**4** Becket-Skerry association (10%) – this association consists of well-drained Becket soils and moderately well-drained Skerry soils. The Becket-Skerry association has a depth to bedrock greater than 60 inches. Rock fragment are dominantly gravel and range from 5 to 30 percent in the solum and from 5 to 40 percent in the substratum. (NRCS, 2024).

All other soil series each compose less than 7% of the watershed area. Sandy loam soils are scattered throughout the watershed and mucky soils tend to be in and around wetlands. The northwest portion of the watershed has large rock outcrop area (Figure 20).

Soil erosion hazard is dependent on a combination of factors, including land slope, weather, soil texture, soil composition, permeability, and soil structure (O'Geen, Elkins, & Lewis, 2006). Soil erosion hazard should be a primary factor in determining the rate and placement of development within a watershed. Soils with negligible soil erosion hazard are primarily low-lying wetland areas near abutting streams. By contrast, steeper slopes tend to have a higher proclivity to erosion.

Soil erosion hazard is identified by four ratings within United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) soils data:

1. **Slight** – erosion is unlikely to occur under standard conditions.
2. **Moderate** – some erosion is likely and erosion-control measures may be required.
3. **Severe** – erosion is very likely and erosion-control measures and revegetation efforts are crucial.
4. **Very Severe** – significant erosion is likely, and control measures may be costly.

Erosion hazard throughout the watershed is 31% slight, 51% moderate, 8% severe, and 2% very severe. The remaining 2% is not rated (Figure 21).

Development should be restricted in areas with severe and very severe erosion hazards due to their inherent tendency to erode at a greater rate than what is considered tolerable soil loss. Since a highly erodible soil can have a greater negative impact on water quality, more effort and investment are required to maintain its stability and function within the landscape, particularly with SCMs that protect steep slopes from development and prevent stormwater runoff from reaching water resources.

#### 3.1.3.3 Shoreline Erosion

Lake levels naturally fluctuate over both short and long timescales due to environmental changes, precipitation patterns, and human activity. Rapid or repeated changes in water level can physically erode shorelines, wash away vegetation, and release nutrients like phosphorus from inundated soils, which can fuel algal blooms and reduce water clarity (Leira & Cantonati, 2008; Zohary & Ostrovsky, 2011). These fluctuations also impact habitat availability for fish, amphibians, and other wildlife, alter nesting locations, and change the distribution of food sources.

Monomonac Lake is particularly vulnerable to shoreline erosion because many homes are close to the water's edge and sit on moderate to steep slopes. The impacts are compounded by human activity such as wake boating, shoreline modification, and storms or droughts that alter water levels rapidly.

The lake is controlled by two dams, the Great Dam (Main Dam) and the emergency/overflow spillway. Operational control of the dams is dictated by an Order of Conditions issued by the Winchendon Conservation Commission with U.S. Army Corps of Engineers concurrence. Renewed every three years, this regulatory framework enforces a strict seasonal water management schedule: drawing the lake down on October 15th and allowing it to refill beginning April 11th (MLPOA, n.d.)

Frequent shoreline disturbance can create a cycle of erosion, where exposed soil leads to more sediment runoff during storms, which then further destabilizes the shoreline. Maintaining or restoring vegetated buffers is critical, as plants stabilize soil, absorb runoff, and trap sediment before it reaches the lake. Other management strategies include minimizing impervious surfaces near the shoreline, constructing stabilized access points for boats, and implementing green infrastructure measures such as swales or rain gardens to capture and slow runoff before it reaches the water. Together, these measures help protect water quality, preserve habitat, and maintain recreational opportunities on the lake.

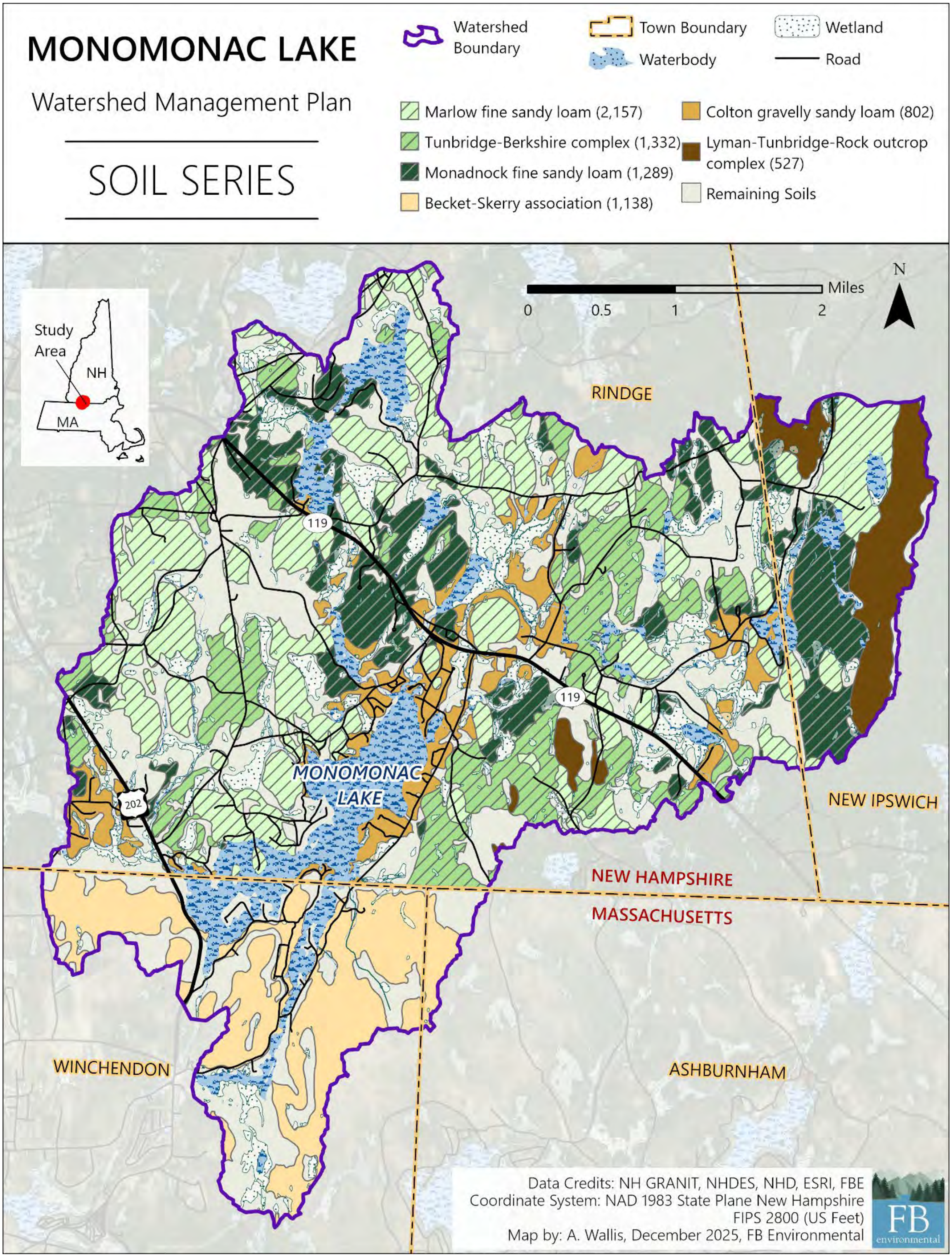



**Figure 20.** Soil series as mapped by the Natural Resources Conservation Service for the Monomonac Lake watershed. Soils covering 500 acres or more of the watershed are identified on the map.

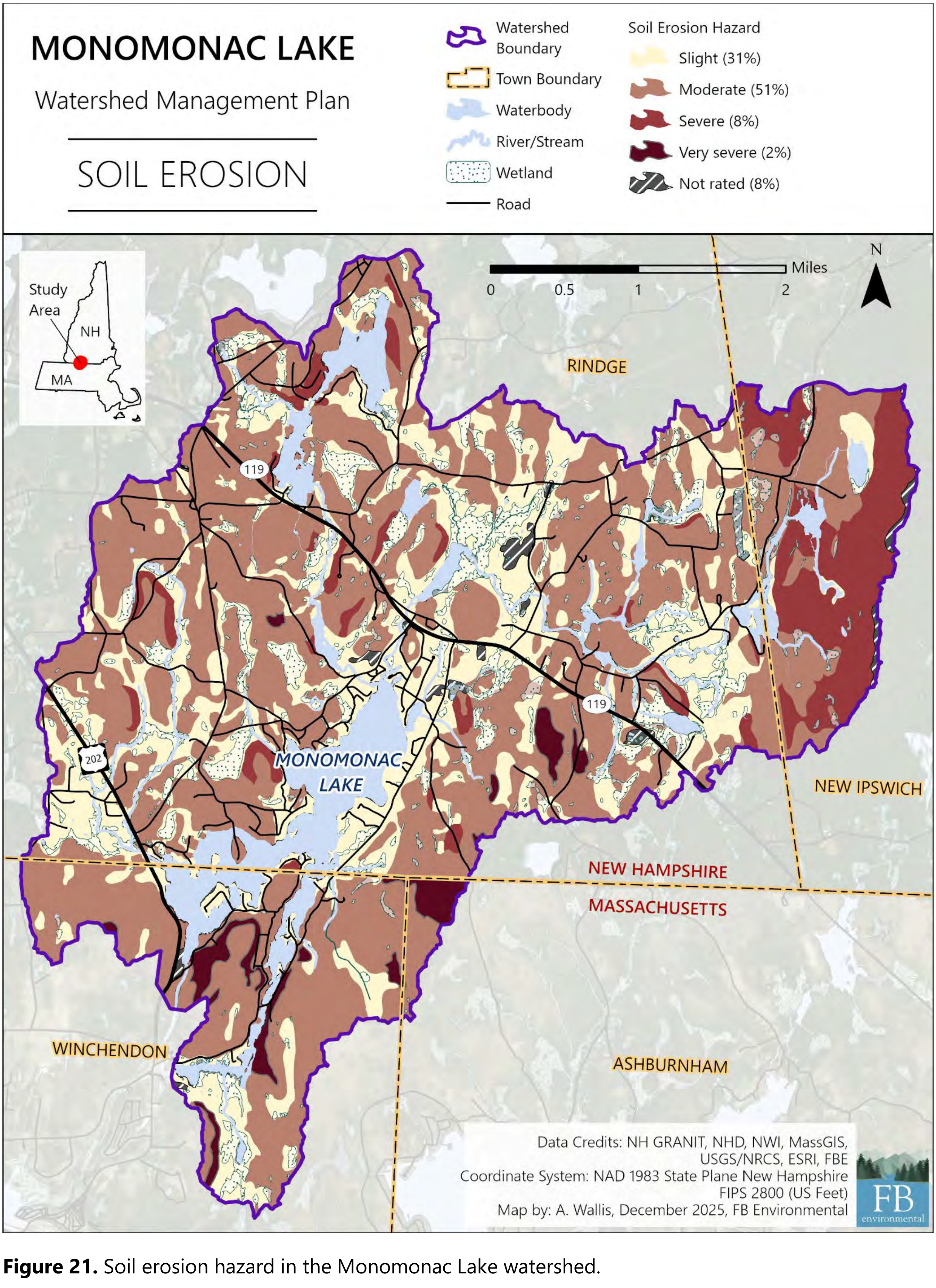
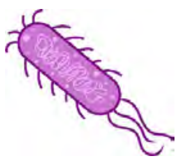



**Figure 21.** Soil erosion hazard in the Monomonac Lake watershed.

### 3.1.4 Septic Systems

All houses in the Monomonac Lake watershed treat wastewater with septic systems. Other homes in the northern, eastern, and western shorelines use septic systems. Septic systems take wastewater from the house, filter out the solids in the septic tank, then discharge the effluent through the leachfield for natural filtration of pollutants such as pathogens, nitrogen, and phosphorus in the soil. When properly designed, installed, operated, and maintained, septic systems reduce pollutants to varying degrees of effectiveness.



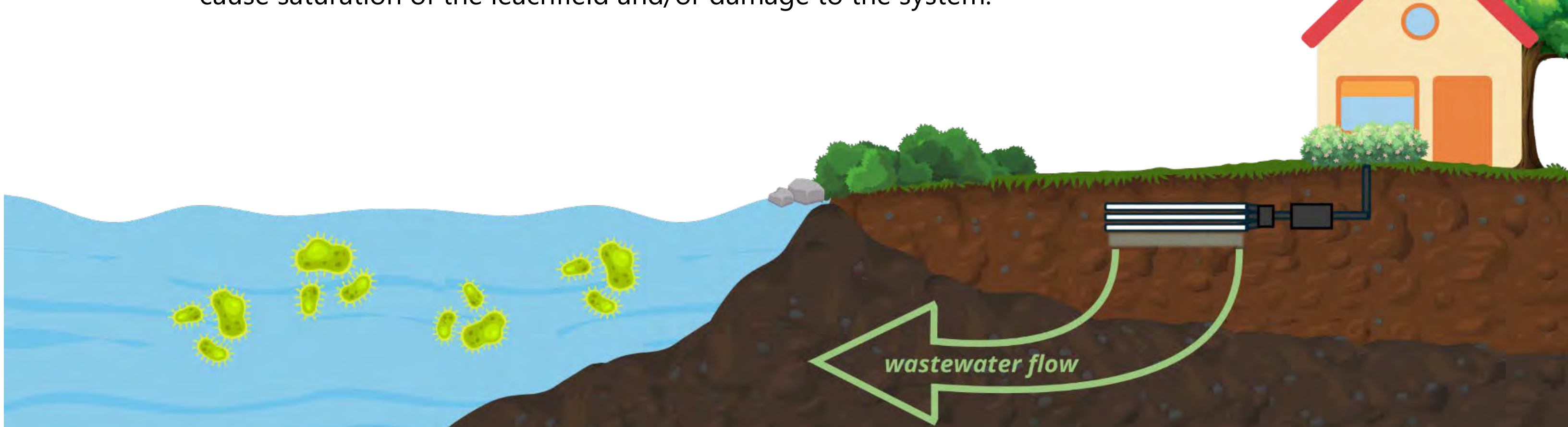
**Pathogens** in wastewater include bacteria, viruses, protozoa, and parasites. Their presence is most often determined by measuring fecal indicator bacteria (*Enterococcus* or *E. coli*), though viruses and other types of bacteria can persist for longer in soil. Pathogens are treated in the leachfield primarily through adsorption to soil particles; poor pathogen treatment can occur in systems which are shallow to groundwater or coarse soils with preferential flow pathways such as macropores or fractured bedrock.


**Nitrogen** in wastewater can be removed into gaseous form through denitrification. Native soils beneath the leachfield are not effective at removing nitrogen (typically <40% removal), though additional denitrification can occur in groundwater, especially if anoxic conditions exist. Advanced septic systems technologies exist to remove nitrogen before wastewater enters the leachfield.


**Phosphorus** in wastewater can be almost entirely retained (>90% removal) in suitable soil conditions by adsorbing to soil particles or forming solid compounds with iron, aluminum, and calcium. Retention can be poor in systems shallow to groundwater or bedrock, soils with preferential flow pathways such as fractured bedrock, and high alkalinity soils low in iron and aluminum.

**Failing or malfunctioning septic systems can release pollutants directly into surface waters.** When a septic system fails, it may break out onto the leachfield surface (ponding), which can run off the property via a flow channel or during storms. Septic system failure can occur in several ways.

- **Old age** can cause the biomat, a layer of organic material that forms beneath the leach field, to become too thick and block flow, which then causes wastewater to pond on the surface.
- **Poor maintenance** can lead to clogging and system back up.
- **Overloading the system** can overwhelm the soils or cause quick biomat development.
- **Extreme storm or flooding events and sea level and groundwater rise** can cause saturation of the leachfield and/or damage to the system.



Regular septic tank pumping is essential for maintaining system functionality and protecting the surrounding environment. Components like distribution boxes and lateral lines should also be regularly inspected and maintained as needed. Over time, solid waste accumulates, increasing the risk of blockages, backups, and system failure. Sludge and scum buildup can hinder waste breakdown, leading to odors and potential contamination of soil and groundwater. Distribution boxes may clog or become unlevel, causing localized overloading of the leach field. Routine maintenance helps prevent costly repairs, extends system lifespan, and ensures effective wastewater management while safeguarding public health and the environment.

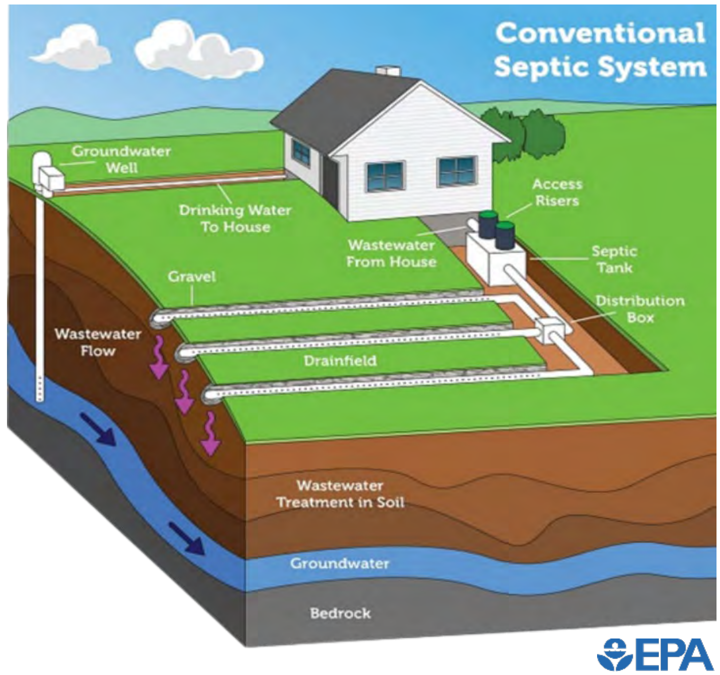



*Diagram of a septic system and the wastewater flow through the ground to reach surface waters.*

In Massachusetts, the design and installation of septic systems are regulated by Title 5 of the Massachusetts State Environmental Code. Title 5 was overhauled in 1995 which required inspections for all septic systems at the time of property transfer. These inspections are used to identify and replace failing septic systems; the inspection must occur within two years of property transfer. The seller is responsible for providing proof of this inspection before closing. Per the state's regulations, septic systems must have a four-foot vertical separation distance between the bottom of the disposal field and the seasonal high water table, which marks the shallowest level groundwater reaches each year. If soils are particularly quick to drain, a five-foot separation is required.

In 2024, New Hampshire's RSA 485 A:39 was updated to change the requirements for septic systems assessments during real estate transactions of waterfront properties. This change went into effect on September 1, 2024, and shifts the responsibility of septic inspection from the sellers to the buyers. If any part of the septic system lies within 250 feet of lakes, ponds greater than ten acres, coastal waters, or major rivers, the buyer must ensure a septic system inspection is complete prior to property transfer. The change was introduced in response to increasing cyanobacteria outbreaks in the state, with the goal of reducing phosphorus runoff from failing systems. If a septic system is deemed to be failing, it must be repaired or replaced within 180 days of the property transfer, with costs negotiated between the buyer and seller. New Hampshire's septic system design standards require a two-foot vertical separation distance. The vertical separation distance can in-part dictate the percentage of phosphorus that is retained in the soils beneath each septic system (Karathanasis et al., 2006), with one meter (roughly 39 inches) being recommended for optimal phosphorus retention (Baer et al., 2019).

There is currently no mandated septic system inspection or pumping requirement within the Monomonac Lake watershed aside from those required at the time of property transfer. For more information, see Section 4.2.2, Table 14. FBE gathered information on septic system practices from 433 properties within 250 feet of the shoreline of Monomonac Lake by using the NHDES Subsurface Application Status Query and by scanning records in-person at the Winchendon Board of Health. Additional records from Goddard Road and Wellington Road were also compiled at the request of MLPOA. FBE also hosted a questionnaire to supplement the information from the records search that included information about type of system, age of system, maintenance frequency, property use (year-round or seasonal), number of occupants, and distance to the waterbody.

Based on the records search and survey, an estimated 67% of septic systems within 250-feet of the Monomonac Lake shoreline are older than 25 years old. Pumping and inspection records were only available for properties in Massachusetts, which revealed that many properties are pumped annually and many older systems have been inspected in the past ten years due to Title 5 inspection requirements. Ninety-seven (97) septic systems in Winchendon have inspection reports on record, with fifty (50) of these occurring within the past ten years. Site specific soil data from each permitted system were not explicitly recorded as part of this WMP. However, FBE's observations while scanning records and conversations with Town of Winchendon staff suggest that the soils around the Monomonac Lake shoreline are gravelly and rocky, which can pose a phosphorus loading concern for septic systems. Coarse-textured or rocky soils provide fewer sites for phosphorus to be adsorbed to and can provide preferential flow pathways that allow septic system effluent to circumvent treatment as it percolates downward. Ensuring there is an adequate vertical separation distance of at least one meter and/or using septic system designs that utilize upper soil horizons can increase phosphorus retention at these particularly vulnerable locations.

Of the 491 properties within 250 feet of the lake with septic systems, 87 septic surveys were completed, resulting in a 18% survey success rate. Results indicated that 41% of respondents are concerned about the impact of septic systems on water quality. Similarly, 38% of respondents are concerned about the removal of shoreline vegetation and trees, 37% are concerned about fertilizers and lawn care, 28% are concerned about boating impacts, and 9% are concerned about stormwater runoff. Percentages added up to greater than 100% because respondents were concerned about multiple pollutant sources.

### 3.1.5 Fertilizers

When lawn and garden fertilizers are applied in excessive amounts, in the wrong season, or just before heavy precipitation, they can be transported by rain or snowmelt runoff to lakes and other surface waters where they can promote cultural eutrophication and impair the recreational and aquatic life uses of the waterbody. Many states and local communities are beginning to set restrictions on the use of fertilizers by prohibiting their use altogether or requiring soil tests to demonstrate a need for any phosphate application to lawns.

### 3.1.6 Pets

Fecal matter from pets can be a significant contributor of bacteria and nutrients to surface waters.


**Dogs** are estimated to produce 200 grams of feces per day each, which contain concentrated amounts of bacteria estimated at 4.6 billion fecal coliform bacteria (Van der Wel, 1995). Phosphorus comprises an estimated 3.2% of dog waste by weight.


**Cats** can also contaminate surface waters. A 2007 study detected cat-sourced *E. coli* in stormwater (Ram, et al., 2007). Phosphorus comprises an estimated 2.0% of cat waste by weight.

If pet feces are not properly disposed of (e.g., dog waste left outside or cat litter dumped outside), these bacteria and nutrients can be washed off the land and transported to surface waters by stormwater runoff. Pet feces can also enter surface waters by direct deposition of fecal matter from pets standing or swimming in surface waters.

### 3.1.7 Agriculture


Stormwater runoff can pick up farm animal waste from sources such as manure, silage storage facilities, livestock grazing, and barnyard areas and carry bacteria and nutrients to waterways. Farm activities like plowing, livestock grazing, vegetation clearing, and vehicle traffic can also result in soil erosion and associated nutrient pollution through direct or indirect contact with surface waters.

Excessive or ill-timed fertilizer application or poor storage increases the potential for these nutrients and bacteria to wash away with precipitation, reducing both water quality and crop benefits. The key to fertilizer application is to apply the right type and amount at the right time. When used appropriately, synthetic fertilizers or animal manure can fertilize crops, restore nutrients to the land, and minimize pollution. When improperly managed, pollutants can easily enter waterways. See Section 4.2.7 for management strategies.

Agriculture in the Monomonac Lake watershed primarily includes cropland, hayfields, and grazing areas. The LLRM results showed that agriculture covers 2% of the watershed and contributes 13% of the total phosphorus load to Monomonac Lake (Figure 10).

### 3.1.8 Future Development

Understanding population growth, and ultimately development patterns, provides critical insight into watershed management, particularly as it pertains to lake water quality. The population in Rindge and New Ipswich, NH and Winchendon, MA has increased by an estimated 11,431 residents in total from 1970 to 2020 (Figure 22). It is important to note that many shoreline properties are occupied seasonally.

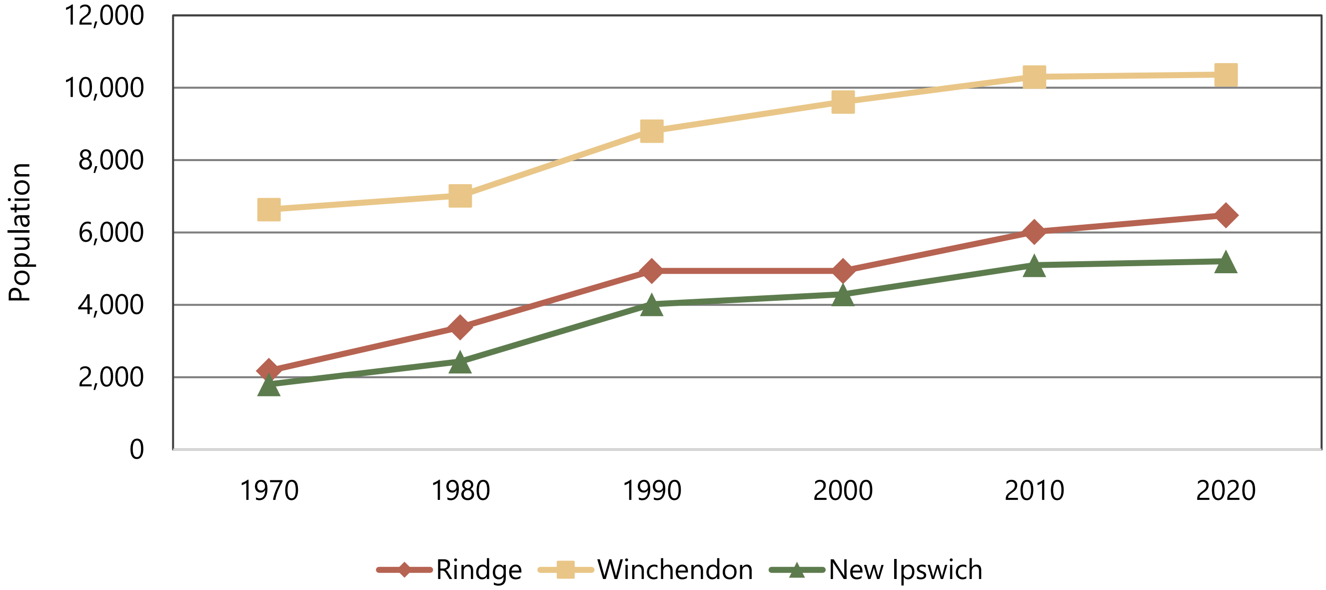



**Figure 22.** Population of Ringe and New Ipswich, NH and Winchendon, MA. Data from the U.S. Census Bureau.

Monomonac Lake has long been treasured as a recreational haven for both summer vacationers and year-round residents. The area offers fishing, hiking, boating, canoeing, kayaking, and swimming in the summer, and ice fishing, cross-country skiing, snowshoeing, and snowmobiling in the winter. According to the MLPOA, more and more homes are being converted from seasonal use to year-round use, which often entails increasing the building footprint size, impervious surfaces, and wastewater loading capacity. Growth figures and estimates suggest that towns should continue to consider the effects of current municipal land-use regulations, particularly impervious cover limits, on local water resources. As the region's watersheds are developed, erosion from disturbed areas and runoff from impervious surfaces increases the potential for water quality to decline.

## 3.2 POTENTIAL CONTAMINATION SOURCES

Point source pollution can be traced back to a specific source such as a discharge pipe from an industrial facility, municipal wastewater treatment plant, or a permitted stormwater outfall, making this type of pollution relatively easy to identify. Section 402 of the Clean Water Act requires all such discharges to be regulated under the National Pollutant Discharge Elimination System program to control the type and quantity of pollutants discharged. National Pollutant Discharge Elimination System is the national program for regulating point sources through issuance of permit limitations specifying monitoring, reporting, and other requirements under Sections 307, 318, 402, and 405 of the Clean Water Act.

NHDES operates and maintains the OneStop database and data mapper, which house data on potential contamination sources within the State of New Hampshire. Identifying the types and locations of potential contamination sources within the watershed may help identify sources of pollution and areas to target for restoration efforts.

Massachusetts operates and maintains the MassDEP Solid Waste Disposal and Diversion GIS data layer; however, no potential contamination sources identified in the watershed through these data.

Potential point sources in the watershed include above and underground storage tanks, solid waste facilities, hazardous waste sites, automobile salvage yards, remediation sites, and other local potential contamination sources (Figure 23).

### 3.2.1 Above and Underground Storage Tanks

Above and underground storage tanks include permitted containers with oil and hazardous substances such as motor fuels, heating oils, lubricating oils, and other petroleum and petroleum-contaminated liquids. There is one aboveground storage tank within the New Hampshire portion of the Monomonac Lake watershed. The one tank in Rindge, NH is owned by the Roy Brothers Oil Co., Inc. There are 14 underground storage tanks within the New Hampshire portion of the watershed. The tanks are scattered throughout the watershed and are mostly owned for commercial purposes such as gas stations or marinas. Ownership of these tanks includes commercial industries, gas stations, construction companies, schools, and local government.

### 3.2.2 Solid Waste Facilities

There are three solid waste facilities within the New Hampshire portion of the watershed. The only operational facility is the Rindge Transfer Station which is located on Route 119. The other two facilities are closed, including the Rindge Recycling Center and the East Rindge Landfill which is unlined.

### 3.2.3 Hazardous Waste Sites

Hazardous waste generating facilities are identified through the EPA's Resource Conservation and Recovery Act and require federal or state regulation. There are two hazardous waste generating facilities in the watershed, both of which are listed as inactive.

### 3.2.4 Local Potential Contamination Sources

Local potential contamination sources are sites that may represent a hazard to drinking water quality supplies due to the use, handling, or storage of hazardous substances. There may be overlap between local potential contamination sources and other potential contamination sources identified in this section. Of the four local potential contamination sources within the New Hampshire portion of the watershed, all are in Rindge.

### 3.2.5 Automobile Salvage Yards

The NHDES Automobile Salvage Yards dataset tracks municipally licensed motor vehicle salvage and scrap recycling facilities statewide. There are two automobile salvage yards in the New Hampshire portion of the watershed. These yards can contribute to polluted runoff that contains gas, oils, or other chemicals associated with vehicle repair and maintenance. The automobile salvage yards are both active.

### 3.2.6 Remediation Sites

The 31 remediation sites present within the New Hampshire portion of the watershed include sites with hazardous waste, non-hazardous and non-sanitary holding tanks, initial spill response sites, dump sites, formerly leaking residential or commercial heating tanks, leaking motor oil tanks, underground injection control of wastewaters not requiring a groundwater discharge permit,  water treatment works, and an old plane crash site.

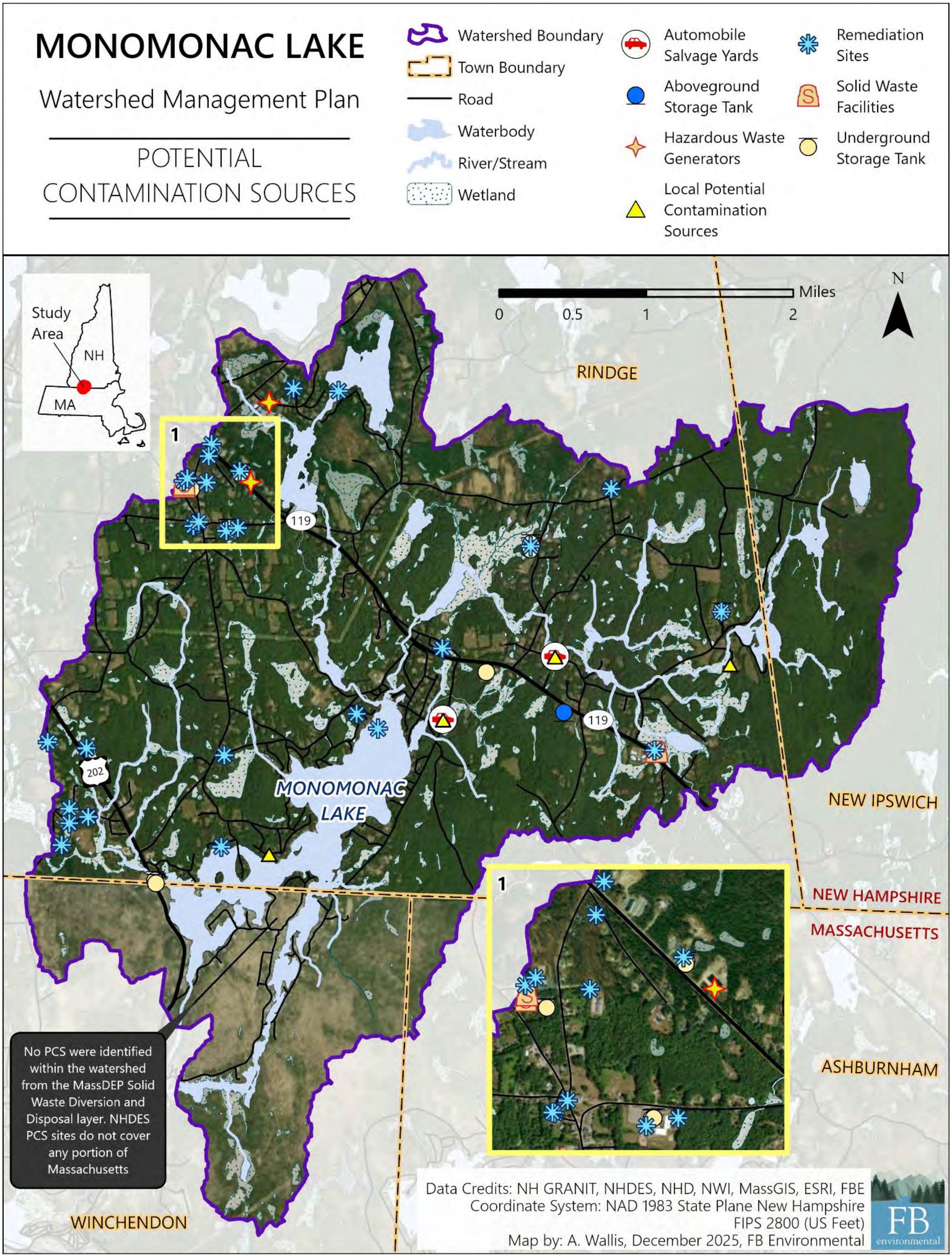



**Figure 23.** Potential contamination sources in the Monomonac Lake watershed.

## 3.3 WILDLIFE

Fecal matter from wildlife such as geese, gulls, ducks, and beaver may be a significant source of nutrients in some watersheds. This is particularly true when human activities, including the direct and indirect feeding of wildlife and habitat modification, result in the congregation of wildlife (CWP, 1999).


Geese, gulls, and ducks are of particular concern because they often deposit feces near or directly into surface waters. High-risk areas include large, mowed fields and parking lots adjacent to lakes and streams, as well as the undersides of bridges with pipes or joists that attract pigeons and other birds.

Studies show that geese inhabiting riparian areas increase soil nitrogen availability (Choi, et al., 2020). When submerged in water, the droppings from geese and gulls quickly release nitrogen and phosphorus into the water column, contributing to eutrophication in freshwater ecosystems (Mariash, Rautio, Mallory, & Smith, 2019).

Similarly, beaver impoundments can increase concentrations of nitrogen, ammonia, and dissolved organic carbon downstream compared to streams without beaver activity in New England (Bledzki, Bubier, Moulton, & Kyker-Snowman, 2010). The LLRM estimates that waterfowl are likely contributing 16.1 kg/yr or 2% of the total phosphorus load to Monomonac Lake.

# 3.4 REGIONAL TEMPERATURE AND PRECIPITATION TRENDS

Over the last century, New England's air temperature has risen faster than the rest of the continental U.S., making it one of the fastest warming regions in the world (Karmalkar & Horton, 2021). Comparing the period of 1900–1904 to 2020–2024, New England's mean annual temperature rose by 2.5°C, with an even more pronounced increase of 4.1°C during the winter months (Young & Young, 2025). The IPCC (2021) projects with high confidence that these temperature trends will continue through the end of the century, fundamentally changing New England's hydrologic processes (Scholl, McCabe, Olson, & Powlen, 2025).

***Changes in Ice and Snow Dynamics***

Rising winter temperatures are significantly shortening the "ice-in" duration for New England lakes. Compared to the 1800s, lakes are freezing later and thawing earlier as a warming atmosphere accelerates snowpack and ice melt (Scholl, McCabe, Olson, & Powlen, 2025). This earlier "ice-out" date extends the biological growing season, which can increase the duration of anoxia in bottom waters. Figure 24 displays ice-out dates for Monomonac Lake from 2004-2022 (with data gaps in 2007 and 2012-2014). The data show a trend towards earlier ice-out dates. Additionally, Hill et al. (2014) projected U.S. stream temperatures to rise by 0.6°C (±0.3°C) per 1°C increase in local air temperature, although the exact increase depends on cool groundwater influence, the presence of impoundments, stream flow, and level of urbanization (Letcher, et al., 2016). Warmer streams will experience reduced dissolved oxygen levels and increased biological activity.

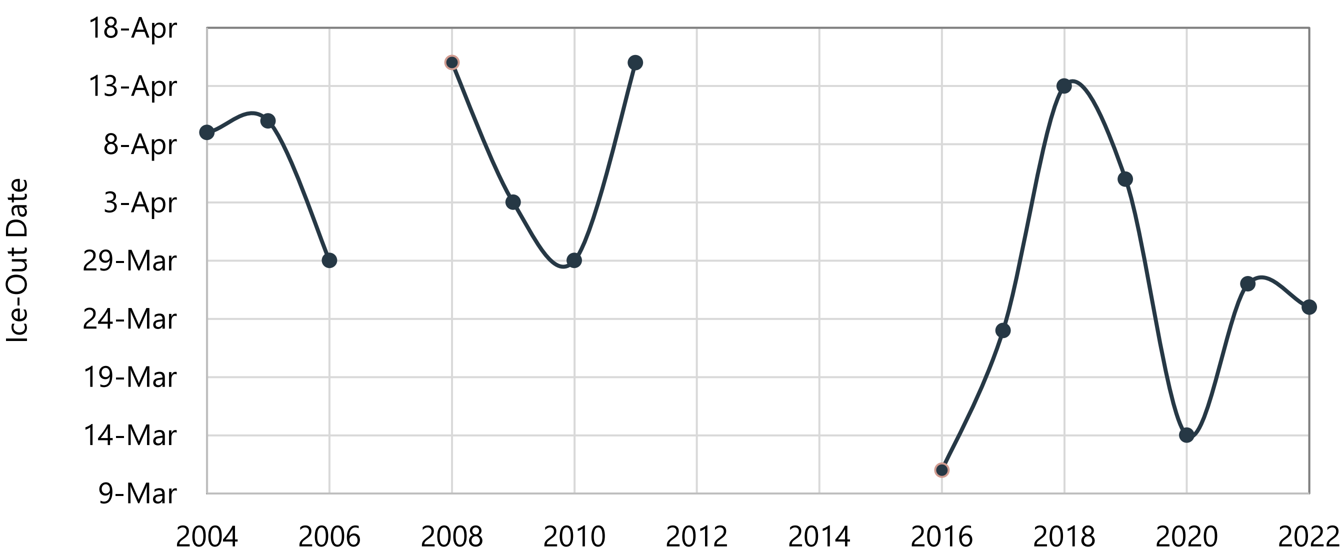
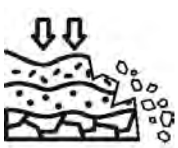



**Figure 24.** Ice-out dates for Monomonac Lake from 2004-2022.

Snow cover is also in sharp decline. When comparing 2000–2004 to 2020–2024, snow cover days decreased by 30–40% in southern New England and by 10–15% in northern New England (Young & Young, 2025). Along with higher winter air temperatures, reductions in snow cover are also driven by a shift in winter precipitation, with more moisture falling as rain rather than snow (IPCC, 2021; Scholl, McCabe, Olson, & Powlen, 2025). Research indicates a 20-day increase over the past century in winter days with bare ground and above-freezing daytime temperatures (Contosta, et al., 2019). Timber harvesting and heavy equipment operations frequently rely on frozen ground to protect vegetation, roots, and wet soils from compaction and erosion (Rittenhouse & Rissman, 2015; Toot, et al., 2025). Conducting logging operations during these warm intervals can damage soil structure and root systems, leaving them highly vulnerable to erosion during the spring thaw and snowmelt.

An additional consequence of this warming is the increased frequency of rain-on-snow events. Data from the Mount Washington Observatory (2023) and recent observations across New Hampshire (Aldrich, 2025) indicate a statistically significant increase in rain-on-snow days. These events destabilize and weaken the snowpack, leading to earlier melting. For forested watersheds in New England, this loss of snowpack creates the following two primary watershed management concerns.



*Soil Erosion and Compaction*
A thick snowpack acts as a buffer to impacts from winter logging operations. Reduced snow cover combined with partially thawed soils leads to an increased risk of soil compaction and erosion from heavy machinery and log skidding (Toot, et al., 2025).

*Forest Health*
Without the insulating effect of snow, soils are subject to deeper freezing, which damages root systems. Experiments at Hubbard Brook Experimental Forest in New Hampshire show a 40% decline in the weight of living sugar maple trees following reduced snowpack treatments, with projections suggesting sugar maple canopy cover could decline by up to 95% by 2099 under high-emissions scenarios (Reinmann, Susser, Demaria, & Templer, 2019).

***Precipitation and Streamflow Extremes***

The Northeast has experienced a consistent rise in annual precipitation since 1960, a trend the IPCC (2021) predicts with very high confidence will continue. Most notably, the number of extreme precipitation events has increased by 60% since the 1950s in the Northeast (USGCRP, 2023), the regions with the greatest increase in the nation. The combination of more intense rainfall and earlier snowmelt has shifted regional hydrology toward earlier peak flows and increased river flood discharge volumes and frequencies (IPCC, 2021; Scholl, McCabe, Olson, & Powlen, 2025). Increasing storm frequencies will flush more nutrients to surface waters, which may trigger algal blooms under warmer air temperatures. These weather trends, along with increased land development throughout the region, will continue to impact water quality in New England over the coming decades.

# 4 MANAGEMENT STRATEGIES

The following section details management strategies for achieving the water quality goal and objectives using a combination of structural and non-structural restoration techniques, as well as outreach and education and an adaptive management approach. A key component of these strategies is the idea that existing and future development can be remediated or conducted in a manner that sustains environmental values. All stakeholder groups have the capacity to be responsible watershed stewards, including citizens, businesses, the government, and others. Specific action items are provided in the action plan (Section 5).

## 4.1 STRUCTURAL NONPOINT SOURCE RESTORATION

Structural nonpoint source restoration techniques are engineered infrastructure designed to intercept stormwater runoff, often allowing it to soak into the ground, be taken up by plants, harvested for reuse, or released slowly over time to minimize flooding and downstream erosion. These SCMs often incorporate some mechanism for pollutant removal, such as sediment settling basins, oil separators, filtration, or microbial breakdown. They can also consist of removing or disconnecting impervious surfaces, which in turn reduces the volume of polluted runoff generated, minimizing adverse impacts to receiving waters.

### 4.1.1 Watershed and Shoreline Stormwater Control Measures

A total of 21 sites from the watershed survey and 99 high/medium impact rated shoreline properties from the shoreline survey were documented to have some impact on water quality through the delivery of phosphorus-laden sediment (refer to Section 3.1.1-3.1.2). As such, structural SCMs to reduce the external watershed phosphorus load are a necessary and important component for the protection of water quality in the watershed.

The following series of SCM implementation action items are recommended for achieving Objective 1:

- Provide technical assistance and/or implementation cost sharing to 23 high impact shoreline properties identified during the shoreline survey. Encourage landowners to implement SCMs on the 76 medium impact shoreline properties identified during the shoreline survey. Workshops and tours of demonstration sites can help encourage landowners to utilize SCMs on their own property. Conduct regular shoreline surveys to continue prioritizing properties for technical follow-up. Improving shoreline practices on these properties has the potential to reduce total phosphorus load to the lake by 35.3 kg/yr.

- Implement SCMs for the 21 sites identified during the watershed survey. These SCM sites have the potential to reduce total phosphorus load to the lake by 4.4 kg/yr.

For the proper installation of structural SCMs in the watershed, the MLPOA, WSLA, and other stakeholders should work with experienced professionals on sites that require a high level of technical knowledge (engineering). Whenever possible, pollutant load reductions should be estimated for each SCM installed. More specific and additional recommendations are included in Section 5. For helpful tips on implementing SCMs, see Additional Resources.

## 4.2 NON-STRUCTURAL NONPOINT SOURCE RESTORATION

Non-structural nonpoint source restoration techniques refer to a broad range of behavioral practices, activities, and operational measures that contribute to pollutant prevention and reduction. The following section highlights important restoration techniques for several key areas, including pollutant reduction best practices, zoning and ordinance updates, land conservation, septic system regulation, sanitary sewer system inspections, fertilizer use prohibition, agricultural practices, pet waste management, and nuisance wildlife controls.

### 4.2.1 Pollutant Reduction Best Practices


Pollutant reduction best practices include recommendations and strategies for improving road management and municipal operations for the protection of water quality. Following standard best practices for road maintenance and drainage management protects both infrastructure and water quality through the reduction of sediment and other pollutant transport. Refer to the *New Hampshire Stormwater Manual* (UNH Stormwater Center, Comprehensive Environmental Inc., & NH Department of Environmental Services, 2025) and the Massachusetts Stormwater Handbook for standard road design and maintenance best practices.

Winchendon, MA is an MS4 (Municipal Separate Storm Sewer System) regulated community and is subject to regulation under the Clean Water Act's NPDES program. MS4s are publicly owned stormwater drainage systems, including roads, storm drains, and ditches, that discharge stormwater directly into surface waters such as rivers, lakes, and oceans. The regulated MS4 area for Winchendon does not cover any area within the Monomonac Lake watershed; the MS4 area begins at the outlet of Whites Mill Pond and covers much of downtown Winchendon near the intersections of Routes 202, 140, and 12.

A community becomes regulated as an MS4 if it is either defined by the U.S. Census as an urbanized area (based on population density) or if the town is designated by the U.S. EPA or state as an MS4 based on water quality needs or potential impacts of stormwater discharges on local water bodies.

Regulated MS4 communities must develop and implement stormwater management programs that reduce pollution from stormwater runoff to protect water quality. These regulations provide excellent guidance for water quality protection and are outlined by the MassDEP's MS4 General Permit.

The Town of Winchendon has been regulated with MS4 since 2018. The following are management practices taken by the Town of Winchendon to support healthy water quality, including the reduction of bacteria pollution, through the MS4 program:

- Stormwater Management Plan (2025).
- Education and outreach focused on proper grass care, fertilizer use, and alternative landscaping, linked on their MS4 Public Education webpage.
- Training of municipal employees in best practices and stormwater control measures.
- Inspection and enforcement program for erosion and sediment control for active construction sites (developed standards).
- Post-construction ordinance, street design and parking lot guidance report, and green infrastructure report.
- Nitrogen source identification study and planning for structural SCMs that remove nitrogen.
- Tracking, mapping, and investigating stormwater infrastructure.
- Annual street sweeping and ditch, culvert, storm drain, and catch basin cleaning and repair.
- Stormwater Pollution Prevention Plan.
- Illicit Discharge Detection and Elimination program, including dry weather outfall sampling.

Even though none of the New Hampshire watershed towns are required to comply with the six minimum control measures under the New Hampshire Small Municipal Separate Storm Sewer Systems (MS4) General Permit, each town could consider instituting the permit's key measures, such as street sweeping, catch basin cleaning, and road/ditch maintenance, if not already in place. Research and recommendations on street sweeping to reduce water pollution have been recently developed for New Hampshire (PREP & UNHSC, 2022). The MS4 permit also covers illicit discharge detection and elimination plans (and ordinance inclusion), source control and pollution/spill prevention protocols, and education/outreach and training for residents, municipal staff, and stormwater operators, all of which are aimed at minimizing polluted runoff to surface waters.

#### 4.2.2 Septic System Regulation

When properly designed, installed, operated, and maintained, septic systems can treat residential wastewater and reduce the impact of excess pollutants in ground and surface waters. It is important to note, however, that traditional septic systems are designed for pathogen removal from wastewater and not specifically for other pollutants such as nutrients. The phosphorus in wastewater is "removed" only by binding with soil particles or being recycled through plant growth but is not removed entirely from the watershed system. Achieving nutrient removal may require advanced or alternative septic systems, which are more expensive than conventional systems. These systems can reduce nitrogen and phosphorus inputs to surface waters significantly, but cost considerations should be factored into any overlay district requirements or incentive programs. Proper design, installation, operation, maintenance, and replacement considerations include the following:

A. Proper **design** includes adequate evaluation of soil conditions, seasonal high groundwater or impermeable materials, proximity of sensitive resources (e.g., drinking water wells, surface waters, wetlands, etc.).

B. Proper siting and **installation** mean that the system is installed in conformance with the approved design and siting requirements (e.g., setbacks from waterways).

C. Proper **operation** includes how the property owner uses the system. While most systems excel at treating normal domestic sewage, disposing of some materials, such as toxic chemicals, paints, personal hygiene products, oils and grease in large volumes, and garbage, can adversely affect the function and design life of the system, resulting in treatment failure and potential health threats; proper operation also includes how the property owner protects the system. For example, allowing vegetation with extensive roots to grow above the system can result in clogs, and driving large vehicles over the system may crush or compact piping or leaching structures.

D. Proper **maintenance** means having the septic tank pumped at regular intervals to eliminate accumulations of solids and grease in the tank. It may also mean regular cleaning of effluent filters, if installed. The frequency of septic pumping depends on the use and total volume entering the system. A typical three-bedroom, 1,000-gallon tank should be pumped every three to four years.

E. Proper **replacement** of failed systems may include programs or regulations to encourage upgrades of conventional systems (or cesspools and holding tanks) to more innovative alternative technologies.

Management strategies for reducing water quality impacts from septic systems (as well as cesspools and holding tanks) start with education and outreach to property owners so that they are better informed and able to properly operate and maintain their systems. Outreach may be targeted at encouraging homeowners to get their system inspected or pumped if the system is older or lacks inspection records. Systems not passing inspection should be repaired or replaced. Other management strategies include setting local regulations to enforce proper maintenance and inspection of septic systems and establishing funding mechanisms to support replacement of failing systems (with priority for cesspools and holding tanks). Future efforts may include targeting specific systems on coarse, gravelly soils for replacement, though this would require additional planning and data collection from septic system designs. These systems are more likely to provide inadequate phosphorus retention. Remediation may include moving the system location to finer-textured soils that are deep to bedrock and lack gravel or cobbles. Certain septic system designs utilize upper soil layers that can provide additional treatment in the soil. Specifically targeting systems on these coarse or shallow to bedrock soils may reduce phosphorus loading to Monomonac Lake even if no evidence of failure is present from the surface.

As an alternative to individual onsite systems, community septic systems have been implemented in other lakefront settings to reduce nutrient loading and improve long-term maintenance reliability. Under this approach, multiple homes are served by a shared treatment and leachfield system rather than individual septic systems. A key advantage is that system operation and maintenance are managed by a designated entity, such as a homeowner’s association or municipal body, reducing the risk of system neglect or failure by individual property owners. If properly designed, sited, and maintained, community septic systems can improve treatment performance and reduce phosphorus loading to surface waters. However, siting considerations remain critical and should ensure adequate phosphorus attenuation by maximizing separation from the shoreline, prioritizing soils with strong structure and higher iron and aluminum content and potentially incorporating raised or engineered soil treatment areas.

### 4.2.3 Zoning and Ordinance Updates

Regulations through municipal zoning and ordinances such as low impact development strategies that prevent polluted runoff associated with new and re-development projects in the watershed are equally important as implementing structural SCMs on existing development. In fact, local land use planning and zoning ordinances can be the most critical components of watershed protection. FBE completed an ordinance review of natural resource protections for the towns of Rindge, NH and Winchendon, MA (Table 14). These municipalities were prioritized because they comprise the majority of the Monomonac Lake watershed and therefore play a critical role in influencing land use, shoreline development, and water quality conditions within the lake. These municipalities have incorporated several important regulations into their local ordinances, including wetlands protections, floodplain regulations, setback requirements, and SCMs, though the level of detail, consistency, and enforcement mechanisms vary between the communities. A more robust review of these ordinances is encouraged to develop more specific recommendations for improving regulations related to natural resource protection. In addition, the municipalities should also consider the staffing capacity and administrative support necessary to effectively enforce both existing and proposed regulations.

**Table 14.** Ordinance review of regulatory and non-regulatory tools for natural resource protection in the towns of Rindge, NH and Winchendon, MA.

## Regulatory Tools

| Strategy | Rindge | Winchendon |
|---|---|---|
| **Zoning districts addressing environmental protection** | **Existing:** The Gateway Central District is to "preserve valuable historical, cultural, and natural features within the District and to minimize adverse environmental impacts on water and air quality and scenic vistas and the effect of light and noise pollution.<br>**Recommendation:** Establish a "Lake and Wetland Conservation Overlay District" in Rindge to apply stricter development standards around key waterbodies. This could include larger setbacks, limits on non-residential uses, enhanced stormwater controls, and stricter septic requirements, offering protections beyond existing zoning and state shoreland rules. | **Existing:** Wetlands Conservancy, Floodplain Conservancy, and Groundwater Protection Overlay Districts, each providing protections related to water quality, flood resilience, and groundwater safety. The Lake Monomonac Overlay District, while not primarily for environmental protection, was created to address the unique constraints of undersized parcels near the lake. It allows reasonable property use while aligning with MGL c. 131 §40 and the Massachusetts State Building Code; setbacks follow R10 zoning standards despite parcels being in the R40 zone.<br>**Recommendation:** Consider expanding impervious surface limits town-wide, requiring green infrastructure (e.g., rain gardens, permeable pavement) in new development, and enhancing buffer requirements around all waterbodies. Additionally, require regular maintenance plans for stormwater systems and incentivize low-impact development practices. |
| **Shoreland zoning** | **Existing:** Wetlands Conservation District includes all wetlands and surface waters with a 150-foot buffer. Buildings are generally prohibited within 50 feet of high water marks, though no local shoreland protection districts are designated; state shoreland rules still apply.<br>**Recommendation:** Consider adopting specific shoreline zoning that includes setbacks, native | **Existing:** The 2023 Zoning Bylaw does not directly address this. However, within the Planned Development District, waterfront development must include or maintain public access through linear walkways and/or parks, which may count toward the required open space.<br>**Recommendation:** Consider adopting specific shoreline zoning that includes setbacks, native vegetation buffers, limits on |

| Strategy | Rindge | Winchendon |
|---|---|---|
| | vegetation buffers, limits on impervious surfaces, and requirements for erosion control measures during construction. | impervious surfaces, and requirements for erosion control measures during construction. |
| **Subdivision of waterfront parcels** | **Existing:** Not mentioned in the 2025 Zoning ordinance.<br>**Recommendation:** Create a subdivision section to include a setback for wastewater systems, impervious area, and shoreline buffers, etc. for lake protection. | **Existing:** Not mentioned in the 2023 Zoning Bylaw.<br>**Recommendation:** Create a subdivision section to include a setback for wastewater systems, impervious area, and shoreline buffers, etc. for lake protection. |
| **Cluster development and/or open space provisions for subdivisions** | **Existing:** The 2022 Master Plan Draft promotes a subdivision approach that preserves scenic, agricultural, and habitat values by clustering development away from sensitive areas such as wetlands, shorelines, floodplains, steep slopes, and wildlife corridors (p. 5-24).<br>**Recommendation:** Encourage cluster development to preserve open space, protect shorelines and wetlands, limit impervious surfaces, and maintain natural buffers. Require permanent conservation of open space and connectivity to natural areas. | **Existing:** Cluster development is not addressed in the 2023 Zoning Bylaw. In the Planned Development District, projects over 1.5 acres must set aside at least 10% of the land as common open space, preferably with vegetated areas like small parks. Open space requirements for subdivisions are unclear.<br>**Recommendation:** Include clear open space and cluster development provisions in the zoning bylaw to guide subdivision layout. Require preservation of natural features, minimum open space percentages, and vegetated buffers. |
| **Protection of wetlands** | **Existing:** Rindge's Wetlands Conservation Ordinance establishes 150-foot buffers around surface waters and 50-foot buffers around vegetated wetlands. Prohibits new buildings within 50 feet, septic systems within 100 feet, and increases in stormwater runoff. Limits fertilizer use, hazardous storage, and tree clearing (maximum 50% over 20 years) in buffer areas. Allows limited access projects with special exception. | **Existing:** Wetland Conservancy District. Prohibited uses within wetlands: septic tanks, cesspools and leaching beds or fields. Business, commercial and industrial buildings, structures, or uses except provided in Subsection B above (see document for details/restrictions).<br>**Recommendation:** Update the 2007 bylaw to reflect current best practices, expanding buffer requirements, and clarifying allowable uses. Consider adopting a local permitting or review |

| Strategy | Rindge | Winchendon |
|---|---|---|
| | **Recommendation:** Expand the wetland buffer to 75–100 feet, require buffer restoration on redeveloped lots, adopt town-wide low impact development standards, and add a review process for development within 250 feet of wetlands. | process for any development within a defined setback (e.g., 100–250 feet) to ensure protection of wetland functions. |
| **Protection of groundwater** | **Existing:** Rindge's Aquifer Protection Ordinance establishes an Aquifer Protection Overlay District to safeguard groundwater resources. Prohibits high-risk land uses (e.g., junkyards, hazardous waste facilities) and limits impervious surface coverage. Requires SCMs for stormwater and regulated substance handling. Applies to wellhead protection areas and stratified drift aquifers.<br>**Recommendation:** Implement a maximum impervious cover per lot in the Aquifer Protection Overlay District. | **Existing:** Groundwater Protection Overlay District: Prohibits hazardous and petroleum waste storage or disposal (with limited exceptions), road salt and de-icing chemical storage, industrial wastewater discharge, uncovered storage of fertilizers/manure, animal feed lots, vehicle services, junkyards, dry cleaning, mining (unless incidental), and impervious cover over 10% of a lot.<br>**Recommendation:** Implement a maximum impervious cover per lot in the Aquifer Protection Overlay District. |
| **Protection of steep slopes** | **Existing:** Steep slope protection is not addressed in the 2025 Zoning Ordinance. The 2002 Water Resource Plan restricts septic systems on slopes ≥12% unless engineered solutions are approved. The Planned Unit Residential Development ordinance discourages development on excessively steep sites.<br>**Recommendation:** Adopt a steep slope overlay district with clear development limits on slopes over 12%, require engineered stormwater controls both during and after construction, and discourage disturbance through zoning and subdivision standards. Consider prohibiting development on slopes greater than 25%. | **Existing:** Driveway slopes are limited to 10% for nonresidential and 20% for residential, with aprons not exceeding 4%. Paving on steep slopes may require a special permit. Construction slopes must not exceed a 3:1 horizontal-to-vertical grade.<br>**Recommendation:** Strengthen slope protections by applying consistent limits across all development types, requiring erosion control for steep driveways or roads, and enforcing the 3:1 maximum construction slope to prevent washouts and protect water quality. Consider prohibiting development on slopes greater than 25%. |

| Strategy | Rindge | Winchendon |
|---|---|---|
| **Septic pump-out ordinance or regulation of septic and sewer systems.** | **Existing:** Rindge has no designated pump-out ordinance. Septic systems must follow NH Department of Health and Water Supply and Pollution Control Commission standards per RSA 147 and 149, with a 100-foot setback from wetlands and surface waters.<br>**Recommendation:** Create mandatory 3–5 year pump-out and inspection in the watershed. | **Existing:** Does not have specified pump out requirement. Winchendon prohibits septic tanks on wetlands and requires state and federal permits for any wastewater discharge.<br>**Recommendation:** Create mandatory 3–5 year pump-out and inspection in the watershed. |
| **Nutrient loading analysis required for fresh waterbodies** | **Existing:** None identified.<br>**Recommendation:** Require stormwater management plans or phosphorus control plans to quantify nutrient loading from planned developments and the estimated load reductions from SCMs and low impact development techniques. | **Existing:** None identified.<br>**Recommendation:** Require stormwater management plans or phosphorus control plans to quantify nutrient loading from planned developments and the estimated load reductions from SCMs and low impact development techniques. |
| **Low impact development requirements and standards** | **Existing:** From the 2025 Zoning ordinance, the area of impervious cover for open space shall be limited to 80% of the entire site.<br>**Recommendation:** Apply low impact development to the watershed. | **Existing:** All development in the Planned Development District must follow low impact development practices per the Massachusetts Stormwater Handbook, unless a special permit justifies conventional drainage. Solar projects also require a low impact development permit under Chapter 190.<br>**Recommendation:** Expand low impact development requirements beyond the Planned Development District to apply town-wide, including all subdivisions and redevelopment projects. |

| Strategy | Rindge | Winchendon |
|---|---|---|
| **Environmental ordinances (e.g. green building codes, green infrastructure, tree preservation, limits on impervious surface cover)** | **Existing:** Not mentioned in the 2025 Zoning ordinance.<br>**Recommendation:** Adopt environmental ordinances that promote green infrastructure, limit impervious surfaces, require tree preservation, and encourage energy-efficient building to support sustainability and water quality protection. | **Existing:** The Route 140 Corridor Overlay District encourages green building and green roofs. Impervious cover is limited to 1% in open space and 10% in the Groundwater Protection District. Parking lots (10+ spaces) require 5% landscaping and one tree per 10 spaces. Disturbed areas near roads must be reforested with 150 trees per acre. A 50–100-foot vegetated buffer is required between commercial/industrial and residential zones.<br>**Recommendation:** Strengthen protections by applying impervious cover limits and reforestation standards town-wide, expanding green building incentives, and requiring vegetated buffers and landscaping in all new developments, not just within overlay districts. |
| **Fertilizer and/or pesticide ordinances** | **Existing:** None; only addressed in the Wetland Overlay. Fertilizer use is restricted within 25 feet of wetlands, ponds, lakes, and streams.<br>**Recommendation:** Adopt a no-phosphorus fertilizer ordinance in the watershed. | **Existing:** In the Groundwater Protection Overlay District, non-domestic, non-agricultural fertilizer use may be allowed by special permit if applied to minimize water quality impacts. Massachusetts Plant Nutrient Regulations apply, which only allow phosphorus-containing fertilizer if a soil test indicates that it is needed or when a lawn is first established or repaired. It also prevents fertilizer use during sensitive times, such as in the winter when soils are frozen.<br>**Recommendation:** Adopt a no-phosphorus fertilizer ordinance in the Monomonac Lake watershed. |
| **Implement and enforce a Stormwater Management Plan** | **Existing:** Not addressed in the 2025 Zoning Ordinance or a published plan. Stormwater and erosion control are covered in site plan review regulations, including drainage, construction, and impervious surface standards. | **Existing:** As an MS4, the town has a stormwater management plan updated in January 2025 and a general program information page.<br>**Recommendation:** Great work! |

| Strategy | Rindge | Winchendon |
|---|---|---|
| | **Recommendation:** Develop a comprehensive stormwater management plan that includes town-wide standards for runoff control, green infrastructure, maintenance requirements, and integration with zoning and subdivision regulations to ensure consistent protection of water quality. | |

### Conservation Funding Strategies

| Strategy | Rindge, NH | Winchendon, MA |
|---|---|---|
| **Development Transfer Overlay District** | **Existing:** None identified.<br>**Recommendation:** Create a Development Transfer Overlay District encompassing infrastructure-dense and growth areas. This overlay district may allow a developer to build at additional density within these areas upon payment of a fee, which is then used to purchase conservation land in areas which are rich in natural resources or are prioritized for conservation. | **Existing:** None identified.<br>**Recommendation:** Create a Development Transfer Overlay District encompassing infrastructure-dense and growth areas. This overlay district may allow a developer to build at additional density within these areas upon payment of a fee, which is then used to purchase conservation land in areas which are rich in natural resources or are prioritized for conservation. |
| **Conservation impact fees** | **Existing:** No programs identified. In 2021, impact fees helped fund recreation equipment for the Playscape at Tetreault Park.<br>**Recommendation:** Implement a conservation impact fee to fund watershed protection efforts. | **Existing:** None identified.<br>**Recommendation:** Implement a conservation impact fee to fund watershed protection efforts. |
| **Wetland mitigation funds** | **Existing:** None identified.<br>**Recommendation:** Connect with NHDES about Aquatic Resource Mitigation funding. | **Existing:** None identified. |

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|---|---|---|
| | | **Recommendation:** Connect with Massachusetts Department of Fish and Game about In-Lieu Fee Program funding. |
| **Fee in lieu of land dedication** | **Existing:** None identified.<br>**Recommendation:** Implement a fee in lieu of land dedication to support land conservation efforts. | **Existing:** None identified.<br>**Recommendation:** Implement a fee in lieu of land dedication to support land conservation efforts. |
| **Stormwater Utility District** | **Existing:** None identified.<br>**Recommendation:** Evaluate the feasibility of establishing a stormwater utility fee. The study will assess potential fee structures, administration, and revenue to support stormwater infrastructure maintenance, replacement, and green infrastructure, with the goal of reducing flooding, water quality impacts, and infrastructure failures. | **Existing:** None identified.<br>**Recommendation:** Evaluate the feasibility of establishing a stormwater utility fee. The study will assess potential fee structures, administration, and revenue to support stormwater infrastructure maintenance, replacement, and green infrastructure, with the goal of reducing flooding, water quality impacts, and infrastructure failures. |
| **Open space or non-lapsing conservation fund** | **Existing:** None identified.<br>**Recommendation:** Establish an open space or non-lapsing conservation fund. | **Existing:** None identified.<br>**Recommendation:** Establish an open space or non-lapsing conservation fund. |
| **Has a Land Use Change Tax per RSA 79-A:25** | **Existing:** Yes, 10% of property's market value.<br>**Recommendation:** Potentially dedicate a larger percentage of the land use change tax to the conservation fund. | **Existing:** Massachusetts taxes land removed from conservation or other qualified reduced-tax use under a different statutory framework (Chapters 61/61A/61B).<br>**Recommendation:** The Town may prepare for right of first refusal opportunities, and may consider appropriating land use change tax revenue specifically to conservation. |
| **Participate or collaborate with a local watershed association** | **Existing:** No formal collaboration noted.<br>**Recommendation:** Partner and collaborate with MLPOA for future education, conservation, and WMP implementation. | **Existing:** WSLA collaborates with the Winchendon Conservation Commission and town administrators on land conservation; the town generally supports WMP efforts and allows access to municipal records. |

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|---|---|---|
| | | **Recommendation:** Partner and collaborate with WSLA for future education, conservation, and WMP implementation. |
| **Participate or collaborate with a local land trust** | **Existing:** Yes, Land trusts in the area include Monadnock Conservancy and Northeast Wilderness trust and residents of Lake Monomonac.<br>**Recommendation:** Keep up the great connections! | **Existing:** Massachusetts Residents of Lake Monomonac.<br>**Recommendation:** Keep up the great connections! |

## Non-regulatory Strategies

| Strategy | Rindge, NH | Winchendon, MA |
|---|---|---|
| **Open space plan** | **Existing:** None identified.<br>**Recommendation:** Seek funding and create an Open Space Plan for the town. | **Existing:** Yes, around Monomonac Lake, small lots and poor soils make meeting standard septic–well setbacks difficult. Reduced setbacks (50–100 feet) are allowed if water tests clean. Despite development, water quality remains good. No weekly monitoring occurs due to lack of a public beach. Enhancing recreational use is a goal.<br>**Recommendation:** Strengthen protections around Lake Monomonac by requiring enhanced septic system inspections and upgrades for properties with reduced setbacks. Voluntary water testing program. |
| **Master plan addresses natural resources and environmental protection** | **Existing:** The first listed in the economic vision for Rindge: "The Town's rural character, enhanced by an abundance of natural resources -- its lakes, mountains, agriculture, and open space -- shall be | **Existing:** Mentions open space goals. Preserve wildlife and plant habitats and natural resources and protect environmentally sensitive areas (Open Space and Recreation Plan Goal #3). Enhance efforts for the acquisition, protection and maintenance of open space and recreation lands (Open Space and Recreation Plan Goal #7). |

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| | preserved and protected and the Town's rich historic legacy shall be honored."<br>**Recommendation:** Support the Town's economic vision by adopting conservation zoning measures that protect open space, forests, and agricultural land, and by integrating historic preservation guidelines into development review. | **Recommendation:** Support the Town's economic vision by adopting conservation zoning measures that protect open space, forests, and agricultural land, and by integrating historic preservation guidelines into development review. |
| **A town-wide natural resources inventory** | **Existing:** Yes, completed in 2018.<br>**Recommendation:** Consider updating the natural resources inventory with current wetland, habitat, and hydrologic data as it is over 10 years old. | **Existing:** None identified.<br>**Recommendation:** Seek funding for and create a town-wide natural resources inventory. |
| **Smart Growth Plan** | **Existing:** None identified.<br>**Recommendation:** Create a Smart Growth Plan to reduce development pressure near shorelines and streams. | **Existing:** None identified.<br>**Recommendation:** Create a Smart Growth Plan to reduce development pressure near shorelines and streams. |
| **Stormwater system mapping** | **Existing:** None identified.<br>**Recommendation:** Map stormwater infrastructure, including catch basins, wastewater and stormwater lines, and outfalls. | **Existing:** None identified.<br>**Recommendation:** Map stormwater infrastructure, including catch basins, wastewater and stormwater lines, and outfalls. This is also required for MS4 communities. |
| **Consistent Public Outreach and Engagement / Public education programs** | **Existing:** Yes; Rindge Clubs and Organizations.<br>**Recommendation:** Increase cross-state boundary communications. | **Existing:** Yes; Winchendon Community Action Committee.<br>**Recommendation:** Increase cross-state boundary communications. |

| | | |
|---|---|---|
| **Have established conservation commission** | **Existing:** Yes.<br>**Recommendation:** Consider expanding the Conservation Commission's role to include annual shoreline assessments and culvert evaluations. | **Existing:** Yes.<br>**Recommendation:** Consider expanding the Conservation Commission's role to include annual shoreline assessments and culvert evaluations. |
| **Incentivize and/or encourage property owners to implement low impact development and stormwater management practices** | **Existing:** None identified.<br>**Recommendation:** Consider incentivizing and encouraging low impact development through outreach programs, workshops, or financial incentives. | **Existing:** None identified.<br>**Recommendation:** Consider incentivizing and encouraging low impact development through outreach programs, workshops, or financial incentives. |
| **Encourage property owners to put land into farmland/tree growth programs** | **Existing:** None identified.<br>**Recommendation:** Consider encouraging landowners to take advantage of state agricultural and forestry programs. | **Existing:** None identified.<br>**Recommendation:** Consider encouraging landowners to take advantage of state agricultural and forestry programs. |

Local land use planning and zoning ordinances should consider incorporating resiliency strategies for protecting water quality and improving infrastructure based on temperature, precipitation, water levels, wind loads, storm surges, soil moisture, and groundwater levels (Ballestero, Houle, Puls, & Barbu, 2017). There are nine strategies which can aid in minimizing the adverse effects associated with environmental stressors, including the following (McCormick & Dorworth, 2019), several of which are partially addressed within the current ordinances of the watershed municipalities but could be further strengthened and expanded. More details on ordinance recommendations and suggestions can be found in Table 14.

- ***Installing Green Infrastructure and Nature-Based Solutions***
  Planning for greener infrastructure requires creating a network of interconnected natural areas and open spaces for groundwater recharge, pollution mitigation, reduced runoff and erosion, and improved air quality. Examples of green infrastructure and nature-based solutions include forest, wetlands, natural areas, riparian (banks of a water course) buffers, and floodplains; all of which already exist to various extents in the watershed and have minimized the damage created by intense storms. Other examples of engineered green infrastructure that apply concepts from nature to treat stormwater include Regenerative Stormwater Conveyance, bioswales, and infiltration tree trenches. As future development occurs, these natural barriers must be maintained or even increased to reduce runoff of pollutants into freshwater. See also Section 4.2.3: Land Conservation.

- ***Using Low Impact Development Strategies***
  Replacing traditional approaches to stormwater management such as curbs, pipes, storm drains, gutters, and retention ponds with innovative approaches such as bioretention, vegetated swales, and permeable paving.

- ***Minimizing Impervious Surfaces***
  Impervious surfaces such as roads, buildings, and parking lots should be minimized by creating new ordinances and building construction design requirements which reduce the imperviousness of new development. Property owners can increase the permeability of their lots by incorporating permeable driveways and walkways. In some cases, reducing mandatory minimum parking spaces for development may help achieve this goal.

- ***Encouraging Riparian Buffers and Maintaining Floodplains***
  Municipal ordinances should forbid construction in floodplains, and in some instances, floodplains should be expanded to increase land area to accommodate larger rainfall events. Riparian buffers and filter strips along waterways should be preserved or created to slow runoff and filter pollutants.

- ***Protecting and Re-establishing Wetlands***
  Wetlands are vital for preservation because wetlands hold water, reduce flooding, recharge groundwater, and mitigate water pollution.

- ***Encouraging Tree Planting***
  Trees help manage stormwater by reducing runoff and mitigating erosion when adjacent to surface waters. Trees also provide critical shading and cooling to streams, lake shorelines, and land surfaces.

- ***Promoting Sustainable Landscaping Using Native Vegetation***
  Landowners should promote the use of native vegetation in landscaping, and landscapers should become familiar with techniques which minimize runoff and the discharge of nutrients into waterbodies (Chase-Rowell, Davis, Hartnett, & Wyzga, 2012).

- ***Slowing Down the Flow of Stormwater***
  To slow and infiltrate stormwater runoff, roadside ditches can be armored or vegetated and equipped with turnouts, settling basins, check dams, or infiltration catch basins. Rain gardens can retain stormwater, while water bars can divert water into vegetated areas for infiltration. Water running off roofs can be channeled into infiltration fields and drainage trenches.

- ***Coordinating Infrastructure, Housing, and Transportation Planning***
  Coordinate planning for infrastructure, housing, and transportation to minimize impacts on natural resources. Critical resources, including groundwater, must be conserved and remain free of pollutants especially as future droughts may deplete groundwater supplies.

### 4.2.4 Land Conservation

Land conservation is essential to the health of a region, particularly for the protection of water resources, enhancement of recreation opportunities, vitality of local economies, and preservation of wildlife habitat. Land conservation is one of many tools for protecting water quality for current and future generations. For the Monomonac Lake watershed, 24%, or 2,718 acres, of the watershed’s area (not including the lake) has been classified as conserved land (Figure 25). Considering the Whites Mills Pond watershed, this number increases to 26%, or 3,140 acres. Major conserved areas in New Hampshire include the Wapack Wilderness, Mountain Pond Forest, Converse Meadow, the Weinberg property, and the Sandback Wilderness. In Massachusetts, major conserved areas include the Winchendon Springs Wildlife Management Area and Marchmont CR. Many of the conserved areas border parts of waterbodies or riverways in the watershed. It is noted that 194 acres of conservation land was added to Winchendon in 2025 near the southern end of the lake, but this parcel was not yet available in the data used for this analysis and is not shown in Figure 25. Of the total conservation land within the watershed, 65% is privately owned, 18% is owned by the state, and 17% is municipally owned.

As land conservation is essential to the future of this region, local groups should continue to pursue opportunities for land conservation in the Monomonac Lake watershed based on the highest valued habitat identified by the New Hampshire Fish and Game Department. The New Hampshire Fish and Game Department ranks habitat based on value to the State, biological region (areas with similar climate, geology, and other factors that influence biology), and supporting landscape. These habitat rankings are published in the State’s 2025 Wildlife Action Plan, which serves as a blueprint for prioritizing conservation actions to protect Species of Greatest Conservation Need in New Hampshire (NHFG, 2025). The Monomonac Lake watershed is located in the Hillsboro Inland Hills and Plains ecological region (NHFG, 2025). Approximately 399 acres (3%) of the New Hampshire portion of Monomonac Lake watershed are considered Highest Ranked Habitat in New Hampshire, and 759 acres (6%) are classified as the highest ranked habitat in the biological region (Figure 26).

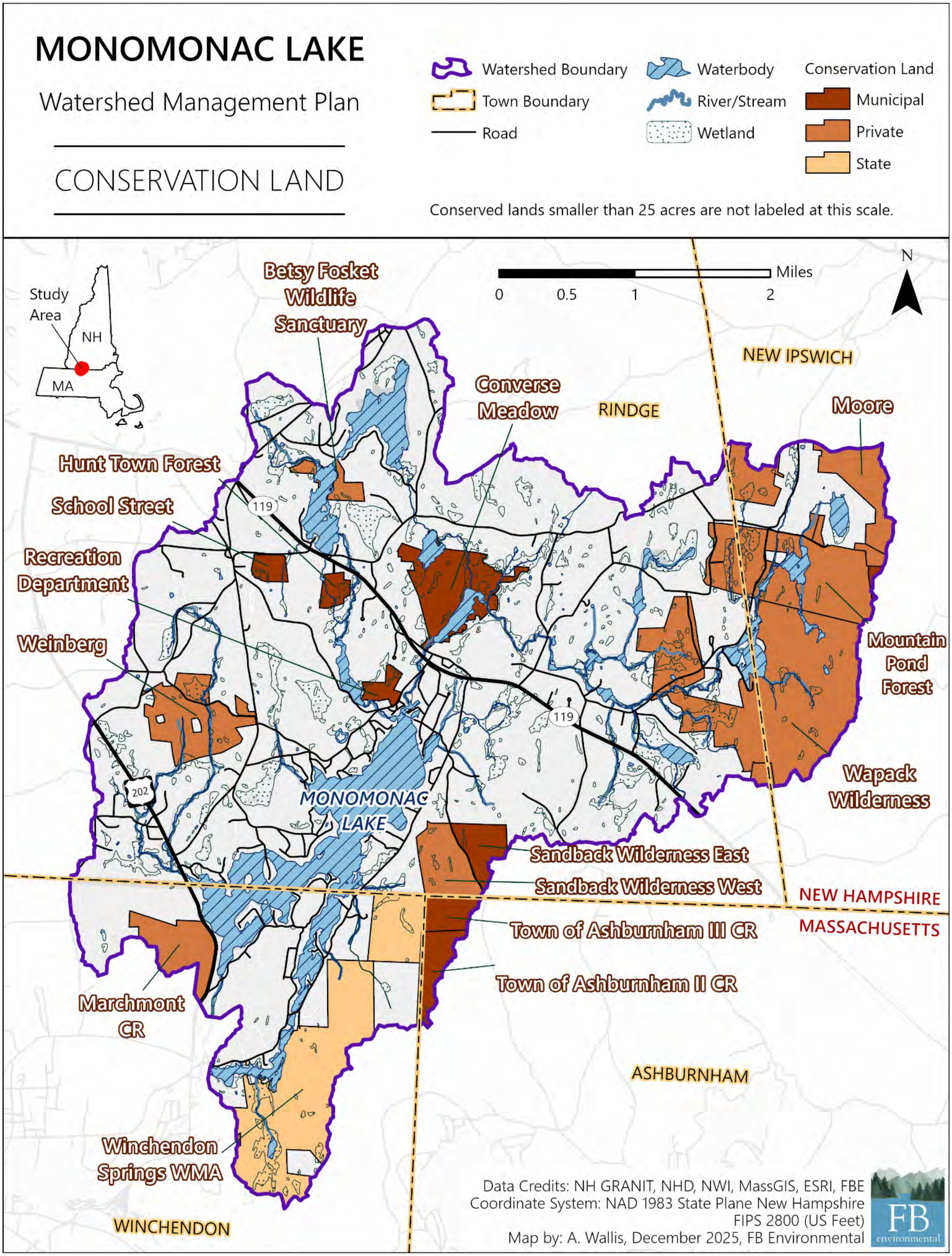



**Figure 25.** Conserved land by owner type in the Monomonac Lake watershed.

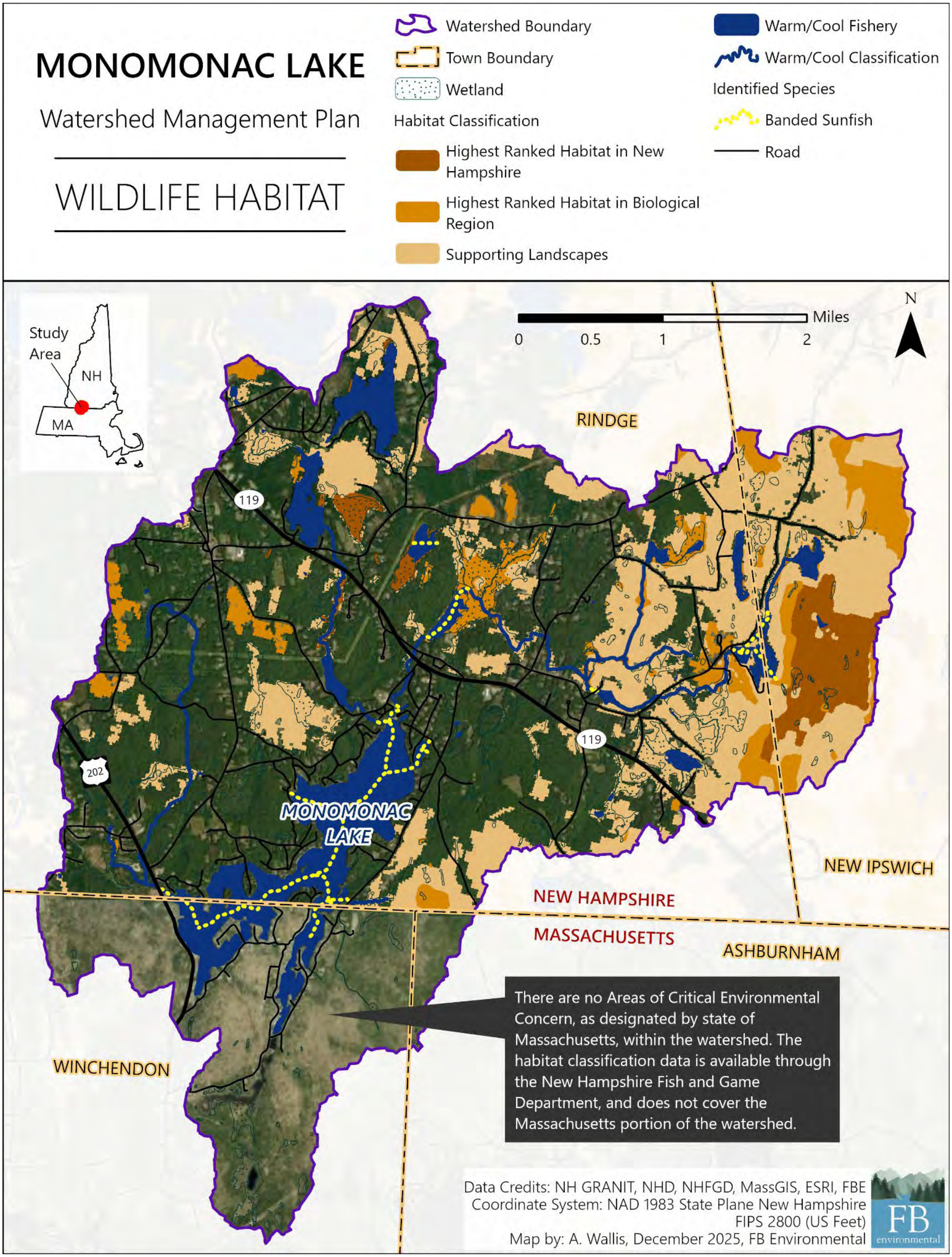



**Figure 26.** Wildlife habitat in the Monomonac Lake watershed.

### 4.2.5 Fertilizer Use Prohibition


Management strategies for reducing water quality impacts from residential, commercial, and municipal fertilizer application start with education and outreach to property owners. New Hampshire law prohibits the use of fertilizers within 25 feet of surface waters. Outside of 25 feet, property owners can have their soil tested before considering application of fertilizers to their lawns and gardens to determine whether nutrients are needed and if so in what quantity or ratio. A soil test kit can be obtained through the UNH Cooperative Extension. Many state and local governments are beginning to set restrictions on the use of fertilizers by prohibiting their use altogether or requiring soil tests to demonstrate a need for any phosphate application to lawns. The watershed municipalities could consider a similar prohibition, at the very least within a watershed zoning overlay for major lakes and ponds. In 2024, HB1293 was passed by the legislature to prohibit the sale of fertilizer with a phosphate content level greater than 0.67%.

Massachusetts has Plant Nutrient Management regulations through the Department of Agricultural Resources that were passed in 2012. The regulations prohibit the use of phosphorus containing fertilizers on agricultural and non-agricultural uses except in circumstances where a soil test dictates that the soils are phosphorus deficient. Phosphorus-containing fertilizers may also be used when establishing or repairing a lawn. These fertilizers must be clearly marked by retailers, and professional applicators must track their fertilizer use. Fertilizer application is also prohibited when soils are frozen or saturated, or on areas within 20 feet of water resources or 100 feet of surface waters used as a public drinking water supply.

### 4.2.6 Agricultural Practices

Manure and fertilizer management and planning are the primary tools for controlling nutrient runoff from agricultural areas. Direct outreach and education should be conducted for small farms and any larger-scale operations in the watershed. Agricultural best practices aim to reduce nutrient, sediment, and bacteria load into waterbodies while ensuring agricultural productivity; however, the selection of practices should consider local conditions – such as climate, soil type, hydrology, land use, funding, and other factors – to maximize effectiveness (EPA, 2004).

NRCS is a key resource for farmers and landowners in developing and implementing agricultural practices to improve water quality. Through various programs, the NRCS provides both financial and technical assistance for projects aimed at reducing runoff and improving soil health (Levy, 2023). In New Hampshire, the most implemented practices (by acre application) between 2005 and 2023 were cover cropping (31.8%) and conservation crop rotation (29%), which continue to be the two most popular practices to date (USDA, 2023a). Larger-scale agricultural operations can work with the NRCS to complete a Comprehensive Nutrient Management Plan. These plans address soil erosion and water quality concerns of agricultural operations through setting proper nutrient budgets, identifying the types and amount of nutrients necessary for crop production, and ensuring the appropriate storage and handling of manure. Manure should be stored or applied to fields properly to limit runoff of solids containing high concentrations of nutrients. Manure and fertilizer management involve managing the source, rate, form, timing, and placement of nutrients. Writing a Comprehensive Nutrient Management Plan is an ongoing process because it is a working document that changes over time. The Environmental Quality Incentives Programs (EQIP) through NRCS is one of their flagship programs with the highest rates of implementation in 2023 (64%). Other notable programs include the Conservation Program and Conservation Technical Assistance (USDA, 2023b).

These programs offered by the NRCS can serve as an essential resource for farmers, particularly in addressing environmental concerns in agricultural watersheds (USDA NRCS, 2024). Through continued collaboration with the NRCS and other stakeholders, farmers in the Monomonac Lake watershed can play a pivotal role in enhancing water quality while maintaining agricultural productivity, thus supporting two essential natural resources for community well-being in the region.

***NRCS***

***Cheshire County, NH***
11 Industrial Park Drive,
Walpole, NH
(603) 756-2988
walpole.nrcs.nh@usda.gov

***Worcester County, MA***
52 Boyden Road, Holden, MA
(508) 829-4477
robert.purcell@usda.gov

To access the technical and financial support offered through these programs, it is recommended that farmers and landowners contact their local NRCS office. Information on agricultural best practices have been published in section 1 of the NRCS Field Office Technical Guide for New Hampshire, under the “NH Ag BMPs” section. In this document, agricultural practices are sorted into three main sections: manure, agricultural compost, and chemical fertilizer (Figure 27). These classifications support the initial identification of appropriate practices for each farm, field, or site, depending on local needs. Once the relevant practices are identified, producers can better understand which NRCS practices will support best practices implementation. A full list of NRCS practices are available in Section 4 of the Field Office Technical Guide, with practices relevant to water quality highlighted in Table 15. The Massachusetts Field Office Technical Guide is also available online.

Many of the programs offered by the NRCS are implemented confidentially on private lands, and no public information was available regarding practices within the Monomonac Lake watershed. Because of this confidentiality, there may be established agricultural best practices and/or current projects underway within the region. Nutrient load reductions from agricultural best practices were not calculated as part of the watershed survey and therefore not factored into the loads needed to reach the water quality goal. Any load reductions made on agricultural lands will therefore be a bonus to help the community reach their water quality goal.

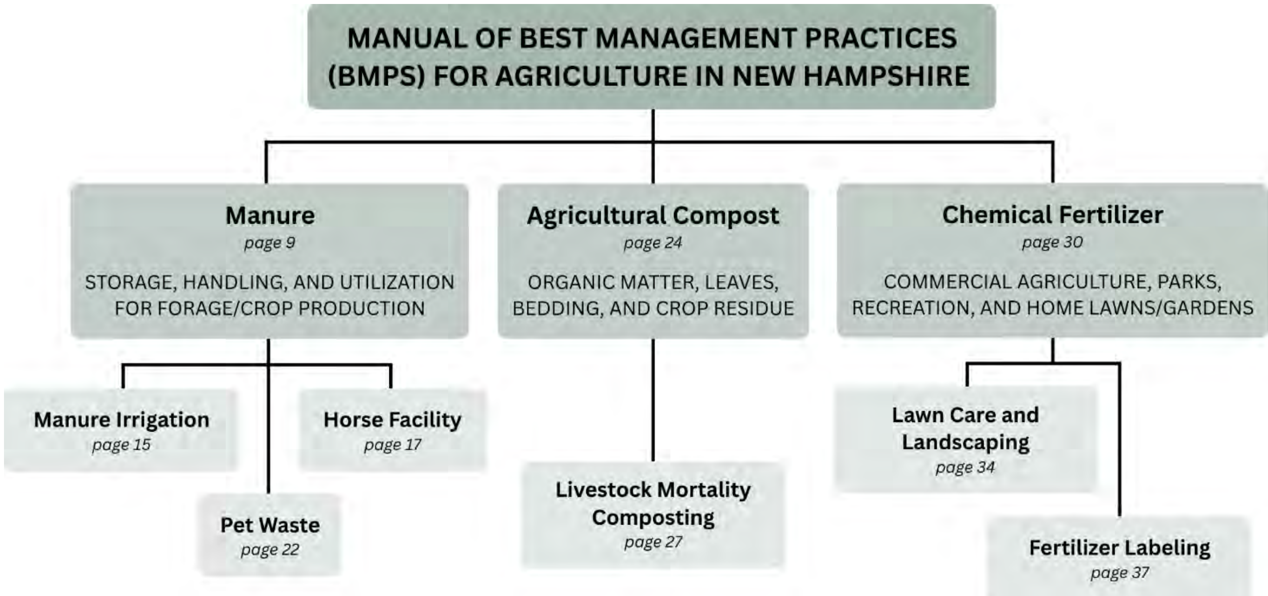


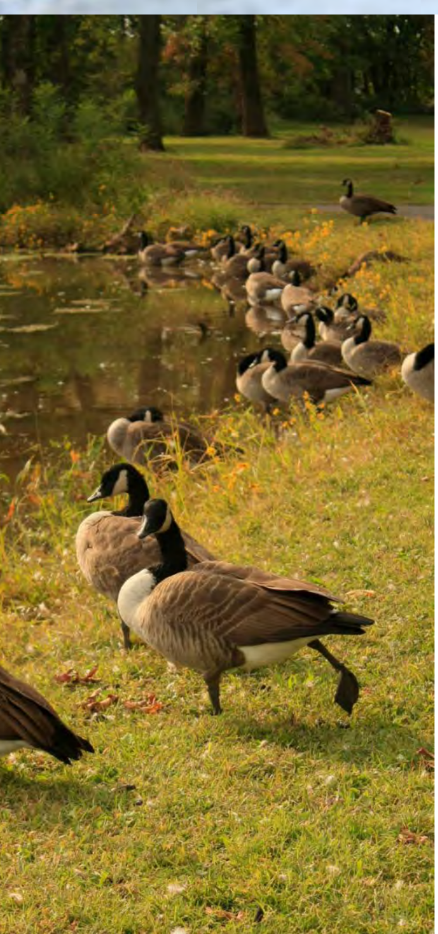

**Figure 27.** Overview of the major topics covered in the *Manual of BMPs for Agriculture in New Hampshire*, to orient producers to relevant sections. Relevant page numbers from the document are listed in each box.

**Table 15.** Conservation Practices covered by the Natural Resources Conservation Service (NRCS). Adapted from the *USDA Conservation Choices; Water Quality Practices*. The table is adjusted to meet current NH NRCS practices (USDA NRCS, 2022). A "Y" indicates that the conservation practice is effective in addressing the pollutant or resource concern; "n" indicates it is not. N = nitrogen. P = phosphorus. Sed = sediment.

| Conservation Practice | Descriptions | N | P | Sed | NRCS Practice # |
|---|---|---|---|---|---|
| **Cover Crop** | Crops, including grasses and legumes for seasonal cover, conservation, and soil health. | Y | Y | Y | 340, 328 |
| **Drainage Water Management** | Water control structure to keep water in the root zone to support excess nutrient uptake before draining. | Y | Y | Y | 587 |
| **Filter Strip** | Strip of vegetation near water to remove pollutants from runoff and wastewater. | Y | Y | Y | 393, 327, 386, 390 |
| **Manure Management** | Manure storage until conditions are appropriate for field application. | Y | Y | n | 318, 313 |
| **No-Till/Strip-Till** | Reducing soil tillage to support soil health. | Y | Y | Y | 329, 345, 346 |
| **Nutrient Management** | Managing the amount, source, placement, and timing of plant nutrients and soil amendments. | Y | Y | n | 590 |
| **Prescribed Grazing** | Managing the harvest of vegetation by rotating grazing animals. | Y | Y | Y | 528 |
| **Riparian Forest Buffer** | Vegetation planted along streams or rivers to reduce nutrients and other pollutants in surface runoff. | Y | Y | Y | 342, 391, 612 |
| **Wetlands** | Marshy area with saturated soils to filter out nutrients, sediments, and other pollutants. | Y | Y | Y | 659, 657 |

### 4.2.7 **Pet Waste Management**

Pet waste collection as a pollutant source control involves a combination of educational outreach and enforcement to encourage residents to clean up after their pets. Public education programs for pet waste management are often incorporated into a larger message of reducing pollutants to improve water quality. Signs, posters, brochures, and newsletters describing the proper techniques to dispose of pet waste can be used to educate the public and create a cause-and-effect link between pet waste and water quality (EPA, 2005). Adopting simple habits, such as carrying a plastic bag on walks and properly disposing of pet waste in dumpsters or other refuse containers, can make a difference. It is recommended that pet owners do not put dog and cat feces in a compost pile because it may contain parasites, bacteria, pathogens, and viruses that are harmful to humans and may or may not be destroyed by composting. "Pooper-scooper" ordinances are often used to regulate pet waste disposal. These ordinances generally require the removal of pet waste from public areas, other people's properties, and occasionally from personal property, before leaving the area. Fines are typically the enforcement method used to encourage compliance with these ordinances.

### 4.2.8 **Nuisance Wildlife Controls**

Human development has altered the natural habitat of many wildlife species, restricting wildlife access to surface waters in some areas and promoting access in others. Minimizing the impact of wildlife on water quality generally requires either reducing the concentration of wildlife in an area or reducing their proximity to a waterbody. There are a couple of options for combatting this:

**Prohibit Feeding –** Leverage educational outreach to discourage feeding of waterfowl or other wildlife. Consider developing an ordinance that prohibits the feeding of these animals.

**Wildlife Repellent –** Use scarecrows, kites, a daily human presence, or modification of habitat through plantings to reduce attractiveness of an at-risk area. Providing closed trash cans near waterbodies, as well as discouraging wildlife from entering surface waters by installing fences, pruning trees, or making other changes to landscaping, can reduce water quality impacts.

## 4.3 OUTREACH AND EDUCATION

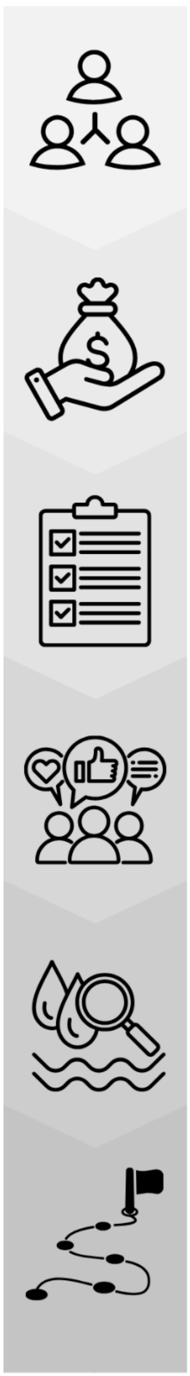
Awareness through education and outreach is a critical tool for protecting and restoring water quality. Most people want to be responsible watershed stewards and not cause harm to water quality, but many are unaware of best practices to reduce or eliminate contaminants from entering surface waters.

The MLPOA and WSLA are the primary local entities for education and outreach campaigns in the watershed and for development and implementation of the plan. Each organization has incredible local capacity to carry out protection efforts. MLPOA has 12 board members, six committees, and 73 members as of July 2026. One priority for MLPOA is to bring new members into the organization as there were 125 members in 2025. WSLA has four officers, a 12-person board of directors, and three committees. Members and local residents have relevant backgrounds that can benefit the outreach and educational programming and move forward goals set forth in the Action Plan. Watershed residents have expertise in engineering, landscaping, and working as an arborist.

The MLPOA and WSLA should continue all aspects of their outstanding and robust education and outreach strategies, including the MLPOA John Sarasin Lake Education Day, the annual WSLA Golf Tournament, guided hikes, boat concerts, workshops, picnics, newsletters, and annual meetings, and should consider developing new or improving existing education opportunities to reach more watershed residents (refer to Section 5: Action Plan). Examples include providing educational materials to existing and new property owners, as well as renters, by distributing through tools and places such as websites, newsletters, social media, community events, or community gathering locations. Additionally, the MLPOA and WSLA should continue to engage with local stakeholders such as conservation commissions, land trusts, municipalities, businesses, and landowners. Educational campaigns should include raising awareness of water quality, septic system maintenance, fertilizer and pesticide use, pet waste disposal, waterfowl feeding, invasive aquatic species, boat pollution, shoreline buffer improvements, gravel road maintenance, and stormwater runoff controls. Educational tools such as interactive story maps, QR-code enabled signs, youth programs, and the development of watershed boundary signs on roads entering the watershed can aim to deepen public understanding of watershed issues. The MLPOA and WSLA should collaborate with other local lake and watershed groups, such as the CLAPA, the PPPA, and others to combine forces on outreach and education initiatives. See below for photos at outreach by the MLPOA.

# 4.4 ADAPTIVE MANAGEMENT APPROACH

**Establishing a formal committee comprised of MLPOA and WSLA members to coordinate an adaptive management approach is strongly recommended.** This approach enables stakeholders to implement restoration actions in phases, using the best available information. Ongoing watershed and water quality monitoring help assess effectiveness of actions, allowing for strategy adjustments before the next restoration phase. Adaptive management ensures efficient resource use through SCM performance testing and monitoring while maintaining a continuous program with adequate funding, stakeholder guidance, and coordination to track long-term restoration progress. The adaptive management components for implementation efforts should include:



**Maintaining an Organizational Structure**

A diverse stakeholder group, including agencies, municipalities, businesses, and landowners, should coordinate watershed management actions, with a formal structure and clear communication.

*Refer to Section 6.1 for more information on plan oversight.*

**Establishing a Funding Mechanism**

A mix of grants, private donations, and municipal funding should be used to support implementation and management actions.

*Refer to Section 6.3 for a list of potential funding sources.*

**Determining Management Actions**

This plan provides a menu of restoration options which serve as a foundation for grant proposals. Once a funding mechanism is established, priority restoration projects can be designed and scheduled for implementation.

*Refer to Section 5 for detailed management actions.*

**Continuing and Expanding the Community Participation Process**

Plan development has actively involved a diverse group of stakeholders, and successful implementation will require their continued participation, along with expanded support, gathered through ongoing public awareness campaigns.

*Refer to Section 4.3 for outreach recommendations.*

**Continuing the Long-Term Monitoring Program**

A water quality monitoring program is necessary to track water quality and measure effectiveness of management practices.

*Refer to Section 6.4 for monitoring options.*

**Establishing Measurable Milestones**

A restoration schedule with milestones for actions and monitoring is essential for the plan's success. Environmental, social, and programmatic indicators have also been identified to track progress.

*Refer to Sections 2.6 for the water quality goal and 6.5 for measurable milestones.*

# 5 ACTION PLAN

## 5.1 ACTION PLAN

### 5.1.1 Top Priority Action Items

Priority Action Items were selected based on their impact in addressing phosphorus, balanced with the need for administration and measurement of progress. Item 1, creating a dedicated group committed to implementing the plan is essential. Items 2 and 4 address pollutant sources and concerns and work towards mitigating them. Items 3, 5, and 6 are focused on education and outreach to build community awareness, momentum, and action towards the water quality goal.

**Top Priority Action Items**

**Item 1.** Create a Monomonac Lake action committee that will oversee the action plan implementation and track progress.

**Item 2.** Provide technical assistance and find cost sharing options to install SCMs for the 23 high impact shoreline properties.

**Item 3.** Distribute educational materials to property owners about septic system function and proper maintenance.

**Item 4.** Provide technical assistance and find cost sharing options to install SCMs for the 76 medium impact and 132 low impact shoreline properties.

**Item 5.** Continue to promote the LakeSmart program evaluations and certifications through NH Lakes to educate property owners about lake-friendly practices.

**Item 6.** Create flyers/brochures or other educational materials through printed or online mediums, regarding topics such as stormwater controls, road maintenance, buffer improvements, fertilizer and pesticide use.

### 5.1.2 Detailed Action Plan

The action plan (Table 16) outlines responsible parties, approximate costs[2], an implementation schedule, and potential funding sources for each recommendation based on priority order and within the following major categories: (1) Watershed and Shoreline SCMs; (2) Road and Driveway Management; (3) Other Municipal Operations; (4) Municipal Land Use Planning and Zoning; (5) Land Conservation; (6) Septic System Management; and (8) Education and Outreach. The plan is designed to be implemented from 2027-2036 and is flexible to allow for new priorities throughout the ten-year implementation period as additional data are acquired. The timeline for these actions is shown in Figure 28.

**Table 16.** Action plan for the Monomonac Lake watershed.

| # | Category | Action Item | Responsible Party | Estimated Cost / Schedule | Potential Funding Sources (NH & MA) |
|---|---|---|---|---|---|
| **1** | **Education and Outreach** | Establish a committee to oversee action plan implementation and track progress towards reaching the water quality goal. | MLPOA, WSLA, Town of Rindge, Town of Winchendon | N/A<br>2027 | N/A |
| **2** | **Watershed and Shoreline SCMs** | Provide technical assistance and/or implementation cost sharing to watershed/shoreline property owners to install SCMs such as rain gardens and buffer plantings. Prioritize high impact properties identified during the shoreline survey. Cost assumes technical assistance and implementation cost sharing provided to the 23 high impact shoreline properties, as identified in the shoreline survey memo (FBE, 2025)). **Achieves 15% (13.3 kg/yr of 104 kg/yr) of Objective 1 for Monomonac Lake.** | MLPOA, WSLA, Town of Rindge, Town of Winchendon | $230,000<br>2027-2030 | Grants (319, Moose plate), CWSRF, Landowners, Massworks Infrastructure Program, Mass Water Management Act Grant |

[2] Cost estimates for each recommendation will need to be adjusted based on further research and site design considerations.

| # | Category | Action Item | Responsible Party | Estimated Cost / Schedule | Potential Funding Sources (NH & MA) |
|---|---|---|---|---|---|
| 3 | **Septic System Management** | Distribute educational materials to property owners about septic system function and maintenance. This can be especially beneficial for shoreline owners. Target educational materials to systems older than 25 years old or those in Massachusetts that have no inspection or pumping records in the past ten years. Outreach materials may educate homeowners about the signs of septic system failure (older systems), encourage proper operations (all systems), or encourage homeowners to get their system pumped or inspected (older systems or those without recent maintenance). | MLPOA, WSLA, Town of Rindge, Town of Winchendon | $3,000 2027-2036 | Town of Rindge, Grant (319), CWSRF |
| 4 | **Watershed and Shoreline SCMs** | Provide technical assistance and/or implementation cost sharing to watershed/shoreline property owners to install SCMs such as rain gardens and buffer plantings. Prioritize medium/low impact properties identified during the shoreline survey. Cost assumes landowner implementation costs (budget: $3,000 each) for the 76 medium impact and 132 low impact shoreline properties, as identified in the shoreline survey memo (FBE, 2025). **Achieves 47% (42.0 kg/yr of 88.9 kg/yr) of Objective 1 for Monomonac Lake.** | MLPOA, WSLA, Town of Rindge, Town of Winchendon | $624,000 2030-2036 | Grants (319, Moose plate), CWSRF, Landowners, Massworks Infrastructure Program, Mass Water Management Act Grant |
| 5 | **Watershed and Shoreline SCMs** | Continue to promote the LakeSmart program evaluations and certifications through NH Lakes to educate property owners about lake-friendly practices such as revegetating shoreline buffers with native plants, avoiding large grassy areas, and increasing mower blade heights to four inches. Cost assumes coordination of and materials for up to ten workshops. | MLPOA, NH Lakes, Town of Rindge | $5,000 2027-2036 | NH Lakes, Grants (319, Moose plate), CWSRF, Town of Rindge |

| # | Category | Action Item | Responsible Party | Estimated Cost / Schedule | Potential Funding Sources (NH & MA) |
|---|---|---|---|---|---|
| 6 | **Education and Outreach** | Create flyers/brochures or other educational materials through printed or online mediums, regarding topics such as stormwater controls, road maintenance, buffer improvements, fertilizer and pesticide use. Cost is highly variable. Advertise technical assistance or cost-sharing for implementation of shoreline SCMs or septic system maintenance/replacement, if offered. | MLPOA, WSLA, Town of Rindge, Town of Winchendon | $20,000-$60,000 2027-2029 | Grants (319), CWSRF |
| 7 | **Septic System Management** | Research septic pumping companies that would give a quantity discount or a discount to members to incentivize septic system pumping. | MLPOA, WSLA | N/A 2027-2029 | MLPOA, WSLA |
| 8 | **Septic System Management** | Target systems older than 25 years old or those without an inspection in the past ten years for an inspection. Remediate/replace systems that do not pass inspection. | MLPOA, WSLA | TBD 2027-2036 | Private landowners, CWSRF, Grants (319, MHSRLP, MCSMP) |
| 9 | **Watershed and Shoreline SCMs** | Complete design and construction of mitigation measures at the five highest-ranked watershed survey sites. **Achieves 2% (1.9 kg of 88.9 kg/yr) of Objective 1 for Monomonac Lake.** | Private landowners and associations | $57,000-$116,000 2027-2032 | CWSRF, Grants (319), Town of Rindge , private landowners, Massworks Infrastructure Program, Mass Water Management Act Grant, NHDOT |
| 10 | **Land Conservation** | Maximize conservation of intact forest and other ecologically important properties though education, zoning, and public or private conservation. | MLPOA, WSLA, Town of Rindge Conservation Commission or other local land trusts, private landowners | TBD 2030-2036 | Grants (Moose Plate, LCHIP, RCCP, NAWCA, LWCF, ACEP, CSP, EQIP, NFWF NEFRF), Town of Rindge, private landowners |

| # | Category | Action Item | Responsible Party | Estimated Cost / Schedule | Potential Funding Sources (NH & MA) |
|---|---|---|---|---|---|
| 11 | **Municipal Land Use Planning & Zoning** | Present WBMP recommendations to Select Board and Planning Board in Rindge and Winchendon to discuss the connection between municipal land use planning and water quality. Provide a five-year status update to the municipal boards demonstrating the progress made on watershed plan implementation. | MLPOA, WSLA | $2,000<br>2027, 2032 | Grants (319), CWSRF |
| 12 | **Septic System Management** | Evaluate locations of older and/or noncompliant septic systems (including cesspools or holding tanks) to identify clusters where conversion to community septic systems might be desirable. Evaluate open space or undeveloped parcels for use as a community septic system. | MLPOA, WSLA | TBD<br>2030-2032 | CWSRF, Grants, Town of Rindge, Town of Winchendon |
| 13 | **Education and Outreach** | Share additional/dynamic information on the MLPOA and WSLA webpages or a social media platform for the organizations, such as water quality data, loon updates, weather conditions, and webcam, to generate more traffic to the website. Publicize events, WMP progress, and workshops through the webpages. | MLPOA, WSLA | N/A<br>2027-2036 | MLPOA, WSLA |
| 14 | **Education and Outreach** | Consider creating a "watershed homeowner" packet that covers topics such as stormwater controls, road maintenance, buffer improvements, fertilizer and pesticide use, pet waste disposal, boat pollution, invasive aquatic species, waterfowl feeding, and septic system maintenance to distribute (mailed separately or in tax bills or posted at community gathering locations or events) to existing and new property owners, as well as renters. Consider reaching out to local real estate companies to collaborate. | MLPOA, WSLA, municipalities | $20,000-<br>$60,000<br>2027-2030 | Grants (319, CWSRF), municipalities, donations |

| # | Category | Action Item | Responsible Party | Estimated Cost / Schedule | Potential Funding Sources (NH & MA) |
|---|---|---|---|---|---|
| 15 | **Land Conservation** | Identify potential conservation buyers and property owners interested in easements within the watershed. Use available funding mechanisms, such as the Regional Conservation Partnership Program (RCPP) and the Land and Community Heritage Investment Program (LCHIP), to provide conservation assistance to landowners. | MLPOA, WSLA, conservation commissions, other local land trusts, private landowners | TBD 2029-2033 | Grants (Moose Plate, LCHIP, RCPP, NAWCA, LWCF, ACEP, CSP, EQIP) |
| 16 | **Septic System Management** | Consider implementing a septic system cost-sharing program that would reduce the burden on homeowners who need to replace their septic systems. Consider collaborating with other local lake associations for additional funding acquisition and cost-sharing power. | MLPOA, WSLA, municipalities | TBD 2029-2032 | MLPOA, WSLA, Town of Rindge, Town of Winchendon, CLAPA, PPPA |
| 17 | **Education and Outreach** | Combine education opportunities by the MLPOA and Town of Rindge Conservation Commission regarding water quality, and how humans can help the ecosystem through initiating LakeSmart, soak up the rain, municipal regulations, and proper septic practices, to generate larger audiences. Consider repeating workshop topics every few years as new members and new homeowners enter the watershed. | MLPOA, Town of Rindge Conservation Commission | TBD 2027-2036 | Town of Rindge |
| 19 | **Municipal Land Use Planning & Zoning** | Incorporate WMP recommendations into municipal master plans and encourage regular review of the WMP action plan. | Town of Rindge, Town of Winchendon | N/A 2027-2030 | Town of Rindge |
| 20 | **Municipal Land Use Planning & Zoning** | Meet with municipal staff to review recommendations to improve or develop ordinances addressing setbacks, buffers, lot coverage, low impact development, and open space. | MLPOA; WSLA; towns of Rindge and Winchendon | $3,000 2030 | Town of Rindge, Town of Winchendon, Grants (319), CWSRF |
| 21 | **Septic System Management** | Institute a minimum pump-out/inspection interval and health regulation or ordinance for shorefront septic systems (e.g., once every 3-5 years). Pump-outs (~$250 per system) are the responsibility of the owner. | Town of Rindge, Town of Winchendon | N/A 2032-2035 | Town of Rindge, Town of Winchendon |

| # | Category | Action Item | Responsible Party | Estimated Cost / Schedule | Potential Funding Sources (NH & MA) |
|---|---|---|---|---|---|
| 18 | **Watershed and Shoreline SCMs** | Complete design and construction of mitigation measures at the next five highest ranked watershed survey sites as opportunities arise. **Achieves 1% (0.9 kg/yr of 88.9 kg/yr) of Objective 1 for Monomonac Lake.** | MLPOA, Town of Rindge, private landowners and associations | $94,000-<br>$188,000<br>2030-2034 | CWSRF, Grants (319, Moose Plate, NFWF 5-Star, ILFP), Town of Rindge, private landowners, Massworks Infrastructure Program, Mass Water Management Act Grant |
| 22 | **Municipal Land Use Planning & Zoning** | Adopt/strengthen zoning ordinance provisions and enforcement mechanisms:<br>1. to promote conservation subdivisions to allow development but also set aside land for conservation.<br>2. to establish a lake protection overlay zoning ordinance that prohibits erosion from sites in sensitive areas (e.g., lake shorefront, along lake tributaries, steep slopes); and<br>3. to promote low impact development practices and reduce impervious areas;<br>4. to require stormwater regulations that align with MS4 Permit requirements (Winchendon is an MS4 community);<br>5. to promote or require vegetative buffers around lake shore and tributary streams;<br>6. require that any shorefront "tear down and replace" home construction does not increase the level of nonconformity compared to the existing structure; | Town of Rindge, Town of Winchendon | N/A<br>2030-2036 | Town of Rindge |

| # | Category | Action Item | Responsible Party | Estimated Cost / Schedule | Potential Funding Sources (NH & MA) |
|---|---|---|---|---|---|
| | | 7. to require shorefront seasonal to year-round conversions of homes to demonstrate no additional negative impacts to lake water quality;<br>8. to enhance performance standards for unpaved roads to prevent erosion and protect lake water quality. | | | |
| **23** | **Education and Outreach** | Educate contractors and municipal staff about erosion and sediment control practices required on plans. Work with Town of Rindge and Winchendon to ensure that there are sufficient resources to enforce permitting conditions. | Town of Rindge, Town of Winchendon | $6,000<br>2030-2036 | Town of Rindge, Town of Winchendon, Grants (319), CWSRF |
| **24** | **Land Conservation** | Enhance community education regarding private land conservation easements. Host workshops educating landowners on the benefits. | MLPOA, Conservation Commission | TBD<br>2030-2034 | Grants (Moose Plate, LCHIP, RCCP, NAWCA, LWCF, ACEP, CSP, EQIP, NFWF NEFRG), Town of Rindge, private landowners |
| **25** | **Septic System Management** | Develop and maintain a town-wide septic inventory database base to facilitate code enforcement of any septic system ordinances. This database should include specific information from septic system permits and designs including system type, depth to groundwater, depth to bedrock, soils, and location. | Town of Rindge, Town of Winchendon | $20,000<br>2032-2036 | Town of Rindge, Town of Winchendon, Grants, CWSRF |
| **26** | **Road and Driveway Management** | Work with the Town of Rindge and Winchendon regarding decreasing their road salt usage on town roads within the watershed due to current trends in water quality and discuss reduced salt areas and low-salt approaches. | Town of Rindge, Town of Winchendon | N/A<br>2030-2032 | Town of Rindge, Town of Winchendon |

| # | Category | Action Item | Responsible Party | Estimated Cost / Schedule | Potential Funding Sources (NH & MA) |
|---|---|---|---|---|---|
| **27** | **Education and Outreach** | Host a large, regional workshop with Contoocook Lake Area Preservation Association (CLAPA) and Pool Pond Protection Association (PPPA) to promote information sharing across watersheds. Collaboration may reveal shared interests and goals between parties. | MLPOA, WSLA, CLAPA, PPPA | $10,000 2032 | Grants, MLPOA, WSLA, CLAPA, PPPA |
| **28** | **Education and Outreach** | Create low-stakes, low-commitment volunteer opportunities to attract new members to the lake associations. These opportunities may be more suitable for young families. These may include one-time cleanup events. | MLPOA, WSLA | N/A 2027-2032 | N/A |
| **29** | **Septic System Management** | Conduct a septic system risk assessment to identify areas in town which may be more susceptible to septic system malfunction due to high groundwaters, soil filtering capacity, risk of flooding, age of infrastructure. | Town of Rindge, Town of Winchendon | $15,000-$20,000 2033-2036 | MLPOA, WSLA, Town of Rindge, Town of Winchendon, CWSRF, Grants (MCSMP) |
| **30** | **Education and Outreach** | Invite municipal staff and representatives of all watershed towns to MLPOA, WSLA annual meetings and other events, such as educational days, lake concerts, and golf tournaments. | MLPOA, WSLA | N/A 2027-2036 | N/A |
| **31** | **Watershed and Shoreline SCMs** | Complete design and construction of mitigation measures at the remaining eleven watershed survey sites as opportunities arise. **Achieves 2% (1.6 kg/yr of 88.9 kg/yr) of Objective 1 for Monomonac Lake.** | MLPOA, Town of Rindge, private landowners and associations | $263,000-$441,000 2033-2036 | CWSRF, Grants (319, Moose Plate, NFWF 5-Star, ILFP), Town of Rindge, private landowners, Massworks Infrastructure Program, Mass Water Management Act Grant |

| # | Category | Action Item | Responsible Party | Estimated Cost / Schedule | Potential Funding Sources (NH & MA) |
|---|---|---|---|---|---|
| 32 | **Road and Driveway Management** | Develop and/or update a written protocol and design standards for road maintenance best practices, including deep sump catch basins. Incorporate water quality considerations and strategies into roadway evaluations and action plans. Review practices for road and drainage maintenance currently used by public and private entities/groups and determine areas for improvement. | Town of Rindge, Town of Winchendon, MLPOA, WSLA | $20,000 2028-2030 | CWSRF, Town of Rindge, Town of Winchendon, Grants (Moose Plate, NFWF 5-Star) |
| 33 | **Land Conservation** | Offer workshops for landowners with ten acres or more for NRCS assistance with land conservation. Cost assumes up to two workshops. | MLPOA, WSLA | $5K 2032-2036 | Grants (RCCP, ACEP, CSP, EQIP) |
| 34 | **Education and Outreach** | Educate private property owners on questions to ask hired landscaping companies to ensure they are complying with shoreland fertilizer rules. | MLPOA, WSLA | N/A 2027-2036 | N/A |
| 35 | **Road and Driveway Management** | Hold informational workshops on proper road/driveway management and winter maintenance and provide educational materials for homeowners about winter maintenance and sand/salt application for driveways and walkways. Cost assumes up to five workshops. | MLPOA, WSLA, Town of Rindge, Town of Winchendon, private landowners | $5,000-10,000 2028-2036 | CWSRF, Town of Rindge, Town of Winchendon, Grants (Moose Plate, NFWF 5-Star), private landowners |
| 36 | **Land Conservation** | Inspect wetlands for Prime Wetland Designations and survey for vernal pools within the watershed. Provide greater support to the watershed's conservation commissions in this endeavor if needed. | Town of Rindge and Winchendon, Conservation Commission | TBD 2030-2032 | Town of Rindge, Town of Winchendon |
| 37 | **Road and Driveway Management** | Establish inspection and maintenance agreements for private unpaved roads. Cost does not include the implementation of proper road maintenance by private landowners and assumes that Town of Rindge / Winchendon can accommodate this additional effort in current budgets. | Town of Rindge and Town of Winchendon, private landowners | N/A 2030-2036 | Town of Rindge, Winchendon, and private landowners |

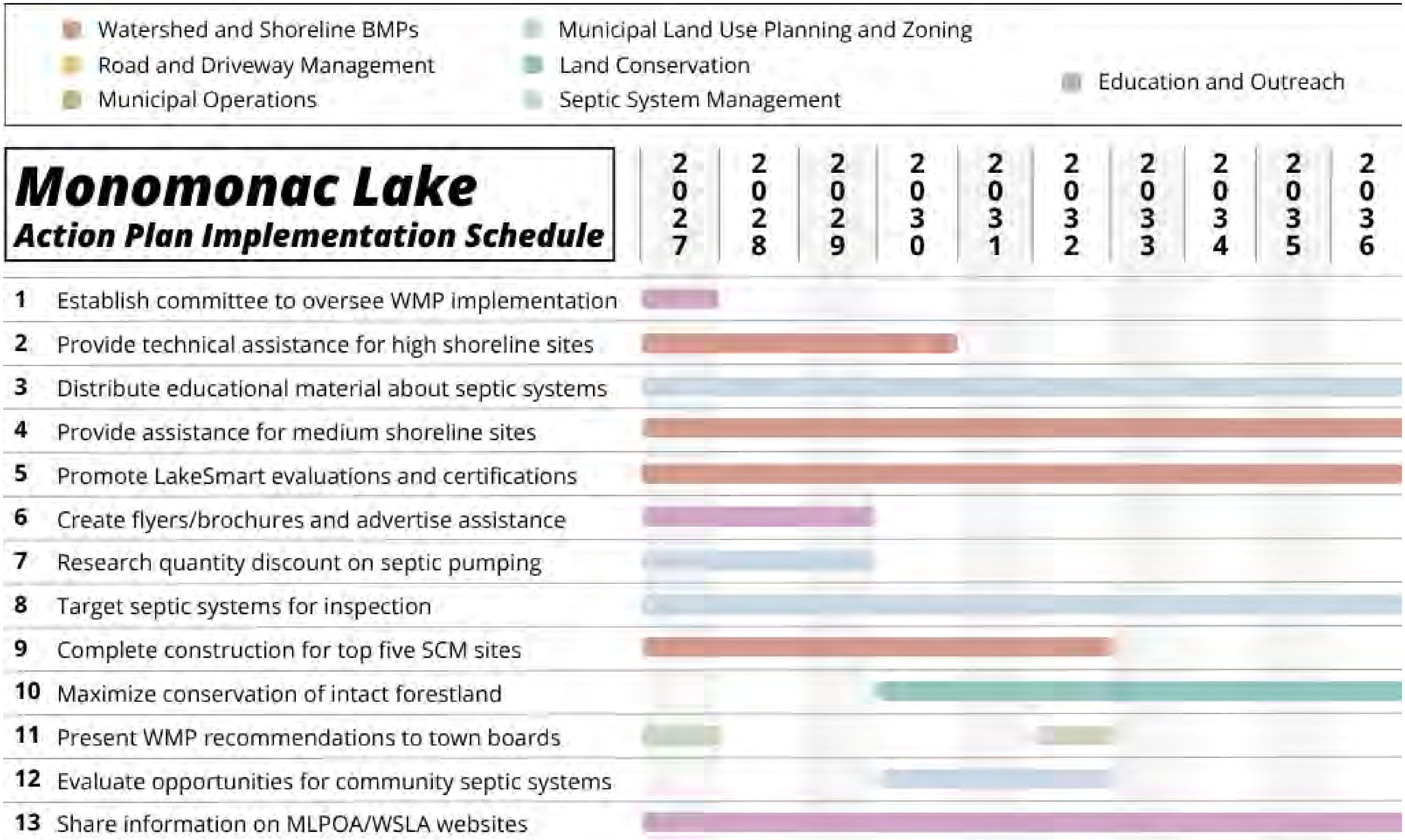
| # | Category | Action Item | Responsible Party | Estimated Cost / Schedule | Potential Funding Sources (NH & MA) |
|---|---|---|---|---|---|
| 38 | **Education and Outreach** | Encourage private property and road owners to hire Green SnowPro certified commercial salt applicators. | MLPOA, WSLA | N/A 2030-2036 | Grants, Town of Rindge and Winchendon |
| 39 | **Municipal Land Use Planning & Zoning** | Increase municipal staff capacity through code enforcers/ building inspectors for inspections and enforcement of stormwater regulations on public and private lands. | Town of Rindge, Town of Winchendon | TBD 2030-2035 | Town of Rindge, Town of Winchendon |
| 40 | **Education and Outreach** | Target seasonal residents / renters, new homeowners, and day visitors for more outreach and education. This can be done through rental properties, boat launches, popular public areas (e.g., stores downtown), and other areas where visitors are known to gather. | MLPOA, WSLA | N/A 2026-2036 | Grants, MLPOA, WSLA |
| 41 | **Road and Driveway Management** | Provide education and training to contractors and municipal staff on protocols for road maintenance best practices. Assumes one workshop. Consider holding joint workshop with Towns or lake associations (or other wider service area) for cost sharing savings. | Towns of Rindge, Winchendon, MLPOA, WSLA | $15,000 2031 | CWSRF, Town of Rindge and Winchendon, Grants (Moose Plate, NFWF 5-Star) |
| 42 | **Land Conservation** | Continue leading guided hikes on conserved parcels to generate support for land conservation throughout the watershed. | MLPOA, WSLA, conservation commissions, other local land trusts, private landowners | N/A 2027-2036 | N/A |
| 43 | **Road and Driveway Management** | Establish a street sweeping program to sweep municipal paved roads. Encourage homeowners to sweep their impervious surfaces after each snowmelt. | Town of Rindge, Town of Winchendon, private landowners | TBD 2032-2036 | Town of Rindge, Town of Winchendon |
| 44 | **Municipal Land Use Planning & Zoning** | Require that all contractors used by municipalities are NHDES-certified so they have adequate low impact development and SCM use ethics. | Town of Rindge | 2030-2036 | Town of Rindge |

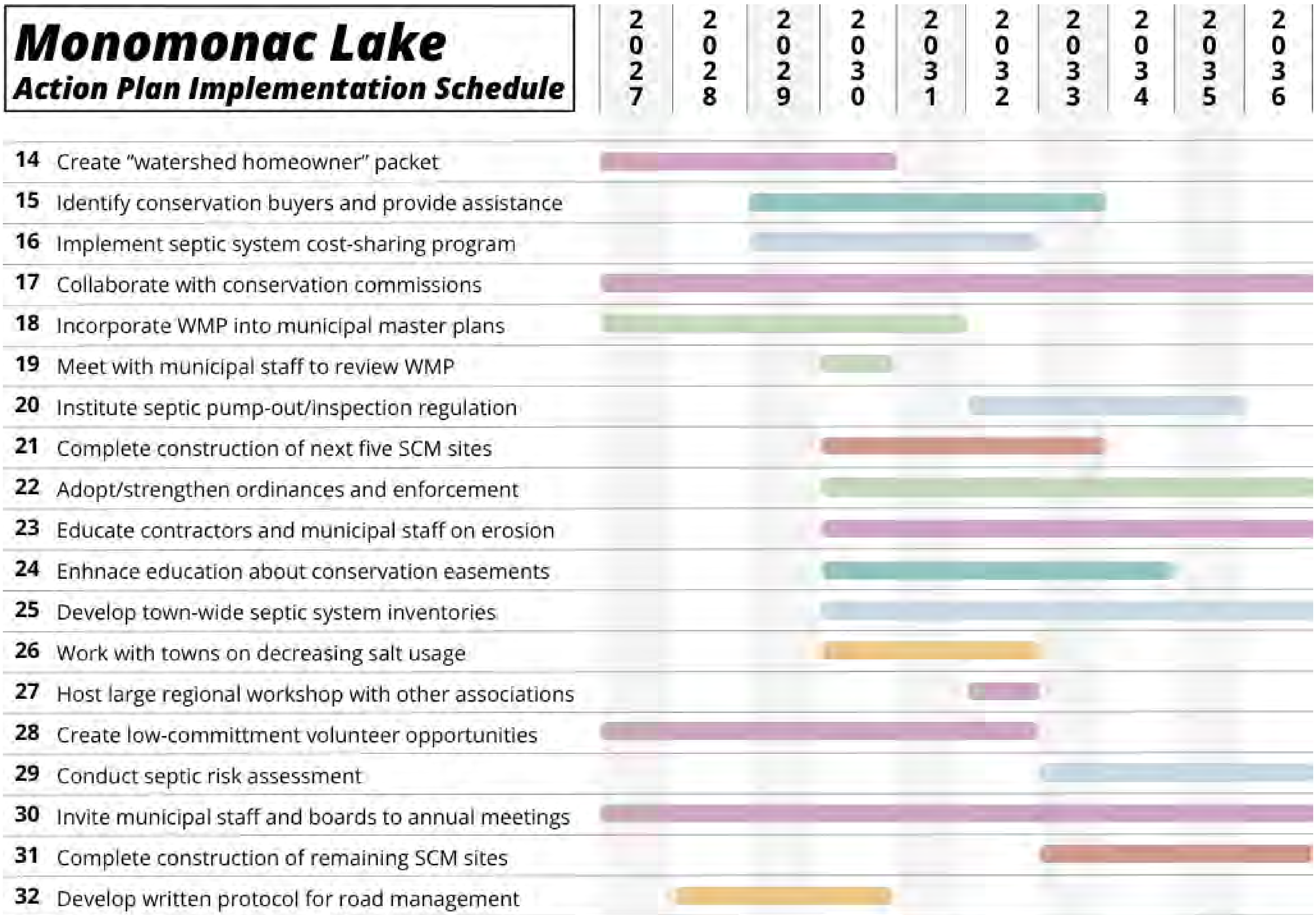
| # | Category | Action Item | Responsible Party | Estimated Cost / Schedule | Potential Funding Sources (NH & MA) |
|---|---|---|---|---|---|
| 45 | **Municipal Operations** | Review and update winter operations procedures to be consistent with Green SnowPro best management practices for winter road, parking lot, and sidewalk maintenance. Continue practicing low salt application practices in the watershed. | Town of Rindge, Town of Winchendon (Public Works/Highway) | Est. $150-250/person 2030-2036 | Town of Rindge |
| 46 | **Municipal Operations** | Review and optimize MS4 compliance for towns (regardless of MS4 designation), including infrastructure mapping, erosion and sediment controls, illicit discharge programs, and good housekeeping practices such as regular catch basin cleaning. | Town of Rindge, Town of Winchendon (Public Works/Highway) | TBD 2030-2036 | Town of Rindge and Winchendon |
| 47 | **Land Conservation** | Update the natural resources inventory for the Town of Rindge. | Town of Rindge, Conservation Commission | $25,000 2027-2029 | Town of Rindge, Grants (NFWF NEFRG), CWSRF |
| 48 | **Education and Outreach** | Collaborate with NH Lakes on legislative or advocacy issues such as boat speed limits. Continue collaborations and participation in the Lake Host program. | MLPOA, WSLA, NH Lakes | N/A 2027-2036 | Grants |
| 49 | **Education and Outreach** | Create a public-facing social media page (Instagram, Facebook) for MLPOA and WSLA efforts and engage local students to maintain it. | MLPOA, WSLA | $500 2027-2036 | MLPOA, WSLA |
| 50 | **Road and Driveway Management** | Contact the NH Department of Transportation regarding decreasing their road salt usage on state roads within the watershed due to current trends in water quality and discuss reduced salt areas and low-salt approaches. | MLPOA, WSLA, NHDOT | N/A 2026-2028 | Private landowners, MLPOA, WSLA |
| 51 | **Watershed and Shoreline SCMs** | Repeat the shoreline and survey in 5 years and in 10 years. Update watershed survey in 10 years when updating the WMP. Use the results to target education and technical assistance for high impact sites. Cost assumes hired consultant for survey and summation of shoreline survey results. | MLPOA, WSLA, Town of Rindge, Town of Winchendon | $20,000 2031, 2036 | Town of Rindge, Town of Winchendon, Grants (Moose plate), CWSRF |

### 5.1.3 Action Plan Implementation Schedule

The following is a graphical timeline of the Monomonac Lake action plan implementation schedule.

**Figure 28.** Monomonac Lake action plan implementation timeline.




Monomonac Lake
Action Plan Implementation Schedule
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
14 Create "watershed homeowner" packet
15 Identify conservation buyers and provide assistance
16 Implement septic system cost-sharing program
17 Collaborate with conservation commissions
18 Incorporate WMP into municipal master plans
19 Meet with municipal staff to review WMP
20 Institute septic pump-out/inspection regulation
21 Complete construction of next five SCM sites
22 Adopt/strengthen ordinances and enforcement
23 Educate contractors and municipal staff on erosion
24 Enhnace education about conservation easements
25 Develop town-wide septic system inventories
26 Work with towns on decreasing salt usage
27 Host large regional workshop with other associations
28 Create low-committment volunteer opportunities
29 Conduct septic risk assessment
30 Invite municipal staff and boards to annual meetings
31 Complete construction of remaining SCM sites
32 Develop written protocol for road management

# Monomonac Lake

## Action Plan Implementation Schedule

2027 2028 2029 2030 2031 2032 2033 2034 2035 2036

| | |
|---|---|
| 33 | Offer workshops for landowners with 10 acres or more |
| 34 | Educate homeowners on questions to ask contractors |
| 35 | Hold workshops on road/driveway winter maintenance |
| 36 | Delineate prime wetlands and vernal pools |
| 37 | Establish maintenance agreements for private roads |
| 38 | Encourage road owners to hire Green SnowPro |
| 39 | Increase municipal staff capacity for enforcement |
| 40 | Target seasonal residents with public-facing outreach |
| 41 | Provide road SCM training to contractors and staff |
| 42 | Continue leading guide hikes on conservation land |
| 43 | Establish street sweeping program |
| 44 | Require all contractors be NHDES-certified for SCMs |
| 45 | Update winter operations to be Green SnowPro |
| 46 | Review and optimize MS4 compliance for towns |
| 47 | Update the Town of Rindge NRI |
| 48 | Collaborate with NH Lakes on statewide advocacy |
| 49 | Create a public facing social media for MLPOA & WSLA |
| 50 | Contact NH DOT on decreasing road salt usage |
| 51 | Update shoreline and watershed surveys |

## 5.2 POLLUTANT LOAD REDUCTIONS

To meet the Objective 1 water quality goal for Monomonac Lake, set a target 5-year phosphorus load reduction of 30.0 kg/yr and a 10-year phosphorus load reduction of 88.9 kg/yr to achieve an in-lake total phosphorus concentration of 10.4 µg/L, which meets state water quality standards for mesotrophic waterbodies and is anticipated to substantially reduce the likelihood of cyanobacteria blooms. The following opportunities for phosphorus load reductions to achieve Objective 1 were identified in the watershed based on field and desktop analyses:

1. Remediating the 21 watershed survey sites could prevent up to **4.4 kg/yr** of phosphorus load from entering Monomonac Lake.

2. Treating shoreline sites could reduce the phosphorus load to Monomonac Lake by **13.3 kg/yr** for the 23 high impact sites (disturbance score 11+), **22.0 kg/yr** for the 76 medium impact sites (disturbance score between 9-10), and **20.0 kg/yr** for the 132 low impact sites (disturbance score between 7-8) identified from the shoreline survey.

3. Upgrading the 292 shorefront septic systems older than 25 years is estimated to reduce the phosphorus load by **29.2 kg/yr** for Monomonac Lake.

**Total potential load reduction = 88.9 kg/yr**

*(meets 100% of reductions needed to achieve Objective 1; Table 17)*

Non-structural SCMs such as educating homeowners about septic system maintenance, fertilizer use, and residential stormwater management may also contribute to reducing phosphorus loading to Monomonac Lake beyond what has been identified through field surveys and desktop analyses (watershed survey, shoreline survey, and septic system inventory) to meet the water quality goal. Preventing septic system failures, reducing residential lawn fertilizer use, and improving stormwater management at the property scale were not included in the goal attainment reality check above.

Objective 2 focuses on preventing or offsetting additional phosphorus loading from anticipated new development. This can be met through ordinance revisions that implement low impact development strategies and encourage cluster development with open space protection, as well as through the conservation of key parcels of forested and open land.

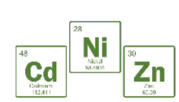
It is important to note that, while the focus of the objectives for this plan is phosphorus, the treatment of stormwater and sediment erosion will result in the reduction of many other kinds of pollutants that may impact water quality. These pollutants would likely include:


**Other nutrients (e.g., nitrogen)**

**Petroleum products**

**Bacteria**

**Road salt/sand**




**Heavy metals (cadmium, nickel, zinc, etc.)**

Without a monitoring program in place to measure these other pollutants, it will be difficult to track the success of efforts that reduce these other pollutants. However, there are various spreadsheet models available that can estimate reductions in these pollutants depending on the types of SCMs installed. These reductions can be tracked to assess long-term response. If additional monitoring funds are available, chloride (road salt), bacteria, and nitrogen sampling would be useful additions.

**Table 17.** Breakdown of phosphorus load sources and modeled water quality for current and target conditions that meet the water quality goal (Objective 1) and that reflect all field identified reduction opportunities in the watershed. Reduction percentages are based out of the current condition value for each parameter. kg/yr = kilograms per year. ppb = parts per billion.

| Parameter | Unit | Current Condition | Five-Year Target Condition | Ten-Year Target Condition | Five-Year Reduction *(unit, % change)* | Ten-Year Reduction *(unit, % change)* |
|---|---|---|---|---|---|---|
| Total phosphorus load (all sources)[3] | kg/yr | 665.1 | 635.1 | 576.2 | -30.0 (5%) | -88.9 (13%) |
| (A) Background phosphorus load[1] | kg/yr | 153.5 | 153.5 | 153.5 | 0.0 (0%) | 0.0 (0%) |
| (B) Disturbed (human) phosphorus load[2] | kg/yr | 511.6 | 481.6 | 422.6 | -30.0 (6%) | -88.9 (17%) |
| (C) Developed land use phosphorus load | kg/yr | 384.8 | 364.7 | 325.1 | -20.1 (5%) | -59.7 (16%) |
| (D) Septic system phosphorus load | kg/yr | 91.4 | 81.5 | 62.2 | -9.9 (11%) | -29.2 (32%) |
| (E) Internal phosphorus load | kg/yr | 35.3 | 35.3 | 35.3 | 0.0 (0%) | 0.0 (0%) |
| In-lake total phosphorus* | ppb | 12.0 | 11.5 | 10.4 | -1.6 (13%) | -1.6 (13%) |
| In-lake chlorophyll-*a** | ppb | 4.0 | 3.8 | 3.3 | -0.7 (18%) | -0.7 (18%) |
| In-lake Secchi disk transparency* | meters | 3.4 | 3.6 | 3.8 | 0.4 (12%) | 0.4 (12%) |
| In-lake bloom probability* | days | 18 | 14 | 8 | -10 (56%) | -10 (56%) |

[1] *Sum of forested/water/natural land use load, waterfowl load, and atmospheric load*

[2] *Sum of developed land use load, shorefront septic system load, and internal load (B = C+D+E)*

[3] *Total phosphorus load (all sources) = A + B*

* *Water quality parameters were sourced from the model and represent average annual (not summer) conditions.*

# 6 IMPLEMENTATION AND EVALUATION

The following section outlines the oversight structure, estimated implementation costs, and funding strategy for the recommended action items in the action plan (Section 5), along with the monitoring plan and performance indicators to track progress over time.

## 6.1 PLAN OVERSIGHT

Successful implementation of this plan will depend on the continued strong coordination led by the MLPOA and WSLA and supported by a diverse group of partners including municipal boards, conservation commissions, state and federal agencies, non-profits, land trusts, schools, businesses, and local landowners. Regular meetings and collaboration across these groups will be essential to fund, implement, and track progress on management actions. The action plan (Section 5) identifies the stakeholder groups responsible for each action. It should be updated every 2, 5, and 10 years to track measurable milestones such as SCM installations, volunteer engagement, and funding secured.

**Roles and Responsibilities**

| | |
|---|---|
| **MLPOA and WSLA** | Continue to lead plan oversight, water quality monitoring, outreach, and fundraising for stewardship and restoration projects. Provide administrative and grant support for SCM implementation and education/outreach efforts. |
| **Municipalities** | Continue to address nonpoint source pollution, maintain roads using best practices, and consider adopting ordinances that protect water quality. |
| **Conservation Commissions** | Continue to collaborate with municipal staff to help implement recommended actions. |
| **NHDES and MassDEP** | Offer technical assistance, permit approval, and the opportunity for financial assistance through EPA Section 319 of the Clean Water Act that supports the NHDES Watershed Assistance Grant Program and other funding programs. |
| **Private Landowners** | Increase awareness and adopt land management practices that minimize pollutant runoff. |

Reducing nutrient loading across the watershed will require a sustained, community-wide effort. Because phosphorus inputs come from many diffuse sources, such as development, roads, and septic systems, continued collaboration, adaptability, and commitment will be key to long-term water quality improvement.

## 6.2 ESTIMATED COSTS

Achieving the water quality goals and objectives outlined in Section 2.4 will depend on available funding and labor resources. The strategy focuses on reducing phosphorus loading through a combination of targeted actions, including phosphorus source control, continued water quality monitoring, and expanded education and outreach. Additional measures, though harder to quantify, such as revising local ordinances to require low impact development practices for new development, identifying and replacing failing septic systems, maintaining roads properly, and improving agricultural practices, will also be critical (see Section 5: Action Plan for details).

With a dedicated stakeholder group in place and with the help of grant or local funding, it is possible to achieve the target phosphorus reductions and meet the established water quality goal Monomonac Lake in the next ten years. **Successful implementation is estimated to cost over a million dollars over the next ten or more years** (Table 18). These estimates will need to be refined as new information becomes available and do not include costs borne by private landowners, such as septic upgrades or private road maintenance.

**Table 18.** Estimated total phosphorus load reduction and total and annual costs for implementation of the action plan. Actions 1, 4, and 6 are necessary to achieve the water quality goal. Other actions are important, but it is difficult to quantify their total phosphorus reduction and costs. kg/yr = kilograms per year.

| Planning Action | Total Phosphorus Reduction *(kg/yr)* | Estimated Total Cost | Estimated Annual Cost |
|---|---|---|---|
| 1. Watershed & Shoreline SCMs | **60** | $1,293,000 - $1,624,000 | $129,300 – 162,400 |
| 2. Road Management | *TBD* | $40,000 - $50,000 | $4,000 - $5,000 |
| 3. Municipal Operations | *TBD* | *TBD* | *TBD* |
| 4. Municipal Land Use Planning and Zoning | (106.7)* | >$5,000 | >$500 |
| 5. Land Conservation | *Included in land use planning and zoning* | $30,000 | $3000 |
| 6. Septic System Management | **29** | $38,000 – $43,000 | $3,800 - $4,300 |
| 8. Education & Outreach | *TBD* | $56,500 - $136,500 | $5,650 - $13,650 |
| **Total** | **89** | **$961,050 - $1,051,100** | **$96,105-$105,110** |

**Estimated increase in phosphorus load from future development in the next ten years. Not included in total.*

## 6.3 FUNDING STRATEGY

It is important that the MLPOA and WSLA develop a strategy to collect the funds necessary to implement the recommendations listed in the action plan (Section 5). Funding to cover ordinance revisions and third-party review could be supported by municipalities through tax collection (as approved by majority vote by town residents). Monitoring and assessment funding could come from a variety of sources, including state and federal grants, municipalities, or donations. Funding to improve septic systems, roads, and shoreland zone buffers would likely come from private landowners. As the plan evolves into the future, the establishment of a funding subcommittee will be a key part in how funds are raised, tracked, and spent to implement and support the plan. Listed below are state and federal funding sources that could assist the MLPOA and WSLA with future water quality and watershed work for Monomonac Lake.

### Funding Options

#### Water Quality and Wastewater Infrastructure

- **EPA Clean Water Act Section 319 Grants (NHDES Watershed Assistance Grants and MassDEP Section 319 Nonpoint Source Competitive Grants Program)**
  Funding for projects to reduce nonpoint source pollution and restore impaired waters. Restoration priorities are identified in the NH Nonpoint Source Management Program Plan (NHDES, 2024c) and the Massachusetts Nonpoint Source Management Program Plan (MassDEP, 2024). These grants are only available for the implementation of WMPs.

- **MassDEP Water Quality Monitoring Grant Program**
  Funding to support ongoing or new monitoring and data collection efforts to increase the amount of external data MassDEP uses for water quality assessments.

- **MassDEP Stormwater MS4 Municipal Assistance Grant Program**
  This program, introduced in 2017, enables groups of Massachusetts municipalities to expand their efforts to meet requirements for the 2016 Small Municipal Separate Storm Sewer System (MS4) General Permits, and to reduce stormwater pollution through coordinated partnerships that emphasize resource sharing.

- **MassDEP Community Septic Management Program**
  Provides low-cost loans to communities to devise local inspection and septic management plans. Local inspection plans are intended to protect environmentally sensitive areas from contamination; septic management plans identify areas that need monitoring and maintenance. The communities in turn provide low-interest betterment loans to eligible homeowners with failed septic systems through their local Boards of Health.

- **Mass Housing Septic Repair Loan Program**
  Offers low and no-interest loans up to $25,000 to repair or replace septic systems.

- **NHDES Cyanobacteria Mitigation Fund**

  The Cyanobacteria Mitigation Fund was established by the New Hampshire legislature in 2023 to help defray the costs of implementing nutrient control practices aimed at reducing chronic and extended cyanobacteria blooms. Municipalities, community water systems, and non-profit lake and river watershed associations are eligible to apply for Cyanobacteria Mitigation Fund assistance. Funding supports projects that implement strategies outlined in watershed management or lake protection plans, with the goal of improving water quality and mitigating harmful algal blooms. Applicants should refer to Administrative Rule Env-Wq 2300 for eligibility requirements and application procedures.

- **NHDES Clean Water State Revolving Fund (CWSRF)**

  Low-interest loans for wastewater system upgrades and stormwater improvements for nonpoint source pollution prevention and watershed protection and restoration. While CWSRF implementation loans are available, they are more limited in scope. Interested parties should consult with NHDES staff to explore potential opportunities.

- **NHDES 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.

- **National Fish and Wildlife Foundation Five Star and Urban Waters Restoration Grants (NFWF 5-Star)**

  Funds for wetland, riparian, in-stream and/or coastal habitat restoration; design and construction of green infrastructure SCMs; water quality monitoring/assessment; outreach and education which address water quality issues in priority watersheds, such as erosion due to unstable streambanks, pollution from stormwater runoff, and degraded shorelines caused by development.

- **USDA Water and Waste Disposal Loan and Grant Program**

  Supports drinking water, stormwater, and sewage systems in rural towns of less than 10,000 residents.

- **EPA Sewer Overflow and Stormwater Reuse Municipal Grants**

  Funds sewer and stormwater infrastructure upgrades, including inspection technologies.

### Land Conservation and Habitat Protection

- **Land and Community Heritage Investment Program (LCHIP)**

  Matching funds for preserving natural, historical, and cultural resources.

- **Aquatic Resource Mitigation Fund**

  Compensatory mitigation funding for wetland and stream restoration/enhancement.

- **North American Wetlands Conservation Act (NAWCA) Grants**
  Matching funds for wetland and upland habitat conservation benefiting migratory birds.
- **National Park Service Land and Water Conservation Fund Grant Program (LWCF)**
  Funds for acquisition of parkland or conservation land; creation of new parks; renovations to existing parks; and development of trails.
- **National Fish and Wildlife Foundation Northeast Forest and River Fund (NFWF NEFRF)**
  $50,000-$200,000 for projects that restore and sustain healthy forests and rivers through habitat restoration, fish barrier removal, and stream connectivity such as culvert upgrades.
- **Massachusetts Wildlife Habitat Management Grant Program**
  Provides assistance to private and municipal owners of protected lands to enhance wildlife habitat, while promoting public access for outdoor recreation.
- **Massachusetts Local Acquisitions for Natural Diversity (LAND) Grant Program**
  Assists cities and towns acquire land for conservation and passive recreation purposes. The grants reimburse cities and towns for the acquisition of land in fee or for a conservation restriction.
- **Massachusetts Parkland Acquisitions and Renovations for Communities (PARC) Grant Program**
  Assists cities and towns in acquiring and developing land for park and outdoor recreation purposes. These grants can be used by municipalities to acquire parkland, build a new park, or to renovate an existing park.
- **Massachusetts Landscape Partnership Grant Program**
  This program seeks to protect large blocks of conservation land. Local, state, and federal government agencies and non-profit groups can use this grant to work together to protect properties that meet the minimum acreage required based on County.
- **Massachusetts Conservation Partnership Grant Program**
  Assists not-for-profit groups in acquiring interests in land for conservation or recreation purposes. Potential projects fall into one of two categories: acquisition of the fee interest in land or a conservation restriction or due diligence costs for donations of land or conservation restrictions. Selected projects must have a conservation restriction held by a municipal or state agency or another land trust. Appropriate public access must also be provided.
- **Mass Audubon 30x30 Catalyst Fund**
  Funding and support to reach Mass Audubon’s goal of conserving 30% of Massachusetts land by 2030.

*See additional grants for land conservation and more in Massachusetts on the **Massachusetts Land Trust Coalition Grants Database**.*

### Agriculture, Forestry, and Land Stewardship

- **U.S. Department of Agriculture Conservation Stewardship Program (CSP)**
  Supports conservation activities on working agricultural and forest lands.
- **U.S. Department of Agriculture Environmental Quality Incentives Program (EQIP)**
  Technical and financial support for agriculture and non-industrial forestry projects that improve environmental health.
- **Agricultural Conservation Easement Program (ACEP)**
  Protects farmland, restores wetlands, and maintains grazing land conservation values.
- **Nutrient Management Loan Program**
  Assists farms with projects like composting, irrigation, and treatment facilities.
- **Regional Conservation Partnership Program (RCPP)**
  Funds collaborative land management, restoration, and conservation projects on agricultural land or non-industrial private forest land to achieve conservation benefits and address natural resource challenges.

### SCMs, Planning, and Flood Resilience

- **New Hampshire State Conservation Committee Moose Plate Grants**
  Up to $40,000 for projects including SCMs, flood resilience, water quality, conservation planning, and land conservation.

## 6.4 MONITORING PLAN

A long-term water quality monitoring plan is critical to evaluate the effectiveness of implementation efforts over time. Given the available historic data, the following monitoring efforts are recommended. These monitoring efforts will be conducted by MLPOA and WSLA as feasible.

A. **Continue routine monitoring for chlorophyll-*a*, color, turbidity, pH, specific conductivity, phosphorus, and chloride** at the deep spot (MONRINAD). Additional sites may be added at lake inlet and outlet streams as resources allow. Observations of weather conditions during the 72 hours prior to each sampling event should be recorded to help interpret results, particularly following storm events.

B. **Collect additional dissolved oxygen and temperature profiles** at least monthly from May 15 to September 30 each year between the hours of 10am and 2pm. Additionally, a dissolved oxygen and temperature profile should be taken whenever grab samples are collected, which can serve as the monthly profile. If resources allow, profiles may be collected as frequently as biweekly during this period. All data should be submitted to the Volunteer Lake Assessment Monitoring Program. Enhanced monitoring of water temperature and dissolved oxygen as the season progresses would help identify the strength and duration of summer stratification and the full extent of anoxia within the lake during this time.

C. **Collect additional phosphorus samples.** Typically, three discrete grab samples for total phosphorus are collected from the surface and bottom water in June, July, and August, as part of the NHDES VLAP program. We recommend expanding this effort to collect discrete grab samples for total phosphorus every two meters from the surface down to one meter above the bottom (6.5 meters) at the deep spot, for a total of 2-3 times between late July and September. This would further refine the concentrations of phosphorus within the water column during the time of the season when stratification is the strongest and anoxia is expected to be at its maximum, all to further refine the amount of phosphorus coming from internal loading.

D. **Conduct an in-depth phyto- and zooplankton analysis** to assess species composition and abundance throughout the season. Collect plankton net tows regularly during the sampling period. Seasonal fluctuations in these communities can help determine the relative abundance of cyanobacteria compared to other families and genera present.

E. **Collect lake sediment samples** to assess the potential for internal phosphorus loading, we recommend collecting lake sediment samples to measure the elemental ratios of phosphorus, aluminum, and iron in the lake's sediment and characterize biologically labile fractions of phosphorus. This would determine how much phosphorus could further contribute to internal loading.

## 6.5 INDICATORS TO MEASURE PROGRESS

The following **environmental**, **programmatic**, and **social** indicators and associated milestones will help to track progress toward meeting the water quality goal and objectives (Table 19). Milestones are set for short-term (2029), mid-term (2032), and long-term (2036) intervals, based on actions identified in the action plan (Section 5). These milestones support periodic plan updates, ensure ongoing relevance, and help the MLPOA and WSLA determine whether adjustments are needed if targets are not being met.

**Environmental indicators** directly measure conditions in the watershed and reflect the relationship between pollutant sources and water quality. They assume implementation of recommended actions from the action plan.

**Programmatic indicators** track watershed protection and restoration activities that help to achieve the water quality goal.

**Social indicators** measure shifts in community practices and behaviors that support management measures and water quality improvement.

**Table 19.** Environmental, programmatic, and social indicators for the Monomonac Lake WMP. Milestones are cumulative, starting at year 1, 2027. ppb = parts per billion.

## Environmental Indicators

| Milestone | 2029 | 2032 | 2036 |
|---|---|---|---|
| Achieve an average summer deep spot epilimnion total phosphorus concentration of 10.4 ppb at the deep spot station [MONRINAD]. | <11.8 ppb | <11.5 ppb | <10.4 ppb |
| Achieve an average summer deep spot epilimnion chlorophyll-*a* concentration of less than 3.3 ppb at the deep spot station [MONRINAD]. | <3.9 ppb | <3.8 ppb | <3.3 ppb |
| Eliminate the occurrence of cyanobacteria or algal blooms in Monomonac Lake (milestones based on modeled results). | 16 days per year | 14 days per year | 8 days per year |
| Achieve an average summer water clarity of 3.8 meters or deeper at the deep spot station [MONRINAD] (based on modeled results). | 3.5 meters+ | 3.6 meters+ | 3.8 meters+ |
| Prevent and/or control the introduction and/or proliferation of invasive aquatic species. | Managed invasives | Minimal invasives | Absence of invasives |

## Programmatic Indicators

| Milestone | 2029 | 2032 | 2036 |
|---|---|---|---|
| Amount of funding secured from municipal/private work, fundraisers, donations, and grants. | $200,000 | $625,000 | $1,000,000 |
| Number of nonpoint source sites remediated. | 3 | 7 | 20 |
| Percentage of shorefront properties with LakeSmart certification. | 10% | 20% | 60% |
| Number of watershed/shoreline properties receiving technical assistance for implementation cost sharing. | 20 | 40 | 120 |
| Number of workshops and trainings for stormwater improvements to residential properties (e.g., NH Lakes). | 1 | 2 | 5 |
| Number of updated or new ordinances that target water quality protection. | 1 | 2 | 3 |
| Number of new municipal staff for inspections and enforcement of regulations. | 1 | 1 | 2 |
| Number of voluntary or required septic system inspections (seasonal conversion and property transfer). | 100 | 200 | 600 |
| Number of septic system replacements. | 50 | 100 | 300 |

| | | | |
|---|---|---|---|
| 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 and winter maintenance. | 1 | 5 | 10 |
| Number of parcels with new conservation easements or number of parcels put into permanent conservation. | 1 | 2 | 5 |
| Number of watershed-based educational materials distributed or articles published. | 200 | 500 | 1,000 |
| Number of new best practices for road management and winter maintenance implemented on public and private roads by the municipalities. | 2 | 5 | 10 |
| Number of municipalities fully implementing key aspects of the MS4 program (regardless of being required to do so). | 1 | 1 | 2 |
| Number of meetings and/or presentations to municipal staff and/or boards related to the WMP. | 2 | 5 | 10 |
| Number of Comprehensive Nutrient Management Plans completed or NRCS technical assistance provided for farms in the watershed. | 1 | 2 | 3 |

## Social Indicators

| Milestone | 2029 | 2032 | 2036 |
|---|---|---|---|
| Number of new association members (for both MLPOA and WSLA). | 20 | 40 | 120 |
| Number of volunteers participating in educational campaigns. | 40 | 80 | 240 |
| Number of people participating in informational meetings, workshops, trainings, SCM demonstrations, or group septic system pumping. | 100 | 200 | 600 |
| Number of watershed residents installing conservation practices on their property and/or participating in LakeSmart. | 40 | 80 | 240 |
| Number of municipal Public Works staff receiving Green SnowPro training. | 1 | 3 | 5 |
| Number of groups or individuals contributing funds for plan implementation. | 25 | 50 | 100 |
| Number of newly trained water quality and invasive species monitors. | 2 | 4 | 6 |
| Percentage of residents making voluntary upgrades or maintenance to their septic systems (with or without free technical assistance), particularly those identified as needing upgrades or maintenance. | 10% | 20% | 60% |
| Number of farmers working with NRCS. | 1 | 2 | 3 |
| Number of weekly visitors to the MLPOA and WSLA websites. | 10 | 20 | 60 |

# ADDITIONAL RESOURCES

Buffers for wetlands and surface waters: a guidebook for New Hampshire municipalities. Chase, et al. 1997. NH Audubon Society.

Commercial Green SnowPro Certification. New Hampshire Department of Environmental Services.

Conserving your land: options for New Hampshire landowners. Lind, B. 2005. Center for Land Conservation Assistance / Society for the Protection of New Hampshire Forests.

Environmental Fact Sheet: Erosion Control for Construction within the Protected Shoreland. New Hampshire Department of Environmental Services, SP-1, 2020.

Gravel road maintenance manual: a guide for landowners on camp and other gravel roads. Maine Department of Environmental Protection, Bureau of Land and Water Quality. April 2010.

Gravel roads: maintenance and design manual. U.S. Department of Transportation, Federal Highway Program. November 2000. South Dakota Local Transportation Assistance Program (SD LTAP).

Innovative land use techniques handbook. New Hampshire Department of Environmental Services. 2008.

Landscaping at the water's edge: an ecological approach. University of New Hampshire, Cooperative Extension. 2007.

Municipal Green SnowPro Certification. New Hampshire Department of Environmental Services.

New Hampshire Homeowner's Guide to Stormwater Management: Do-It-Yourself Stormwater Solutions for Your Home. New Hampshire Department of Environmental Services, Soak Up the Rain New Hampshire. Revised November 2019.

New Hampshire Stormwater Manual. University of New Hampshire Stormwater Center, Comprehensive Environmental, Inc., New Hampshire Department of Environmental Services. 2025.

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# APPENDIX A: SCM MATRIX

**Table A-1.** Site ID, priority rank, location description, latitude, longitude, and estimated pollutant load reductions following Stormwater Control Measure (SCM) implementation for the 20 nonpoint source sites identified in the Monomonac Lake watershed. Sites are grouped by lake and status (completed, designed, or not addressed). Pollutant load reduction estimates are preliminary and are for planning purposes only. TP = total phosphorus. TN = total nitrogen. TSS = total suspended solids. kg/yr = kilograms per year. Details on recommended SCMs by site are available in a separate Microsoft Excel® document.

| Rank | Site | Location | Brief Problem Description | Total Suspended Solids Reduction *(metric tons per year)* | Total Phosphorus Reduction *(kg/yr)* | Total Nitrogen Reduction *(kg/yr)* | Estimated Average Cost | Cost per Kilogram of Phosphorus Reduced |
|---|---|---|---|---|---|---|---|---|
| 1 | DPW-4 | Coot Bay Drive | Steep road leads directly to lake | 0.44 | 0.80 | 4.54 | $12,000 | $15,000 |
| 2 | M-5 | East Monomonac Road | Gully along road to stream crossing | 0.37 | 0.10 | 0.25 | $2,000 | $20,000 |
| 3 | B-11 | Route 119 | Large ditch gully | 1.80 | 0.47 | 1.22 | $57,500 | $122,340 |
| 4 | B-14 | Goddard Road Private Driveway | Gully | 0.41 | 0.11 | 0.28 | $3,000 | $27,273 |
| 5 | B-12 | Lord Hill Road | Large ditch gully on steep slope | 1.63 | 0.43 | 1.11 | $12,000 | $27,907 |
| 6 | B-1 | Boat Launch | Pavement leads directly into lake via boat launch | 0.15 | 0.27 | 2.05 | $89,000 | $329,630 |
| 7 | M-6A-C | E. Monomonac Rd. Culvert, Gully #1-3 | Several road gullies | 0.35 | 0.10 | 0.24 | $9,500 | $95,000 |
| 8 | M-2 | Bridge on Island Road | Channelized ditch erosion | 0.56 | 0.15 | 0.38 | $7,500 | $50,000 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 9 | M-4 | Fourth Street | Gullies along steep road and parking area | 0.06 | 0.19 | 1.00 | $22,000 | $115,789 |
| 10 | M-3 | Second Street | Gravel road gullies | 0.13 | 0.21 | 1.24 | $13,000 | $61,905 |
| 11 | B-13 | Goddard Road | Gully along gravel road | 2.05 | 0.54 | 1.39 | $24,000 | $44,444 |
| 12 | M-9 | Perry Road | Gullies along road to stream crossing | 0.37 | 0.10 | 0.25 | $5,500 | $55,000 |
| 13 | B-8 | Colburn Lane Hill | Gullies | 1.22 | 0.32 | 0.83 | $21,000 | $65,625 |
| 14 | B-2 | Dolly Lane | Gullies | 0.53 | 0.14 | 0.36 | $18,500 | $132,143 |
| 15 | B-10 | Swan Point Road | Crushed culvert causing erosion | 0.29 | 0.08 | 0.20 | $29,500 | $368,750 |
| 16 | M-8 | Bancroft Road Crossing | Riprap washout | 0.15 | 0.04 | 0.10 | $5,000 | $125,000 |
| 17 | B-9 | Colburn Lane Shorefront | Drainage issues apparent via pooling of water | 0.05 | 0.10 | 0.55 | $24,000 | $240,000 |
| 18 | B-6 | Hubbard Hill Road | Extreme erosion | 0.03 | 0.04 | 0.09 | $14,000 | $350,000 |
| 19 | B-4 | Paradise Island Road Shorefront | Gullies | 0.39 | 0.10 | 0.27 | $118,000 | $1,180,000 |
| 20 | B-5 | Paradise Island Road Hill | Gully leads directly to water | 0.47 | 0.12 | 0.32 | $75,000 | $625,000 |
| 21 | M-1 | West Monomonac Road | Channelized erosion | 0.01 | 0.00 | 0.00 | $17,500 | *none* |