



Lake Waukewan and Lake Winona

Watershed Restoration Plan Update

DRAFT | September 2026

Prepared by
FB Environmental Associates



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Prepared by **FB Environmental Associates**
in partnership with the Town of Meredith



Contact

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For questions, comments, or additional information related to the Lake Waukewan and Lake Winona Watershed Restoration Plan Update, please contact the Town of Meredith at alabrecque@meredithnh.org.

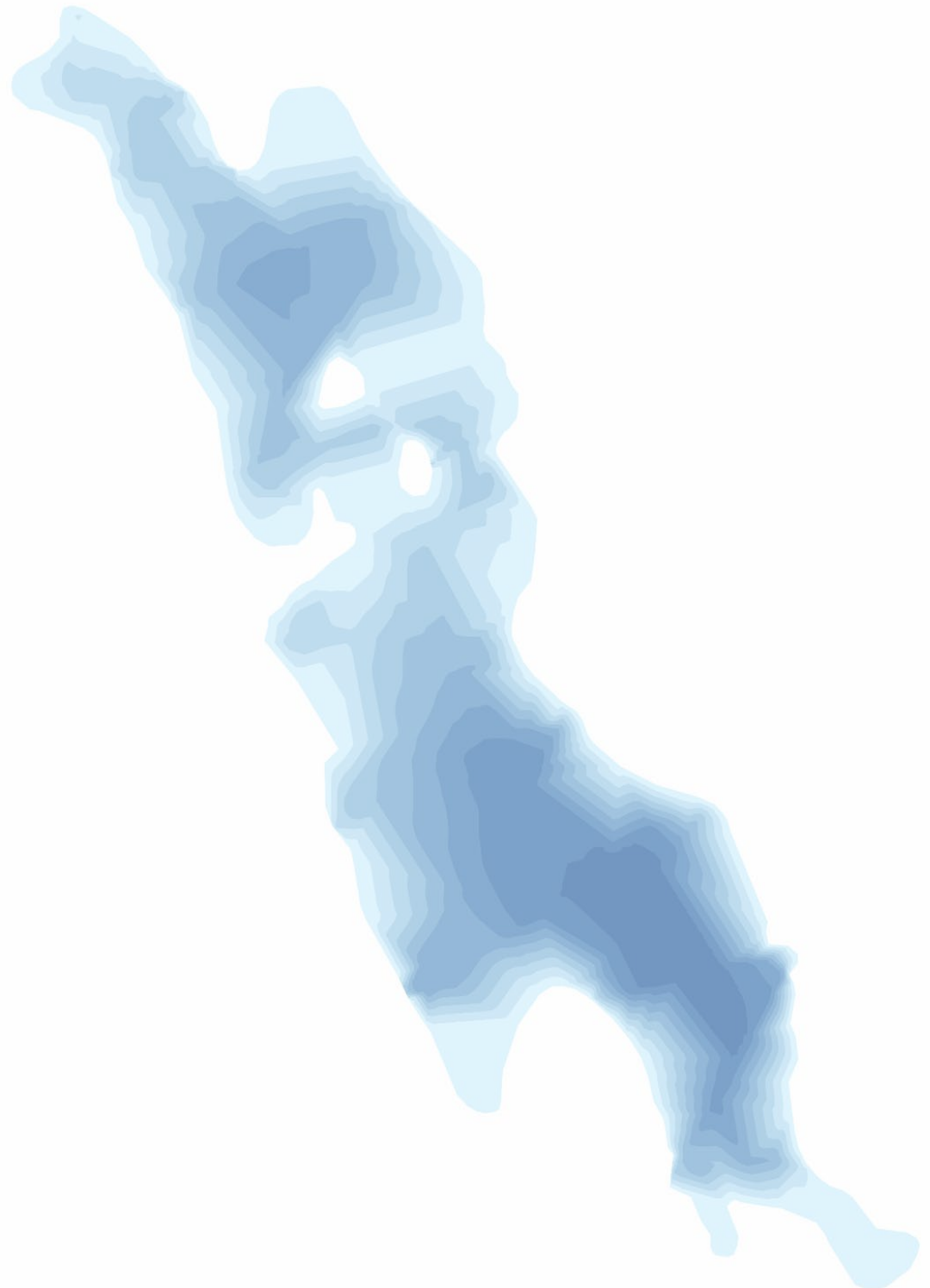


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ABBREVIATIONS

ACRONYM	DEFINITION
AIPC	Aquatic Invasive Plant Control, Prevention and Research Grants
ACEP	Agricultural Conservation Easement Program
BCCD	Belknap County Conservation District
CAGR	Compound annual growth rate
CSP	Conservation Stewardship Program
CWSRF	Clean Water State Revolving Fund
EPA	United States Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
FBE	FB Environmental Associates
GCCD	Grafton County Conservation District
HW	Horsley Witten Group
kg/yr	Kilograms per year
LCHIP	Land and Community Heritage Investment Program
LLRM	Lake Loading Response Model
LSWPG	Local Source Water Protection Grant
LWCF	Land and Water Conservation Fund
LWA	Lake Winnepesaukee Alliance
LWIA	Lake Winona Improvement 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
NOAA	National Oceanographic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
ppb, ppm	parts per billion, parts per million
RSA	Revised Statutes Annotated
SCM	Stormwater control measure
UNH	University of New Hampshire
USDA	United States Department of Agriculture
WRP	Watershed-Based Management Plan
WWAC	Waukegan Watershed Advisory Committee
WWC	Windy Waters Conservancy
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.



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EXECUTIVE SUMMARY

The challenges facing Lake Waukegan and Lake Winona and how we can continue to address them together.

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Lake Waukegan (959 acres) and Lake Winona (159 acres) flow into Meredith Bay in Lake Winnepesaukee, a natural resource central to the ecological health and economic vitality of the New Hampshire Lakes Region. Lake Waukegan is also the public drinking water supply for the Town of Meredith, serving over 3,000 consumers and the Meredith Village District. The 8,189-acre Lake Waukegan and Lake Winona watershed is characterized by forested uplands, extensive wetlands, and two tributary streams and two small ponds that drain to Lake Winona, which then flows to Lake Waukegan via the Smith River. Lake Waukegan has an additional two small ponds and eight tributaries. The lakes' long-term health depends on how communities manage land use, development, and changing environmental conditions. Fortunately, the lakes are supported by the Town of Meredith's Waukegan Watershed Advisory Committee, which is a town committee dedicated to implementing protection efforts in the watershed. Two non-profit organizations, the Windy Waters Conservancy and the Lake Winona Improvement Association, work to protect the lakes.

THE PROBLEM

Lake Waukegan and Lake Winona have historically maintained excellent water quality, but recent cyanobacteria blooms in Lake Winona signal growing threats. Despite generally low nutrient levels, blooms of potentially toxic taxa (*Dolichospermum*) have been observed in multiple years. The use of Lake Waukegan as a drinking water supply warrants additional attention to water quality changes.

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 both Lake Waukegan and Lake Winona.

Surveys identified 77 problem sites with runoff or erosion issues. Modeling showed that runoff from the watershed contributes 56% and 75% of watershed phosphorus load to Lake Waukegan and Lake Winona, respectively. Without action, development and climate pressures will accelerate water quality decline.

THE GOAL

The goal is to protect water quality and recreation in Lake Waukegan and Lake Winona. The Lake Waukegan and Lake Winona Watershed Restoration Plan sets a 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 10% (33 kilograms per year) for Lake Waukegan and 7% (8 kilograms per year) for Lake Winona.

OBJECTIVE 2: Offset phosphorus loading from future development to maintain average summer in-lake total phosphorus concentrations in the next ten years.

THE SOLUTION

The Steering Committee has updated the action plan, which includes:

- **Structural Stormwater Control Measures:** runoff capture, shoreline buffers, erosion stabilization, and septic upgrades.
- **Education and Outreach:** strengthening community education on septic care, fertilizer use, stormwater, and shoreline protection. Collaborate with other nearby lake associations.
- **Monitoring:** continuation of long-term lake monitoring with the New Hampshire Department of Environmental Services Volunteer Lake Assessment Program.
- **Policy and Land Use Tools:** promotion of low impact development and resilient development standards through revision of ordinances.

The cost of implementation is estimated at over two million dollars over the next ten years, funded through state and federal grants, municipal commitments, and private support, 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 (Action Plan).

THE KEY TO SUCCESS

This watershed management plan meets the nine key planning elements required by the United States Environmental Protection Agency. Lake Waukegan and Lake Winona continue to be eligible for federal watershed assistance grants. The success of this plan will depend on continued strong coordination by the Waukegan Watershed Advisory Committee (Town of Meredith), Windy Waters Conservancy, and Lake Winona Improvement Association, 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 Lake Waukegan and Lake Winona and ensure a healthy future for these valuable natural resources.

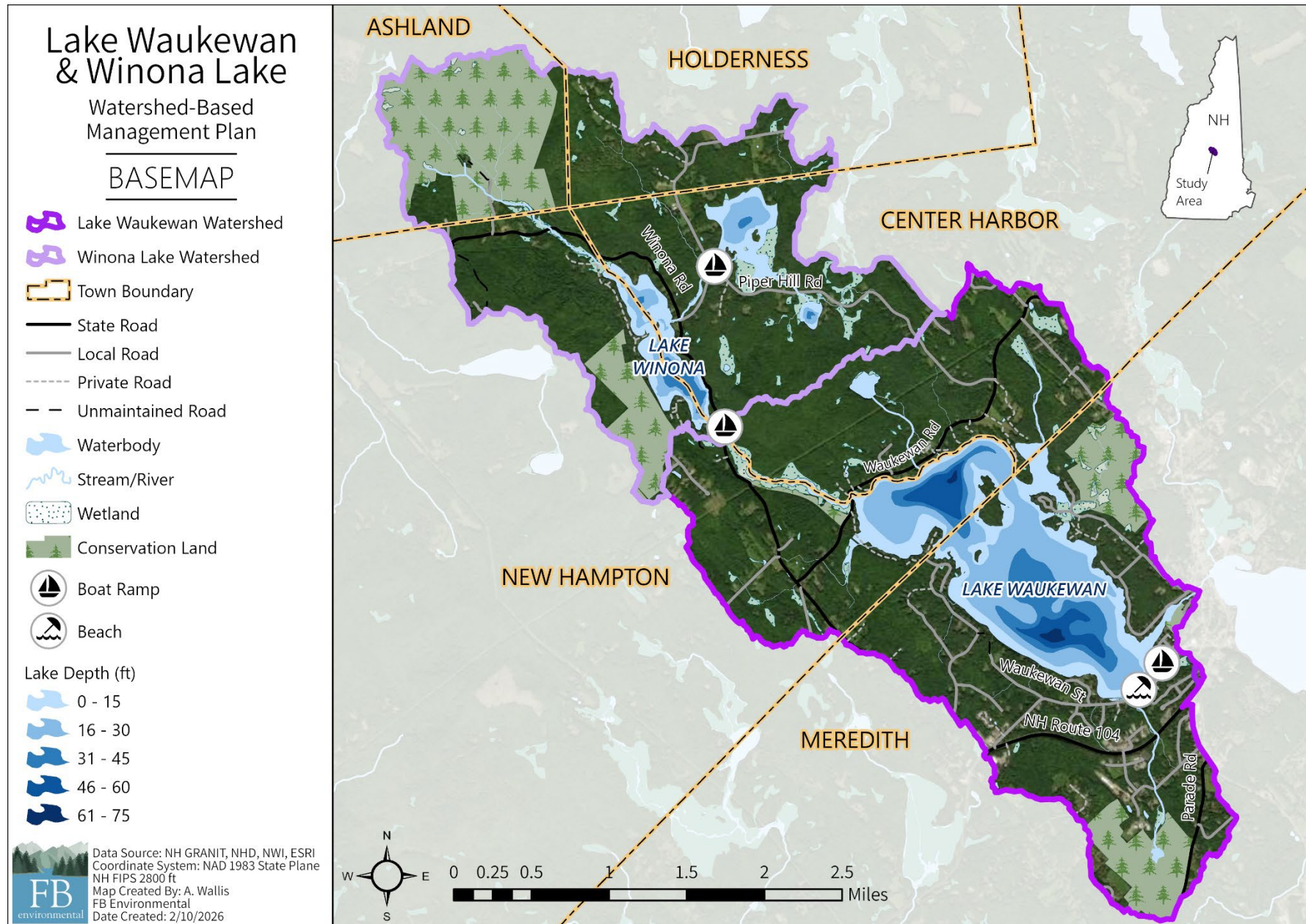


Figure 1. Lake Waukewan and Lake Winona watershed base map.

1 INTRODUCTION

1.1 WATERBODY DESCRIPTION AND LOCATION



Watershed Overview and Hydrology

The Lake Waukegan and Lake Winona watershed encompasses 8189 acres across Meredith (32% of the watershed), Center Harbor (30%), New Hampton (23%), Ashland (9%), and Holderness (6%), New Hampshire (Figure 1). The highest elevation in the watershed is the conserved Pettit Forest, home to the Homestead Forest and Trailhead in Ashland at approximately 1,226 feet above sea level. Lake Waukegan (959 acres) and Lake Winona (159 acres) sit at approximately 540 feet above sea level.

The watershed is characterized by forested uplands, a large wetland between the two lakes, and a network of numerous tributary streams and small ponds, including Bear Pond (13 acres) and Hawkins Pond (91 acres), that drain to Lake Winona and Otter Pond (12 acres) that drains to Lake Waukegan. The two lakes are connected via the Snake River. Lake Waukegan contains few islands, with Chapman Island in the northeast being the largest. The Winnepesaukee Scenic Railroad bisects a small section of Lake Waukegan to form Monkey Pond.

Lake levels are regulated by a dam at the outlet of Lake Waukegan, which influences downstream flow of Lake Waukegan into Lake Winnepesaukee and the Merrimack River system.

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 47.0 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 both lakes 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

shorelines. Major road corridors around Lake Waukegan include Routes 3, 104, and 109 (Parade Road), along with local roads such as Waukegan Street in Meredith, Winona Road in Meredith and New Hampton, Waukegan Road in New Hampton and Center Harbor, and many small private and public roads near the lake shore. Commercial areas include the southern stretch of Waukegan Street in Meredith, the intersection of Hemlock Drive and Reservoir Road in Meredith, a large shopping plaza off Route 104 in Meredith, and near the traffic circle on Route 3. Lake Winona is surrounded by roads, including the state-owned Winona Road in Center Harbor and West Shore Road in New Hampton. Hawkins Pond Road and Piper Hill Road in Center Harbor connect Lake Winona with its upper watershed.

Agricultural areas are scattered throughout the watershed and make up 2% of the watershed land area. These areas include one equestrian facility near Hawkins Pond, a small farm in Holderness, and a few farms near the Lake Waukegan shoreline, including on Perkins Farm Lane and Windy Row Lane. 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 maple. The forests in the upper watershed, particularly around Hawkins Pond and the northeastern shoreline of Lake Winona, have black, scarlet, chestnut, and white oak, hickory, and birch trees. Major wetlands complexes in the watershed are near the Fogg Hill Conservation area, specifically around Hawkins Pond and Bear Pond. The Snake River connects Lake Winona with Lake Waukegan and its surrounding area is designated as a prime wetland. Another large wetland complex exists at the intersection of Bonney Shores Road and Sawmill Shores Road in Meredith. 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, squirrels, 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 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, cormorants, hawks, and bald eagles. Fish and insect populations support both aquatic and terrestrial food webs. Of special note, the watershed towns are home to threatened and endangered species, including reproducing populations of common loons.

Human Use and Water Access



Lake Waukegan, Lake Winona, the upstream ponds, and the contributing watershed support a wide range of recreational opportunities. There are multiple public boat access points in the watershed. The most heavily trafficked boat ramp in the watershed is the Lake Waukegan public boat launch, located on Waukegan Street directly across the street from the Meredith Water Department. The

street adjacent to the boat launch offers free trailer parking, a portable toilet, a public park, and an informational kiosk. The Town Beach is located along Waukewan Street and has free street parking. The lake and the Public Boat Launch site are a short walk from downtown Meredith. There are numerous smaller launches for non-motorized watercraft and beaches owned by private road associations that are open for use by the respective road association members and their guests. There are also unpaved boat launches at the outlets of Lake Winona and Hawkins Pond for public use; these are owned by the New Hampshire Department of Fish and Game. There are no marinas or sources of boat gas on either lake. The lake and watershed are heavily used in the winter for snowmobiling, ice hockey, and ice fishing. The Meredith Rotary Club holds an annual ice fishing derby on the lake. The New England Pond Hockey Classic, which usually occurs on Meredith Bay of Lake Winnepesaukee, is occasionally moved to Lake Waukewan when ice conditions are not sufficiently thick on the bay.

Beyond the recreational and economic value of Lake Waukewan to the watershed towns and the broader community, the primary use of Lake Waukewan is as the public drinking water supply for the Town of Meredith. Lake water is taken from an intake pipe in the southern portion of the lake and piped to the Meredith Water Department on Waukewan Street. Treated water from the plant is piped to over 3,000 consumers in the town and the Meredith Village District, which supports businesses and thousands of tourists every year. During the peak summer months, the Meredith Water Department treats 600,000 gallons of water every day.

1.2 WATERSHED PROTECTION GROUPS



The [Waukewan Watershed Advisory Committee](#) is a standing Town of Meredith committee consisting of volunteers appointed by the Meredith Board of Selectmen. The committee was established after the original watershed restoration plan was finalized in 2016, with the goal of providing an organizational structure for implementation efforts. The committee is the prime entity responsible for implementing the watershed restoration plan, and meets monthly to track progress.



The [Windy Waters Conservancy](#) (WWC) serves as the non-profit lake association for the Lake Waukewan watershed with the goal of preserving and protecting the waterbodies and wetlands in the watershed to preserve their ecology and scenic beauty. The WWC is made up of residents and landowners mostly around the Lake Waukewan shoreline and is led by several volunteer board members. The WWC participates in the New Hampshire Department of Environmental Services (NHDES) Volunteer Lake Assessment Program (VLAP) water testing program to monitor the lakes and track long-term protection efforts. The WWC hosts community engagement events, provides small grants for landowners, and posts relevant information for watershed residents.



The [Lake Winona Improvement Association](#) (LWIA) serves as the non-profit lake association specific to Lake Winona. The LWIA coordinates the lake's VLAP water quality monitoring and the Lake Host program to prevent the spread of aquatic invasive plants. The association's website hosts a plethora of educational materials for homeowners. The LWIA collaborates with the Loon Preservation Committee to monitor the lake's loon population.



The [Lake Winnepesaukee Alliance](#) (LWA) is a non-profit organization that leads watershed planning and restoration, lake science, and advocacy within the Lake Winnepesaukee watershed. The LWA has collaborated on numerous projects centered on Lake Waukegan, including the original 2016 watershed-based plan and a **cyanobacteria** monitoring project in 2024. The LWA also helps with LakeSmart certifications for shoreline properties within the Lake Winnepesaukee watershed.



The [Winnisquam Watershed Network](#) is a non-profit lake organization protecting Lake Winnisquam and its watershed, which is directly adjacent to the Lake Waukegan watershed. Parts of the watershed include land in Meredith and New Hampton. The network has collaborated with WWC/WWAC on regional efforts, including large workshops and outreach events. *Collaboration between adjacent watershed associations that work within the same municipalities may have greater collective power for advocacy or can more effectively leverage funds to achieve a common goal.*



The [Newfound Lake Region Association](#) is the non-profit lake association protecting the Newfound Lake watershed in Bristol, Alexandria, Hebron, and Bridgewater, NH. The association focuses its protection efforts on water quality monitoring, invasive species prevention, land conservation, stormwater management, and education. The association has collaborated with WWC/WWAC on regional efforts, including large workshops and outreach events. *Collaboration between adjacent watershed associations may have greater collective power for advocacy or can more effectively leverage funds to achieve a common goal.*



The [Lake Kanasatka Watershed Association](#) is the non-profit association protecting Lake Kanasatka in Moultonborough, NH. The watershed association has extensively leveraged in-kind time and materials donations from community members to implement their watershed management plan. The association has collaborated with WWC/WWAC on regional efforts, including large workshops and outreach events. *Collaboration between adjacent watershed associations may have greater collective power for advocacy or can more effectively leverage funds to achieve a common goal.*



The **Squam Lakes Association** is a non-profit association protecting the Squam Lakes watershed, with land area in Ashland, Holderness, Center Harbor, Meredith, New Hampton, Sandwich, Campton, and Moultonborough. The association has collaborated with WWC/WWAC on regional efforts, including large workshops and outreach events. *Collaboration between adjacent watershed associations that work within the same municipalities may have greater collective power for advocacy or can more effectively leverage funds to achieve a common goal.*



The **Belknap County Conservation District** (BCCD) and **Grafton County Conservation District** (GCCD) are two of ten county conservation districts in New Hampshire that operate as resource management agencies and subdivisions of local governments. BCCD focuses on improving and maintaining Belknap County's environment through community workshops, stream restoration, invasive species management, and other projects. These organizations work with farmers, landowners, schools, and municipalities to protect natural resources, especially with regard to extreme weather.



Lakes Region Conservation Trust is a non-profit organization "dedicated to the permanent conservation, stewardship, and respectful use of lands that define the character of the Lakes Region and its quality of life." Their vision is a "future where conserved lands support thriving biodiversity, healthy watersheds, and vibrant human communities." Lakes Region Conservation Trust has conserved 162 properties totaling over 28,300 acres in the Lakes Region.



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. Conservation commissions in the Lake Waukewan and Lake Winona watershed include those in Meredith, New Hampton, Center Harbor, Ashland, and Holderness.



Covering 31 communities, the **Lakes Region Planning Commission** is a valuable resource to the region. The Commission aids 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.



Moose Mountains Regional Greenways is a non-profit land trust that works to conserve and connect important natural resource areas across nine communities in the Moose Mountains and Ossipee Mountains 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. In addition to land conservation, they provide technical assistance to towns, offer educational programs, and promote stewardship to help maintain a healthy and resilient regional environment for current and future generations.



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.

1.3 PURPOSE AND SCOPE

The purpose of the Lake Waukewan and Lake Winona Watershed Restoration Plan (WRP) Update is to reprioritize implementation efforts over the next ten years (2027-2036) to continue to improve the water quality of Lake Waukewan and Lake Winona. The plan aims to meet state water quality standards for the designated uses of aquatic life integrity and primary contact recreation for oligotrophic waterbodies and to reduce the likelihood of harmful cyanobacteria blooms in the lakes, with special consideration for Lake Waukewan as a public water supply for the Town of Meredith.

As part of the update of the original 2016 plan (LWA & FBE, 2016), the **build-out analysis**, land-use model, water quality and **assimilative capacity** analysis, and watershed survey were updated to better

understand changes to the sources of phosphorus and other pollutants to the lakes (Sections 2 and 3). Results from these analyses were used to re-establish the water quality goal and objectives (Section 2.6), reprioritize recommended management strategies for the identified pollutant sources (Section 4), and update 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 updated in collaboration with the Steering Committee and public during a community forum (Section 1.4). A 10% conceptual engineering design was produced for one location where stormwater management may be improved (Appendix B), and a *Municipal Stormwater Control Measures Handbook* (FBE, 2026a) was created to guide implementation. This plan update 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 (Section 1.5).

1.4 COMMUNITY INVOLVEMENT AND PLANNING

The plan was updated through collaborative efforts, including several meetings, public presentations, and conference calls. Participants included FB Environmental Associates (FBE), Horsley Witten Group (HW), WWAC, WWC, LWIA, LWA, and representatives from conservation commissions, Boards of Selectmen, and Town of Meredith Staff (see Acknowledgments).

1.4.1 Plan Development Meetings

Several meetings were held over the duration of the plan update. The following list does not include routine annual meetings conducted separately by the WWC or shorter check-in calls that did not involve the entire Steering Committee.

June 13, 2025	The Steering Committee and FBE meet to review the scope of work and kick-off the project.
December 10, 2025	The Steering Committee, FBE, and HW meet to review the watershed survey results and prioritize sites for implementation.
May 5, 2026	FBE meets with the Steering Committee to re-establish the water quality goal, reviewing the existing in-lake water quality and modeling results.
May 21, 2026	HW conducts a site visit with Steering Committee members and Meredith town staff.
July 21, 2026	The Steering Committee and FBE meet to discuss the action plan and implementation timeline.
September 16, 2026	FBE presented the draft watershed management plan at a public forum held at the Meredith Community Center.

1.4.2 Draft WMP Public Presentation and Review Period

A final public presentation was held virtually on September 16, 2026, to summarize the analyses and recommendations detailed in the plan. The presentation was attended by members of the Steering Committee and community. 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 WRP, 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 Lake Waukewan and Lake Winona and describe the updated results of the watershed survey and other assessments. These sources of pollutants must be controlled to achieve the load reductions re-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 Lake Waukewan and Lake Winona 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 Lake Waukegan and Lake Winona. 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 WWAC 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 WWAC 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 Lake Waukegan and Lake Winona, 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.



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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 updated water quality goals and objectives for Lake Waukewan and Lake Winona.

2.1 WATER QUALITY SUMMARY

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

- 🍃 **Lake Waukewan and Lake Winona are known for great water quality.**

Lake Waukewan is legislatively classified as Class A, which represents waters that are of the highest quality and are protected for uses like drinking water (with treatment). The lake serves as the sole drinking water supply for over 3,000 people in Meredith. Lake Waukewan is classified as **oligotrophic** because water quality has consistently met the standards for the healthiest type of lake. Lake Winona is legislatively classified as Class B, which represents waters that are still considered good quality and are the most common, intended to be suitable for swimming, fishing, and supporting aquatic life. It is a **mesotrophic** lake, meaning it has a larger amount of algal growth and is less likely to have a balanced ecological community.

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

Both lakes experience **anoxia** (low **dissolved oxygen**) at the lake bottom during the summer. Lake Winona shows increasing **total phosphorus** concentrations in the **epilimnion** and hypolimnion. Lake Winona has generally higher nutrient concentrations, higher algal biomass, and reduced transparency compared to Lake Waukewan. Cyanobacteria blooms have emerged as a concern in recent years for both lakes.

- 🍃 **Both Lake Waukewan and Lake Winona are free from invasive aquatic plants.**

No aquatic invasive plant species have been found in either lake. Diligent, volunteer-based Weed Watcher and Lake Host programs have kept these invaders out of the lakes.

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. Lake Waukegan is Class A and Lake Winona 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*

Lake Waukegan was oligotrophic in surveys conducted in 1982 and 1994, and Lake Winona was **eutrophic** in 1977 and mesotrophic in surveys conducted in 1984 and 2002. This means the water quality in Lake Waukegan consistently meets the standards for the healthiest type of lake, while Lake Winona is a more productive system with a less balanced ecological community.

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 Revised Statutes Annotated (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 Lake Waukegan and Lake Winona watershed contains seven lake/pond assessment units, four 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; Figure 2). 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.

- Lake Waukegan & Lake Winona are assessed as impaired for aquatic life integrity, with "severe" ratings for low dissolved oxygen concentration and "poor" ratings for dissolved oxygen saturation and low pH. They are also impaired for primary contact recreation with "poor" ratings for cyanobacteria hepatotoxic microcystin. Cyanobacteria blooms are a concern for Lake Waukegan despite the lake's limited bloom history. Lake Winona is more productive than Lake Waukegan and has more frequent and recent blooms.
- Hawkins Pond, which feeds into Lake Winona is assessed by NHDES as impaired for aquatic life integrity, with "severe" ratings due to low dissolved oxygen concentration and saturation and a "poor" rating due to low pH.
- Bear Pond, which feeds into Hawkins Pond, is impaired for aquatic life integrity with a "poor" rating for low pH.
- The only assessed beach, the Lake Waukegan Town Beach, is not assessed as impaired for any designated uses. It is rated as "good" due to low *E. coli* levels. Otter Pond, which feeds into Lake Waukegan and Monkey Pond, a small pond formed by the Winnepesaukee Scenic Railroad, are not impaired for any designated uses due to a lack of data.
- Of the seven tributaries in the watershed that have sufficient data for an assessment, three tributaries to Lake Winona, Heights Brook, Bear Pond Brook, and the northern tributary are assessed as impaired for aquatic life integrity due to low pH. One tributary to Lake Waukegan, the Snake River, shares the same impairment.

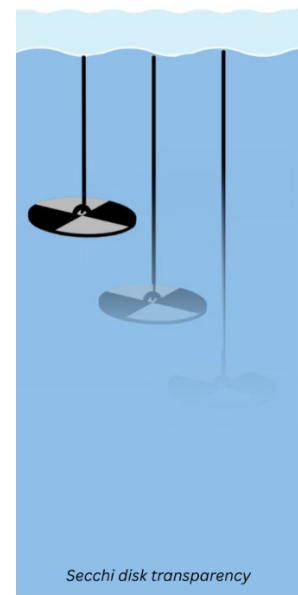
Table 1. NHDES assessment units covering lakes/ponds in the Lake Waukewan watershed and their associated area and water quality rating as reported on the NHDES 2024 Watershed Report Cards.

Assessment Unit Name	AUID	Area (acres)	Water Quality
Lake Waukewan	NHLAK700020108-02-01	926	Severe
Lake Winona	NHLAK700020108-02-02	147.5	Severe
Hawkins Pond	NHLAK700020108-04	91.12	Severe
Bear Pond	NHLAK700020108-01	13	Poor
Otter Pond	NHLAK700020108-05	12.21	No Current Data
Monkey Pond	NHLAK700020108-06	1.34	No Current Data
Lake Waukewan – Public Beach	NHLAK700020108-02-03	0.68	Likely Good

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.

Trends in the trophic state indicators were investigated for each monitoring station and depth, when applicable, for three time periods: (1) the full dataset including all observations through 2025, (2) historical data including all observations through 2015, and (3) recent data including all observations from 2016 to 2025. The analyses and results presented here focus on the two deep spots of Lake Waukewan (Winona deep spot – WAUMERWD, and Mayo deep spot – WAUMERMD) and the Lake Winona deep spot (WINNWHHD).



For total phosphorus, only the historic data for the hypolimnion in the Lake Waukewan Mayo deep spot (WAUMERMD) had a significant decreasing (improving) trend. No other statistically significant trends were found for total phosphorus concentrations at any depths in either of the Lake Waukewan deep spots (WAUMERWD, WAUMERMD) for the full, historic, or recent datasets. The lack of trends in total phosphorus indicates stable conditions for this nutrient in Lake Waukewan over time. However, the total phosphorus concentration increased with depth in the water column from the epilimnion to the hypolimnion at both deep spots in the recent data (Figure 3). Peak concentration for Lake Waukewan during this period in the hypolimnion was 65 ppb for the Winona deep spot and 30 ppb for the Mayo

deep spot. The elevated total phosphorus concentration in the hypolimnion indicates internal loading in Lake Waukewan.

No statistically significant trends were detected for epilimnetic composite samples of chlorophyll-*a*, for the full, historical, or recent dataset at either of the Lake Waukewan deep spots (Figure 4). An increasing (improving) trend for Secchi disk transparency, a measure of water clarity, was observed for the full dataset at the Lake Waukewan Winona deep spot. Lake Winona has an increasing (worsening) trend in epilimnetic total phosphorus for the recent data and in the hypolimnion for the full dataset (Figure 5).

In Lake Winona, Secchi disk transparency significantly decreased (worsened) in the full and historic data, but no trends were detected in the most recent data (Figure 5). The lack of change in the recent 10-year period indicates water clarity has been more stable since 2016. Epilimnetic composite chlorophyll-*a* has statistically increased (worsened) for the full dataset, but no significant trend was detected in the historic or recent data.

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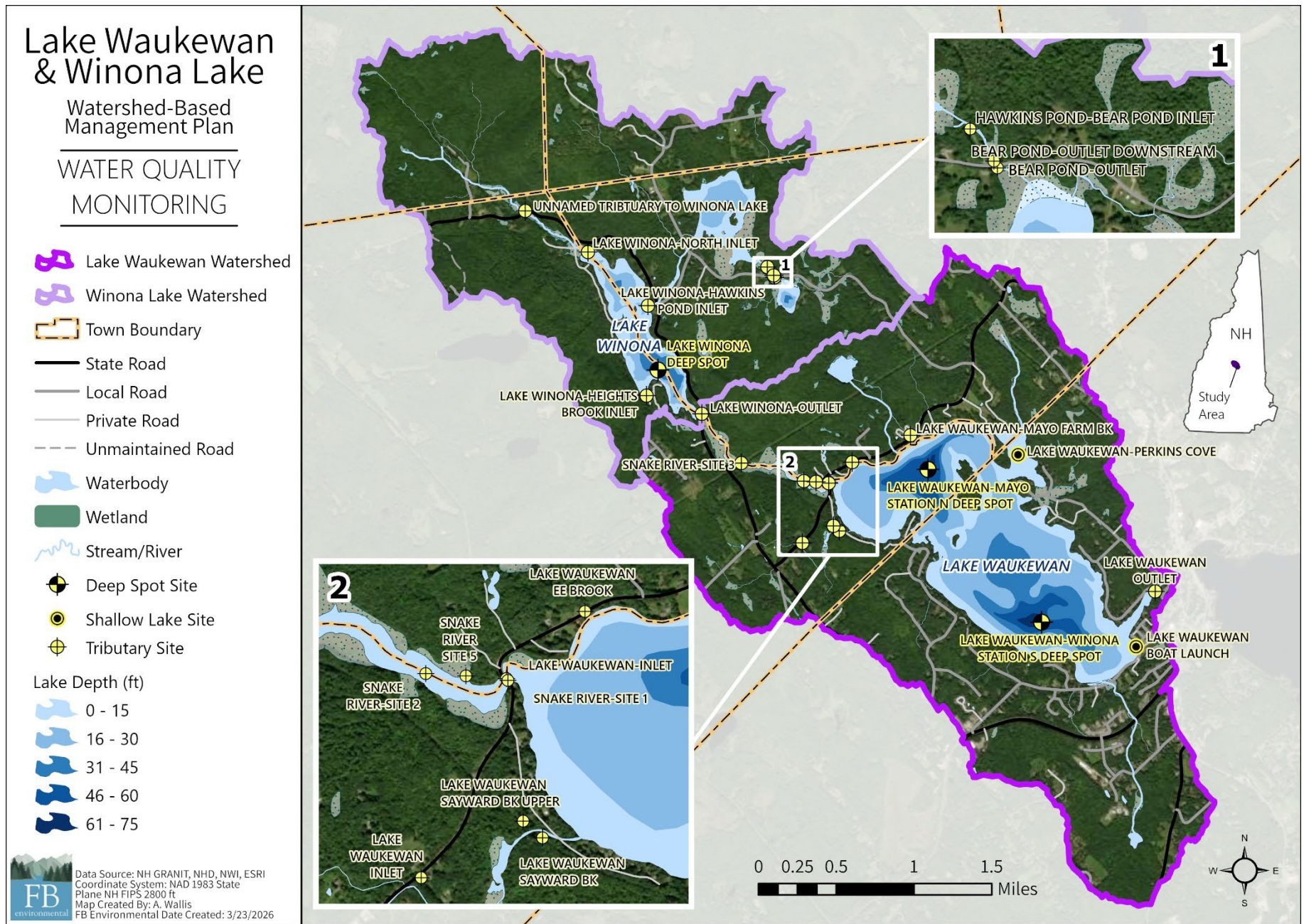


Figure 2. Select water quality sampling sites in the Lake Waukewan and Winona watershed with bathymetry.

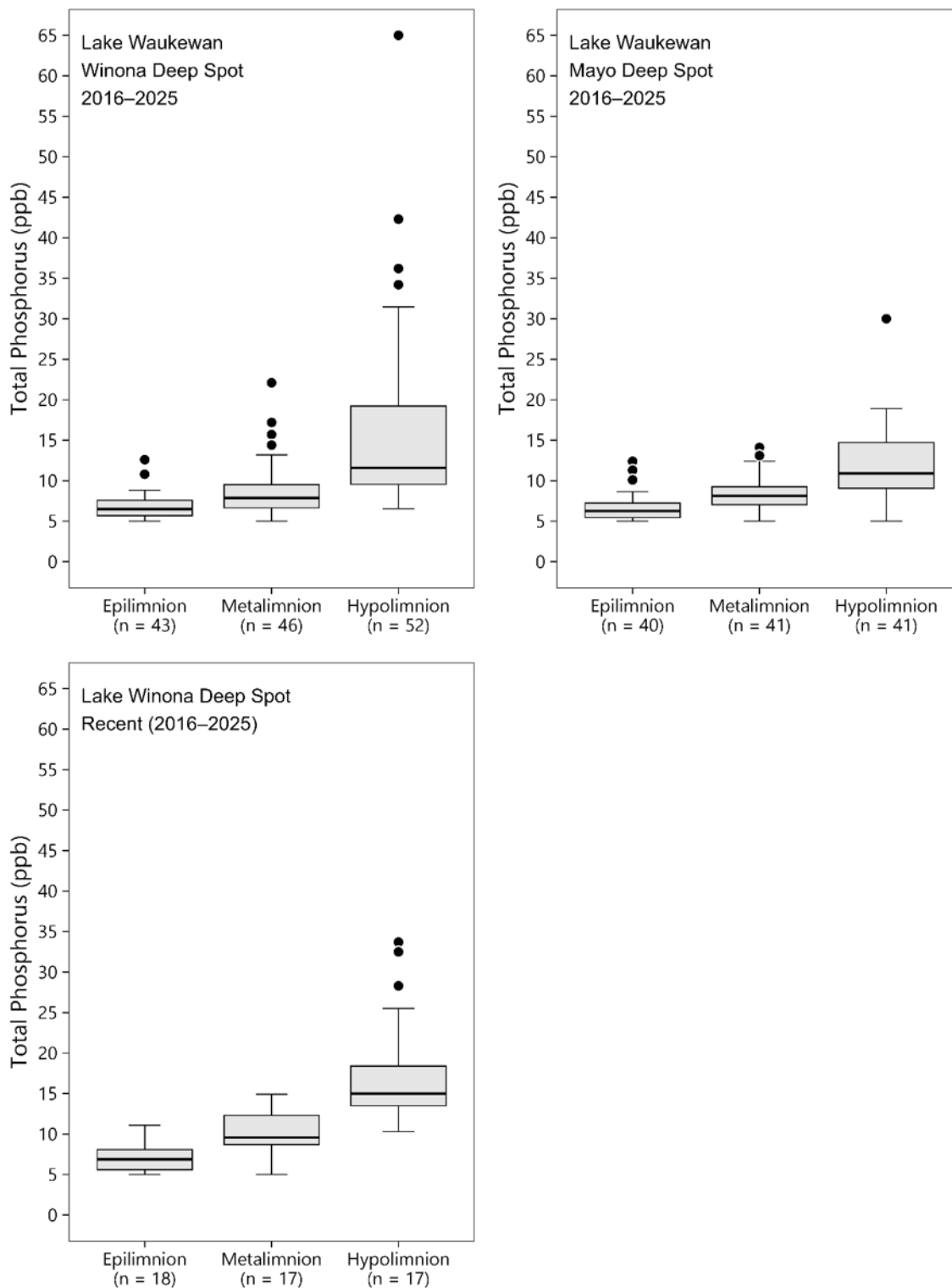


Figure 3. Boxplots showing median total phosphorus concentration in the epilimnion, metalimnion, and hypolimnion of the Winona deep spot of Lake Waukewan (top left), Mayo deep spot of Lake Waukewan (top right), and Lake Winona deep spot (bottom) from the past ten years, 2016-2025. The boxes show the 25th, 50th (median), and 75th percentiles of the data. The whiskers show 1.5 times the interquartile range (or the range from the 25th to 75th percentiles). Points are outlier observations.

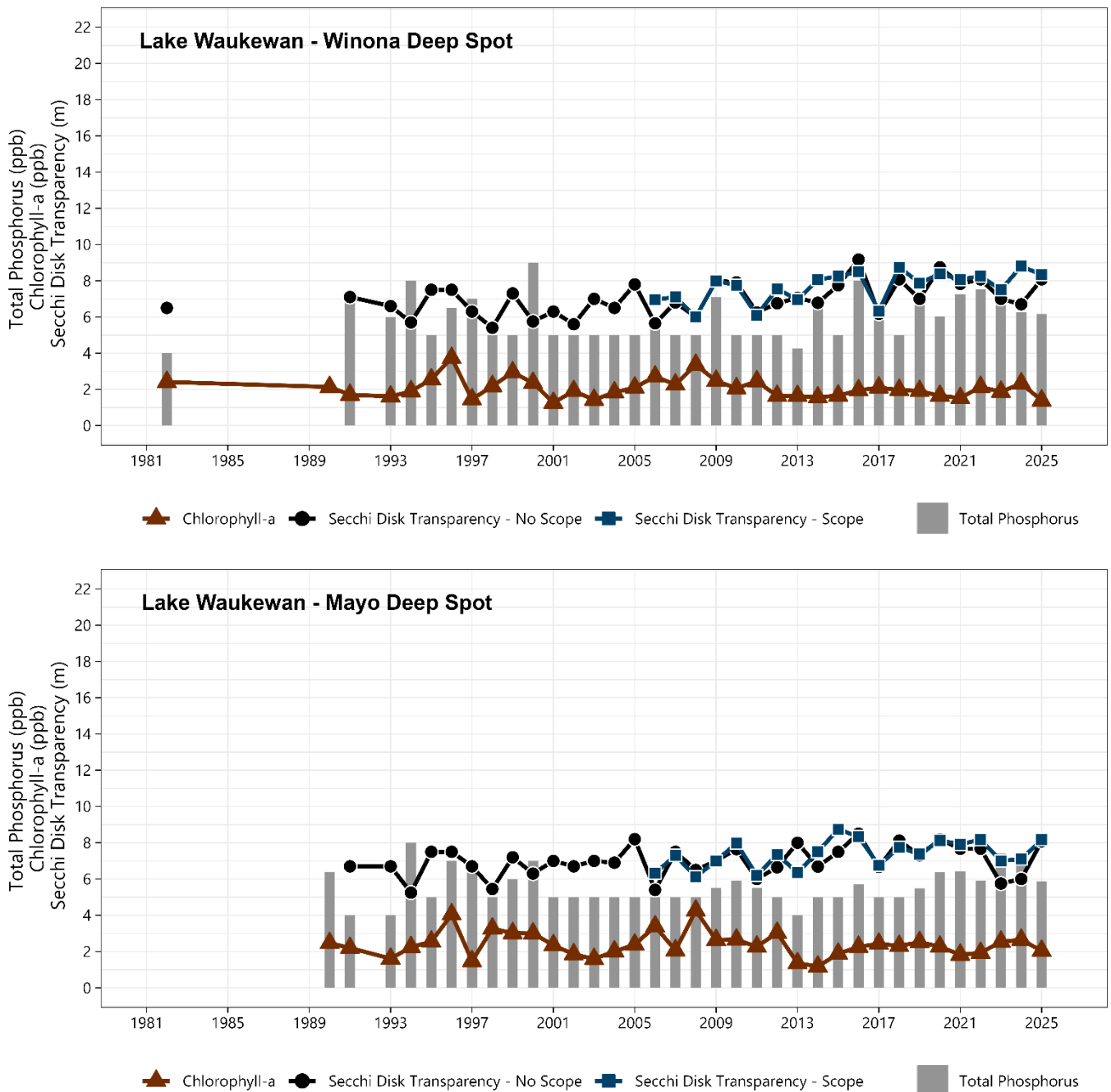


Figure 4. Median epilimnion total phosphorus, median epilimnion chlorophyll-*a*, and median water clarity (Secchi disk depth for scope and no scope methods) measured at the Lake Waukegan Winona (top) and Mayo (bottom) deep spots largely in May-September from 1982-2025. ppb = parts per billion. m = meters.

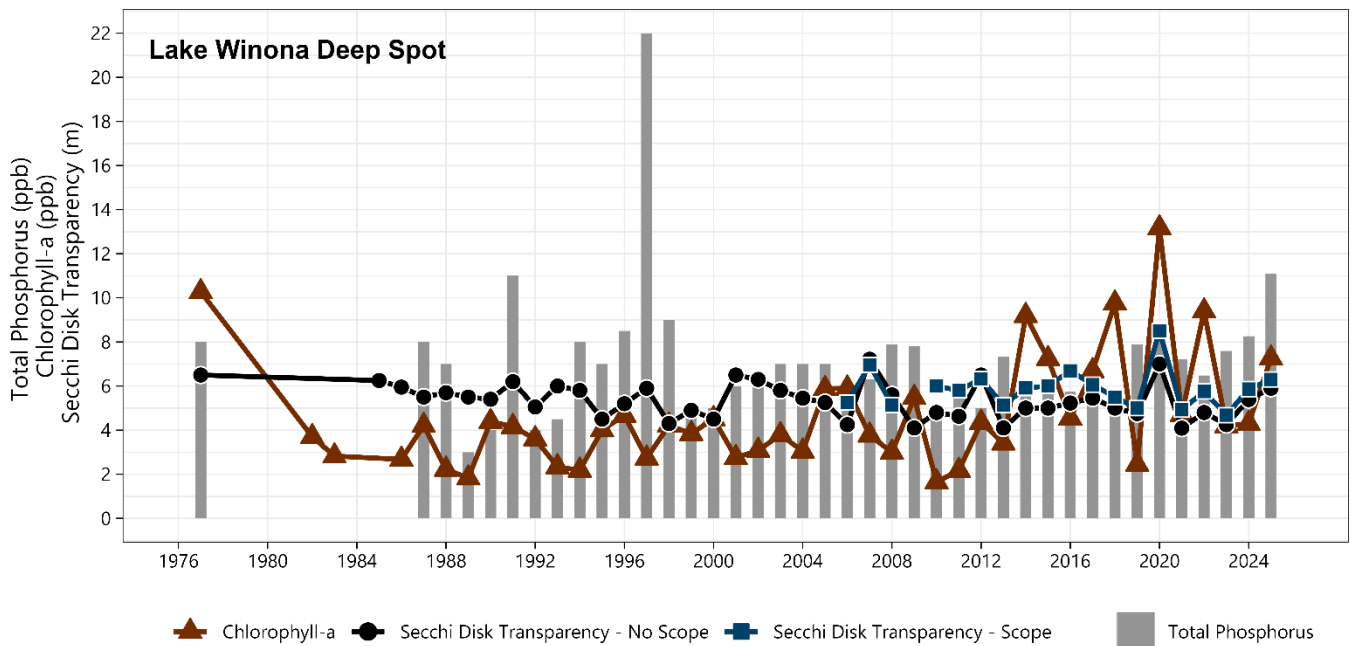


Figure 5. Median epilimnion total phosphorus, median epilimnion chlorophyll-*a*, and median water clarity (Secchi disk depth for scope and no scope methods) measured at the Lake Winona deep spot largely in June-September from 1977-2025. ppb = parts per billion. m = meters.

2.1.3 Stream Total Phosphorus

The water quality of tributaries to Lake Waukegan and Lake Winona can reveal areas throughout the watershed that are contributing disproportionate quantities of certain pollutants. Stream health is also critical because tributaries often abut wetland habitat essential for pollution sensitive aquatic biota including macroinvertebrates. Excess phosphorus loading in streams can lead to eutrophication in downstream lakes and increases the risk of potentially toxic cyanobacteria blooms. Phosphorus can enter streams from watershed sources such as soil erosion, agriculture, and other human disturbances.

Three tributaries to Lake Winona, including the Lake Winona-North Inlet (WINNWHI4), Lake Winona-Heights Brook Inlet (WINNWHI1) and the East Tributary from Hawkins Pond (Lake Winona-Hawkins Pond Inlet, WINNWHI6) have consistent, annual data collection for total phosphorus (Figure 6). The Snake River, which connects Lake Winona to Lake Waukegan, has six sites that are regularly sampled: the Lake Winona Outlet (WINNWHO), Snake River-Site 3 (SNANWH3), Snake River-Site 2 (SNANWH2), Snake River-Site 5 (SNANWH5), Snake River-Site 1 (SNANWH1), and the Lake Waukegan Inlet (WAUMERI) (Figure 7). Lake Waukegan has three additional streams with consistent data (2013-2025), including Mayo Farm Brook (WAUMER6), EE Brook (WAUMER9) and multiple sites along Sayward Brook (in order of upstream to downstream. WAUMER7B, WAUMER7A, WAUMER7) (Figure 8).

Total phosphorus is generally low in all streams to both lakes though still elevated relative to reference undisturbed levels. The highest total phosphorus concentration observed at any site across all sampling events was 53.5 ppb at the Heights Brook Inlet to Lake Winona. This total phosphorus concentration is well below the maximum in-stream total phosphorus observed in highly disturbed or high loading watersheds throughout New Hampshire. NHDES sets guidelines for total phosphorus in streams, stating

that streams are potentially attaining support for aquatic life if the median total phosphorus concentration is below 50 ppb and there are no dissolved oxygen impairments (NHDES, 2024b).

The EPA also provides stream reference values for total phosphorus, which represent undisturbed or natural stream conditions. The EPA's Ambient Water Quality Criteria Recommendations for Rivers and Streams in Nutrient Ecoregion VIII reports a reference condition of 10.0 ppb for total phosphorus. The reference value for the sub ecoregion containing New Hampshire is 5.0 ppb (EPA, 2001).

All streams with available data have median total phosphorus concentrations below the 50 ppb threshold. Streams with the highest median total phosphorus concentration over the past ten years are the East Tributary Hawkins Pond Inlet to Lake Winona (WINNWHI6) with 17.2 ppb, Sayward Brook with 13.9 ppb at the inlet site (WAUMER7), and Heights Brook Inlet to Lake Winona (WINNWHI1) with 13.0 ppb. These sites all have relatively low total phosphorus concentrations compared to streams with more highly disturbed watersheds throughout the state. All other sites included in this analysis have median total phosphorus concentrations below 10 ppb, which is evidence of excellent stream water quality. Because the median total phosphorus concentrations for all streams in the Lake Waukewan and Lake Winona watershed exceed the EPA reference value of 5.0 ppb for Ecoregion VIII, it is likely that all streams are impacted by watershed development, though not at levels indicative of impairment.

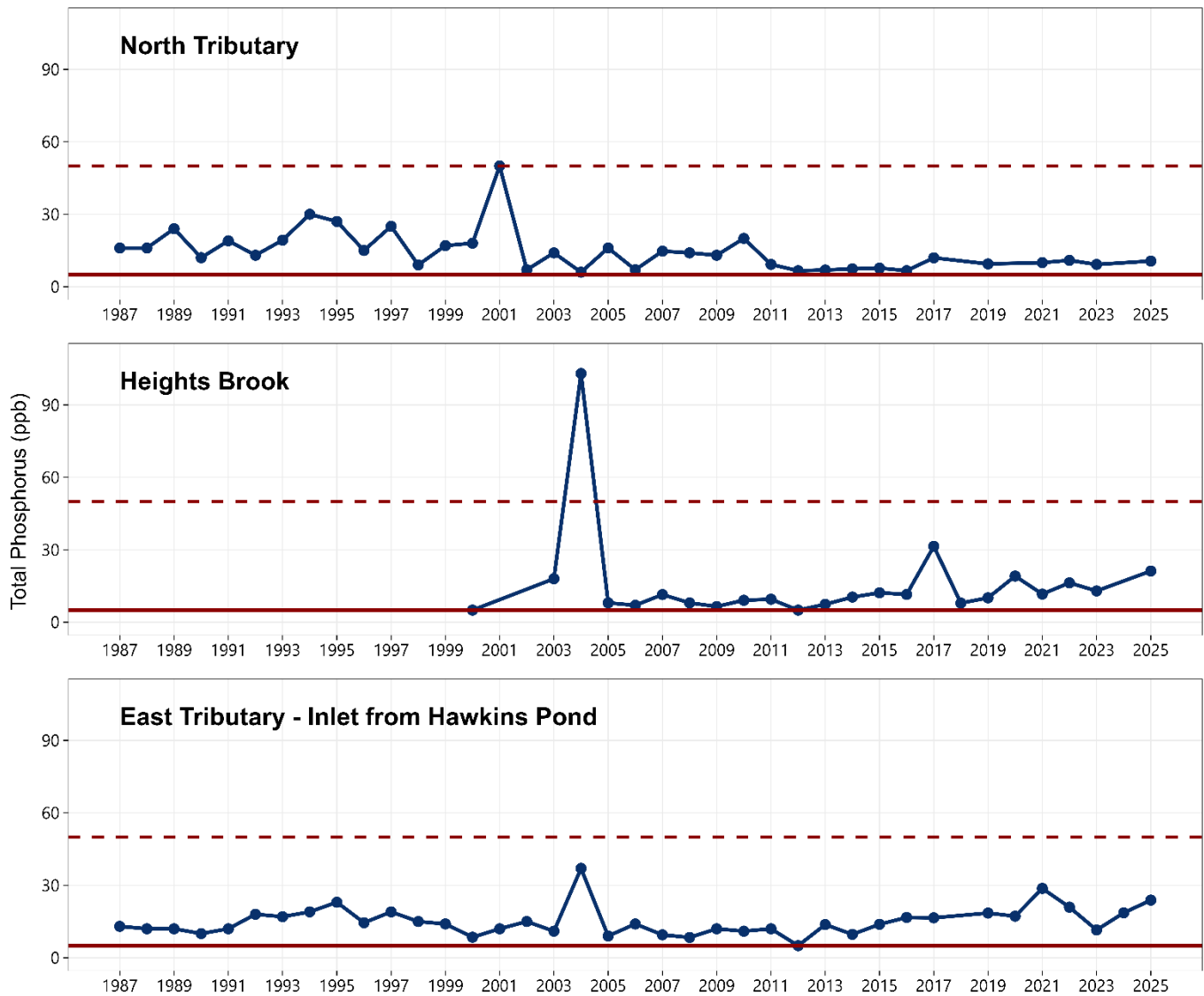


Figure 6. Median annual total phosphorus for the Lake Winona North Inlet from 1987-2025 (WINNWHI4) (top), the Heights Brook Inlet from 2000-2025 (WINNWHI1) (middle) and the East Tributary - Hawkins Pond Inlet from 1987-2025 (WINNWHI6) (bottom). The solid red line represents the reference value (5.0 ppb) for undisturbed streams from the EPA's Level VIII Ecoregion Sub-ecoregion 58. The dashed red line represents the NHDES threshold (50 ppb) for potentially not supporting aquatic life integrity.

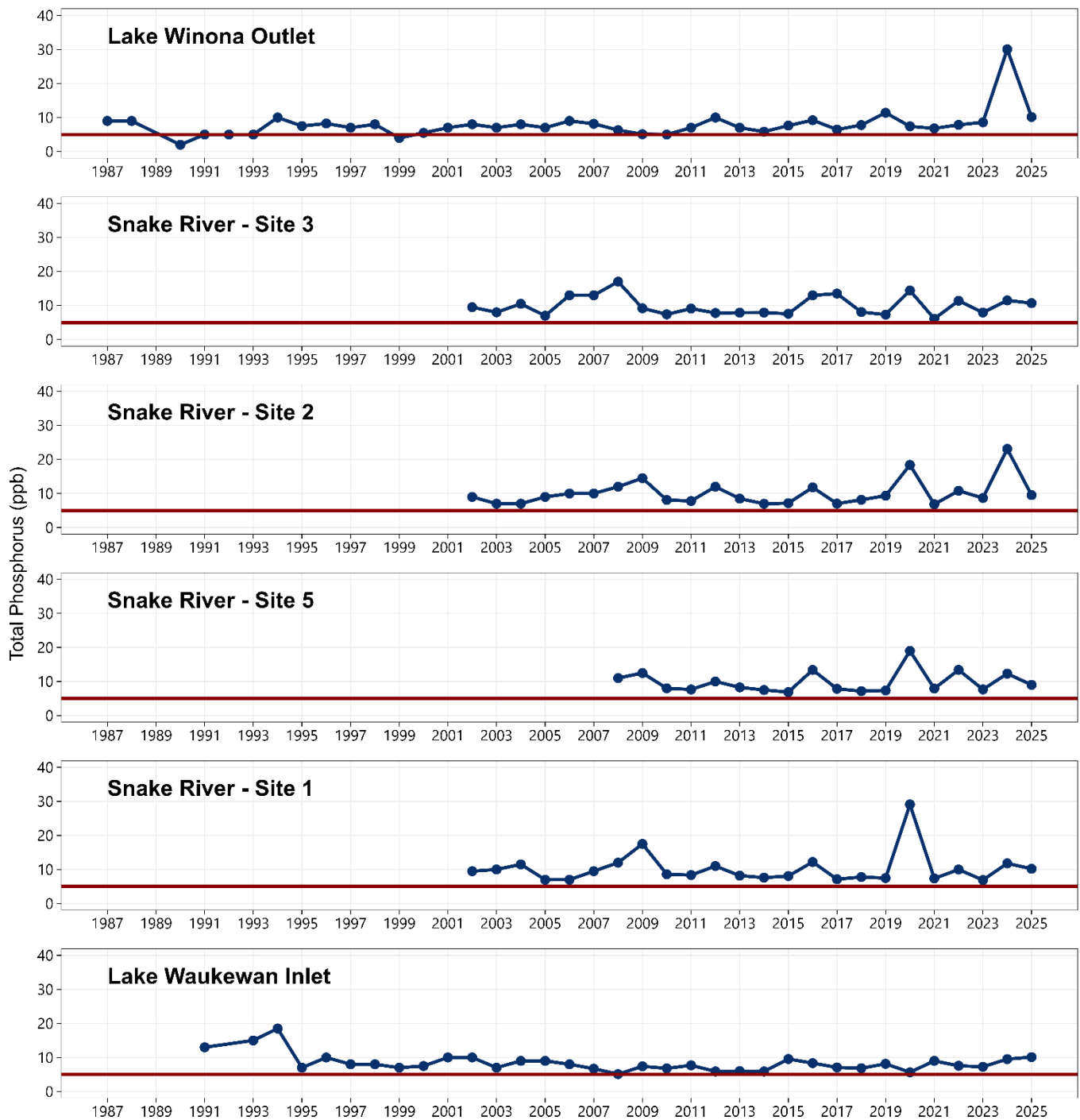


Figure 7. Median annual total phosphorus for the sites along the Snake River, ordered from upstream to downstream (top to bottom). The site IDs, from top to bottom, are as follows: Lake Winona Outlet = WINNWHO, Snake River-Site 3 = SNANWH3, Snake River-Site 2 = SNANWH2, Snake River-Site 5 = SNANWH5, Snake River-Site 1 = SNANWH1, Lake Waukewan Inlet = WAUMERI. The red line represents the reference value (5.0 ppb) for undisturbed streams from the EPA's Level VIII Ecoregion Sub-ecoregion 58.

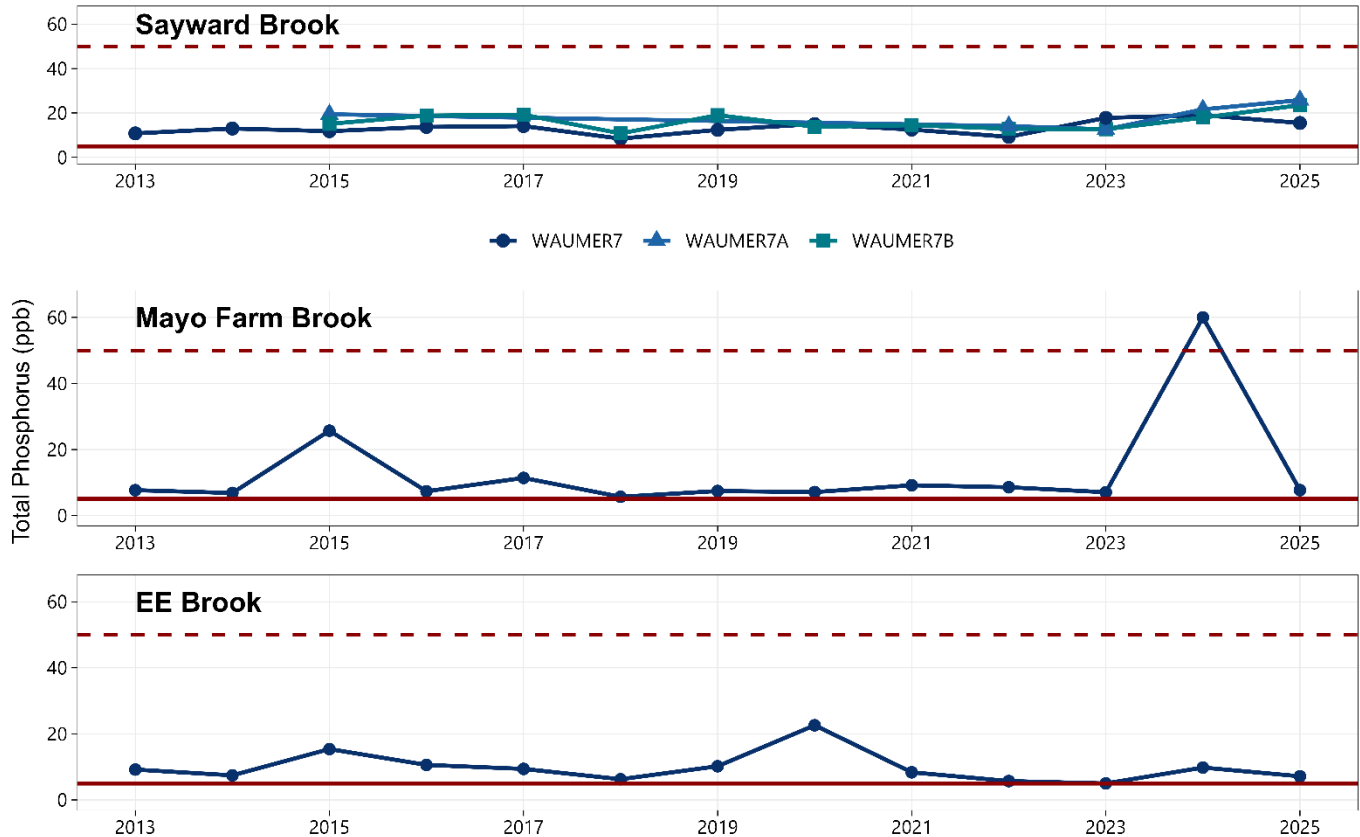


Figure 8. Median annual total phosphorus for three sites on Sayward Brook, ordered from downstream to upstream (WAUMER7, WAUMER7A, WAUMER7B) (top), Mayo Farm Brook from 2013-2025 (WAUMER6) (middle), and EE Brook from 2013-2025 (WAUMER9) (bottom). The red line represents the reference value (5.0 ppb) for undisturbed streams from EPA’s Level VIII Ecoregion Sub-ecoregion 58. The dashed red line represents the NHDES threshold (50 ppb) for potentially not supporting aquatic life integrity.

2.1.4 Shallow Lake Site Total Phosphorus

Total phosphorus concentrations in shallow coves are often higher than those at deep lake sites because they can be strongly influenced by tributaries, pollution sites, and nearshore septic systems with potentially less flushing depending on the lake morphology. High total phosphorus at nearshore sites can signal that pollutants are entering the lake from a specific sub-watershed or shoreline area. Through VLAP, multiple nearshore sites are sampled on Lake Waukegan, including Perkins Cove (WAUMERP) and the Lake Waukegan Boat Launch (WAUMER1).

As expected, total phosphorus at the Perkins Cove site shows slightly higher total phosphorus concentrations than deep water sites, nearing or exceeding the NHDES threshold for oligotrophic waterbodies of 8.0 ppb (Figure 9). In the past ten years, the site has a median total phosphorus concentration of 7.5 ppb. The Lake Waukegan Boat Launch site, which has been sampled since 2015, has far higher total phosphorus concentrations than those observed in Lake Waukegan and many of its tributaries, with a median total phosphorus concentration of 26.4 ppb (mean: 40.4 ppb) over the past ten

years. The highest observed total phosphorus concentration at this site reached 157 ppb in 2019. Phosphorus concentrations at this site regularly exceed mesotrophic and occasionally even eutrophic thresholds (Figure 9), indicating that pollutant sources near the site are impacting water quality. This nearshore site is especially critical given its proximity to the water supply intake pipe.

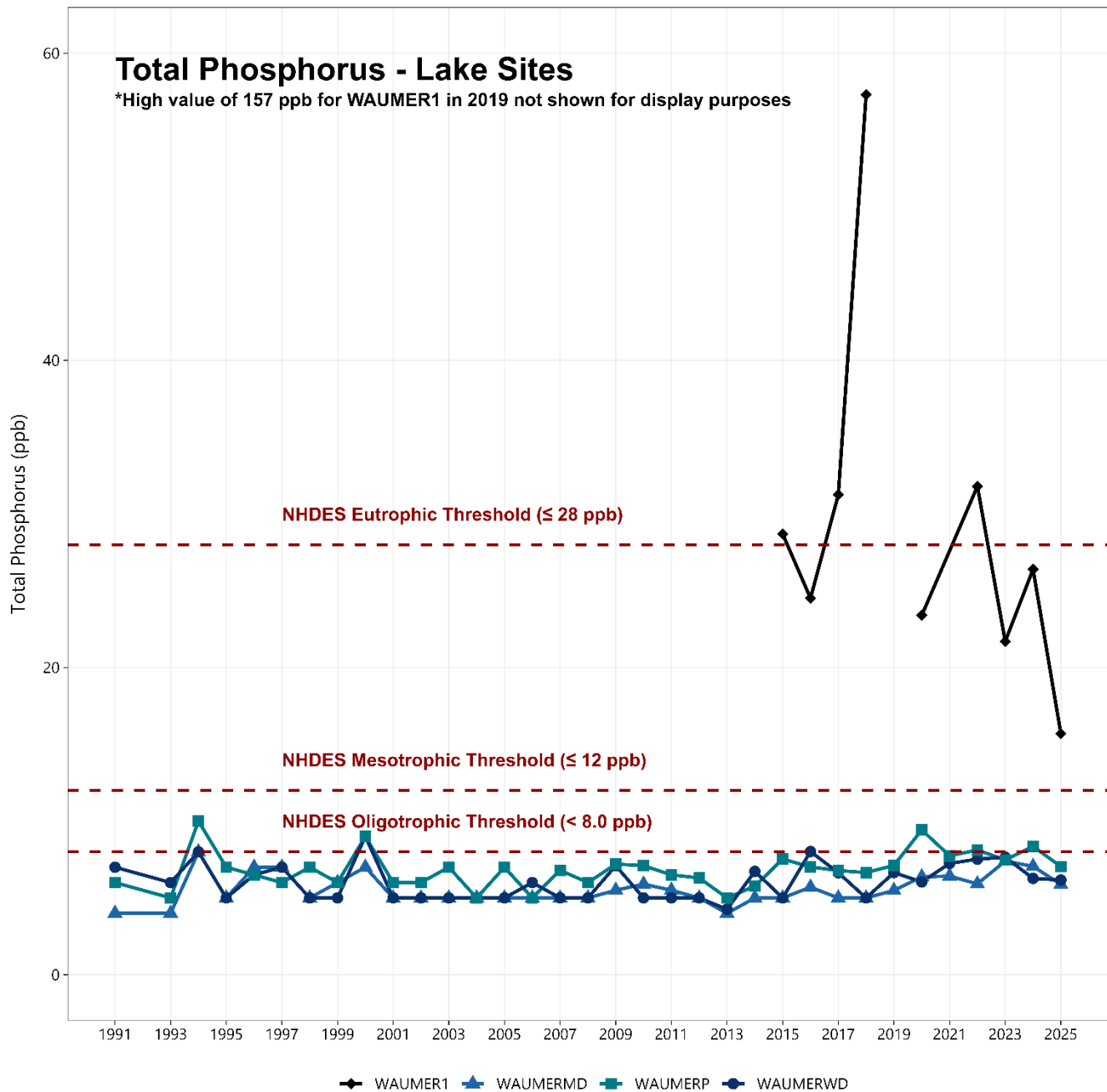


Figure 9. Yearly median total phosphorus concentrations at monitoring locations in Lake Waukegan from 1991-2025, including the boat launch (WAUMER1), Perkins Cove (WAUMERP), and the epilimnion of the Winona Station deep spot (WAUMERWD) and the Mayo Station deep spot (WAUMERMD). A high value of 157 ppb was removed for WAUMER1 in 2019 for display purposes.

2.1.5 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 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 Lake Waukegan and Lake Winona because both lakes are dimictic, meaning they mix fully in the spring and fall and stratify in the summer. However, tracking oxygen and temperature over time is important to detect whether conditions are worsening due to human impacts, such as excess phosphorus entering from the watershed.

Figure 10 shows average temperature and dissolved oxygen profiles for Lake Waukegan during summer stratification from 1990 to 2025. A sharp change in temperature between approximately 4 and 12 meters depth marks the **metalimnion** at the Winona deep spot while the Mayo deep spot metalimnion occurs at 5 to 13 meters. Dissolved oxygen below 5 ppm is observed in areas as shallow as 10 meters at both deep spots, indicating potential impacts to aquatic life. Dissolved oxygen levels below 2 ppm are regularly observed at the Winona deep spot as shallow as 11 meters. Dissolved oxygen is lowest as the lake approaches turnover. These conditions are typically associated with peak internal phosphorus loading. Slight differences in anoxia between the two deep spots in Lake Waukegan are likely a result of the distinct morphometries and sediments found at the deep spots. For example, the Mayo deep spot is slightly shallower and has mucky sediments that are likely to contain more organic matter than the Winona deep spot's clay bottom; therefore, anoxia in the hypolimnion at the Mayo deep spot appears to be more advanced (closer to zero). Conversely, the Winona deep spot

Lake Stratification and Mixing

Lake Waukegan and Lake Winona are **dimictic** lakes, undergoing two cycles of stratification and mixing annually. Stratification takes place during summer, as surface waters warm, forming a thermal barrier due to differences in water densities. Additionally, winter months see stratification when the lake freezes over, with colder surface waters sitting atop warmer bottom waters. Dimictic lakes undergo both "**fall turnover**" and "spring turnover," characterized by the loss of these temperature gradients which enable water mixing once again.

has a smaller hypolimnion volume, meaning anoxia can extend further upward in the water column, with dissolved oxygen below 2 ppm extending up to 12 meters depth compared to 15 meters at the Mayo deep spot.

Figure 11 shows average temperature and dissolved oxygen profiles for Lake Winona during summer stratification for the period of 1977 to 2024. No profiles were collected in 2025. Sharp temperature drops between 4 and 9 meters indicate the approximate metalimnion depth. Dissolved oxygen drops below 5 ppm around 9 meters and below 2 ppm at 12 meters, indicating a vulnerability to internal phosphorus loading at the deep spot.



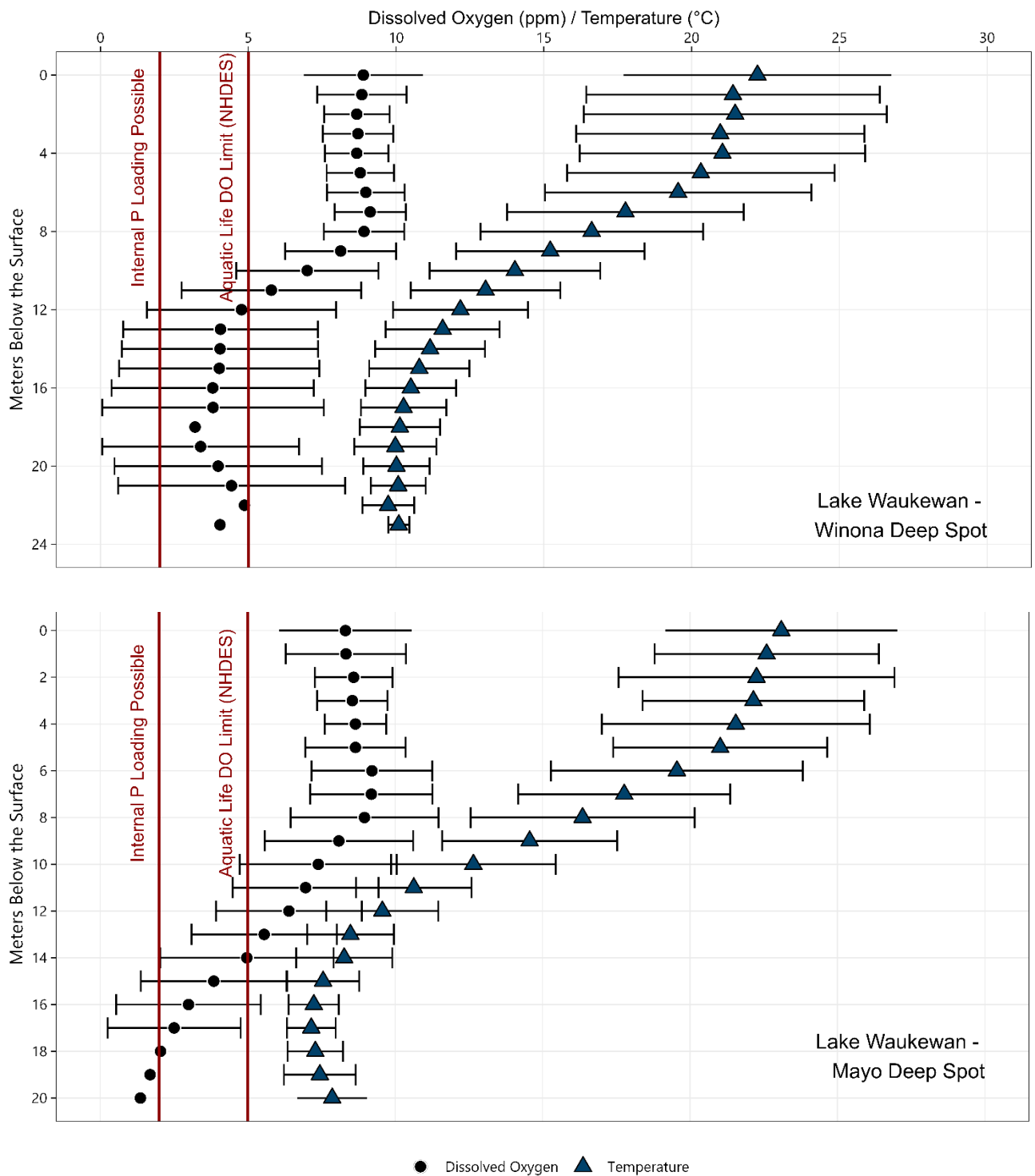


Figure 10. Average dissolved oxygen (black circles) in parts per million (ppm) and water temperature (white triangles) in degrees Celsius (C) by depth in meters below the surface for the Winona deep spot (top) and Mayo deep spot (bottom) of Lake Waukegan. Error bars represent one standard deviation. Data represents profiles collected from 1990 to 2025 (number of unique dates=101 for temperature and n=83 for dissolved oxygen) for the Winona deep spot, and 1990-2024 (n=55 for temperature and n=37 for dissolved oxygen) for the Mayo deep spot. Red lines at 5 ppm and 2 ppm represent thresholds for aquatic life integrity and internal phosphorus loading risk, respectively, due to low dissolved oxygen.

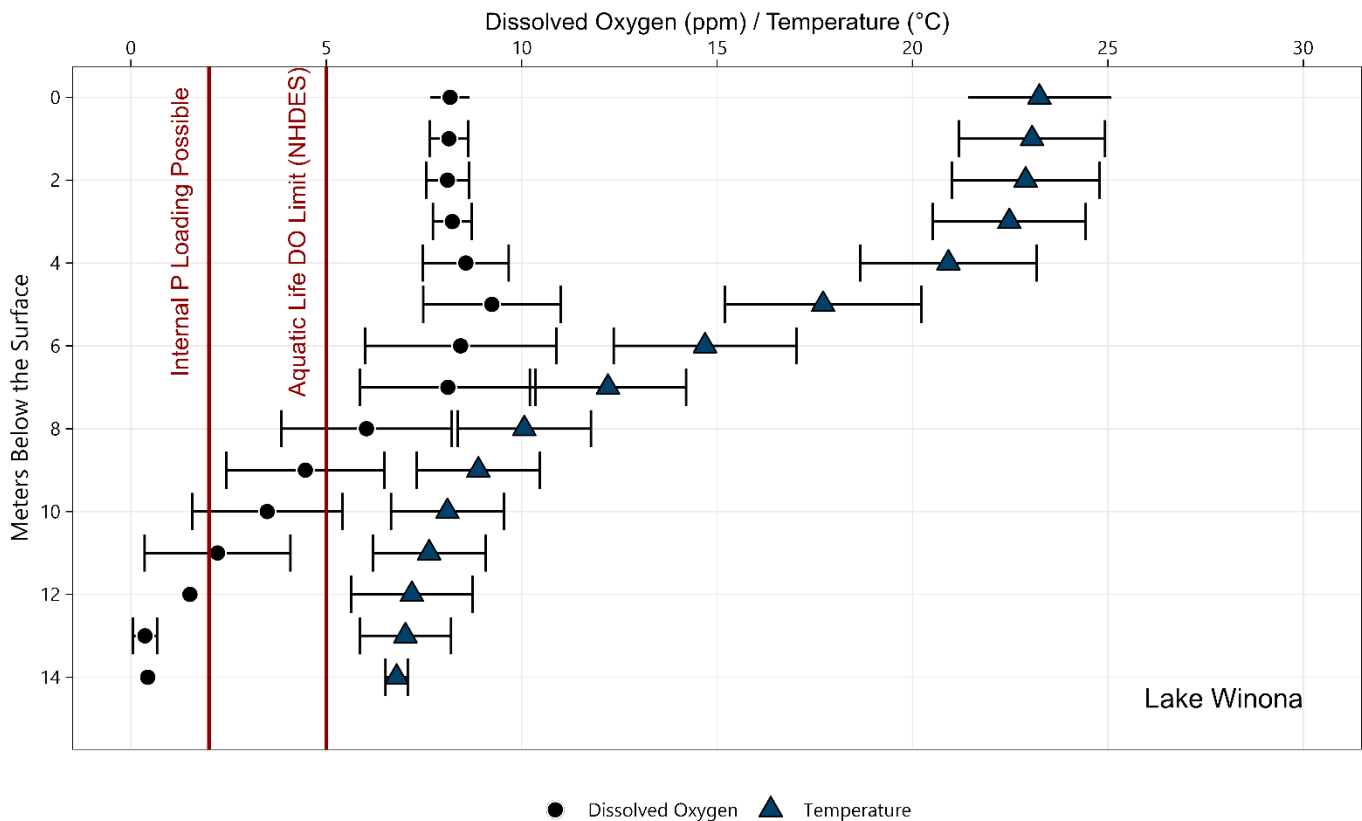


Figure 11. Average dissolved oxygen (black circles) in parts per million (ppm) and water temperature (white triangles) in degrees Celsius (C) by depth in meters below the surface for the Lake Winona deep spot. Error bars represent one standard deviation. Data represents profiles collected from 1977-2024 (number of unique dates=39 for temperature and n=41 for dissolved oxygen). Red lines at 5 ppm and 2 ppm represent thresholds for aquatic life integrity and internal phosphorus loading risk, respectively, due to low dissolved oxygen.

2.1.6 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.

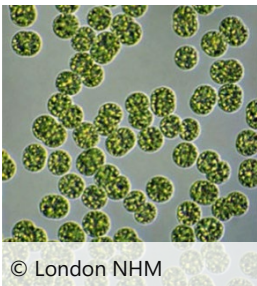
Cyanobacteria are single-celled bacteria that can photosynthesize. They often grow in colonies and, under bloom conditions, can sometimes produce dangerous toxins such as microcystins. These toxins may cause a wide range of health effects in humans, pets, livestock, and wildlife, including neurological, 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 lakes, such as:



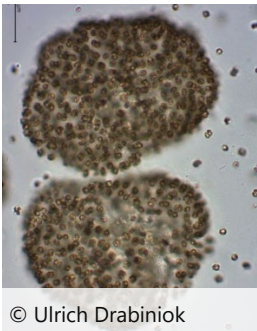
Dolichospermum

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



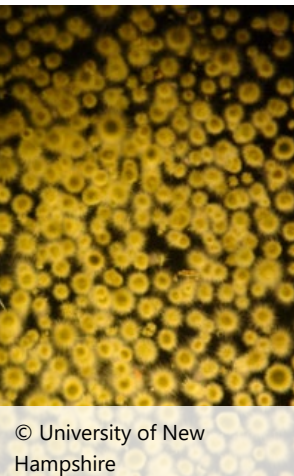
Microcystis

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



Woronichinia

Typically forms dense colonies, can produce microcystin.



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.



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 warming water temperatures 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.

Lake Waukegan has only had one officially reported [NHDES cyanobacteria bloom warning](#) (Table 2). The warning lasted four days in August 2009 and was dominated by *Anabaena* (now *Dolichospermum*) with over 70,000 cells/mL. However, as noted in FBE (2025a), seven other bloom conditions not reported as official warnings occurred on the lake between 2011 and 2020 that were often around the time of fall turnover and had accumulations consistent with *Dolichospermum* blooms. Cyanotoxin testing in Lake Waukegan in 2024 indicated low levels of the toxins that cyanobacteria are capable of producing (FBE,

2025a). The dominant cyanobacteria were picocyanobacteria, which are tiny, unicellular (0.2–2 µm) cyanobacteria that are too small to be seen by the human eye, even when magnified under a microscope. A high relative abundance of picocyanobacteria is reflective of low-nutrient conditions.

Lake Winona has had three cyanobacteria warnings and one watch issued by NHDES, as of January 2026 (Table 1). These have all been dominated by *Dolichospermum*, a dominant cyanobacteria type in the Lakes region. Though the types of toxins produced by this group are dependent upon the species, *Dolichospermum* can produce microcystin (hepatotoxin), cylindrospermopsin (hepatotoxin), and anatoxin-a (neurotoxin).

Table 2. Cyanobacteria bloom history of Lake Waukegan and Lake Winona. ">50%" refers to the sample having a relative abundance greater than 50% for the blooming taxon.

Waterbody	Notification Type	Date Issued	Date Removed	# Days issued	Dominant Taxa	Initial Cyanobacteria Cell Density (cells/mL)
Waukegan	Warning	8/24/2009	8/28/2009	4	<i>Anabaena</i>	>70,000 or >50%
Winona	Warning	8/29/2018	9/7/2018	9	<i>Anabaena</i> / <i>Dolichospermum</i>	1,000,000
Winona	Warning	6/19/2020	6/24/2020	5	<i>Anabaena</i> / <i>Dolichospermum</i>	365,000
Winona	Watch	8/9/2020	none	none	not identified	not counted
Winona	Warning	7/27/2023	8/3/2023	7	<i>Dolichospermum</i>	950,000

Dominant Phytoplankton and Zooplankton

Phytoplankton and zooplankton samples were collected and analyzed during the 1982 and 1994 NHDES trophic surveys for Lake Waukegan and the 1977, 1987, and 2005 NHDES trophic surveys for Lake Winona. They are also collected annually through the VLAP program and monthly during the 2024 field season. A detailed overview of the phytoplankton community in Lake Waukegan for the 2024 summer season, as well as for 2017-2024 based on VLAP data, is provided in FBE (2025a).

The phytoplankton community in Lake Waukegan is typically dominated by diatoms and golden-brown algae, with cyanobacteria dominating occasionally but often comprising less than 10% of the total algal colonies or units. However, composition changes by season and is associated with lake stratification. Overall phytoplankton abundance is low, while diversity and evenness are high, indicating a balanced ecological community and a low productivity trophic state (FBE, 2025a).

Zooplankton samples were collected for Lake Waukegan during the 1982 and 1994 Lake Trophic Surveys (NHDES, 1982; 1994). Each survey includes two biological sampling events; first in summer and in the following winter. During the 1982 survey, no zooplankton taxa were identified as dominant, and zooplankton counts were low with only 18 microcrustacea per liter. In the 1994 survey, crustacean zooplankton far outnumbered rotifers in the summer sample, while zooplankton abundance was lower overall in the winter sample compared to the summer sample. Abundant zooplankton taxa included

Nauplius larvae (copepod), *Calanoid* copepods, *Gastropus* (rotifer), *Keratella* (rotifer), and *Synchaeta* (rotifer).

Enhanced zooplankton monitoring in 2024 indicated a diverse community at the intake and deep spot sites, with 4-12 unique genera observed in each sample, and high diversity and evenness indices (FBE, 2025a). This indicates a well-balanced zooplankton community that can graze on various phytoplankton and is more resilient to environmental changes. However, zooplankton biomass was relatively low.

Cladocerans and copepods comprised most of the zooplankton biomass. Cladocerans found in Lake Waukegan included *Bosmina*, *Daphnia dubia*, *Daphnia pulex*, and *Holopedium*. These crustaceans (especially *Daphnia*) tend to be the most efficient grazers in the lake ecosystem and are often the largest zooplankton depending on the species.

In the Lake Winona NHDES Trophic Surveys (NHDES, 1977; 1987; 2005), phytoplankton communities were dominated by *Dinobryon* (golden-brown), *Asterionella* (diatom), *Urosolenia* (formerly *Rhizosolenia*, a diatom), *Synura* (golden-brown), and *Chrysosphaerella* (golden-brown) in the summer samples. In winter, dominant taxa included *Asterionella*, *Urosolenia*, *Mallomonas* (golden-brown), and *Melosira* (diatom). Zooplankton communities consisted primarily of unidentified Protozoan species, *Keratella* (rotifer), *Nauplius* larva (crustaceans), *Kellicottia* (rotifer), and unidentified rotifer species in the summer surveys. Dominant zooplankton in winter consisted of *Kellicottia*, *Synchaeta* (rotifer), *Nauplius* larva, *Polyarthra* (rotifer), and unidentified ciliate and rotifer species.

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



WWC and FBE sampling Lake Waukegan in 2024. © FBE

2.1.7 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 ($\mu\text{S}/\text{cm}$) for specific conductivity). While long-term median chloride concentrations at the Lake Waukegan and Lake Winona deep spots are below the chronic impairment threshold (Table 3), the boat launch site (WAUMER1) in 2022 was nearly at threshold and 2025 exceeded it, indicating chronic chloride toxicity to aquatic life at that site. Chloride and specific conductivity in the epilimnion of both lakes are above the median for New Hampshire lakes (NHDES, 2024c) (Table 3), and chloride and specific conductivity levels at the Lake Waukegan Boat Launch site (WAUMER1) are far higher than those at both lake deep spots and other shallow sites. The median chloride concentration at the boat launch site is more than four times greater than the median chloride concentration in the rest of the lake (Figure 12, Table 3).

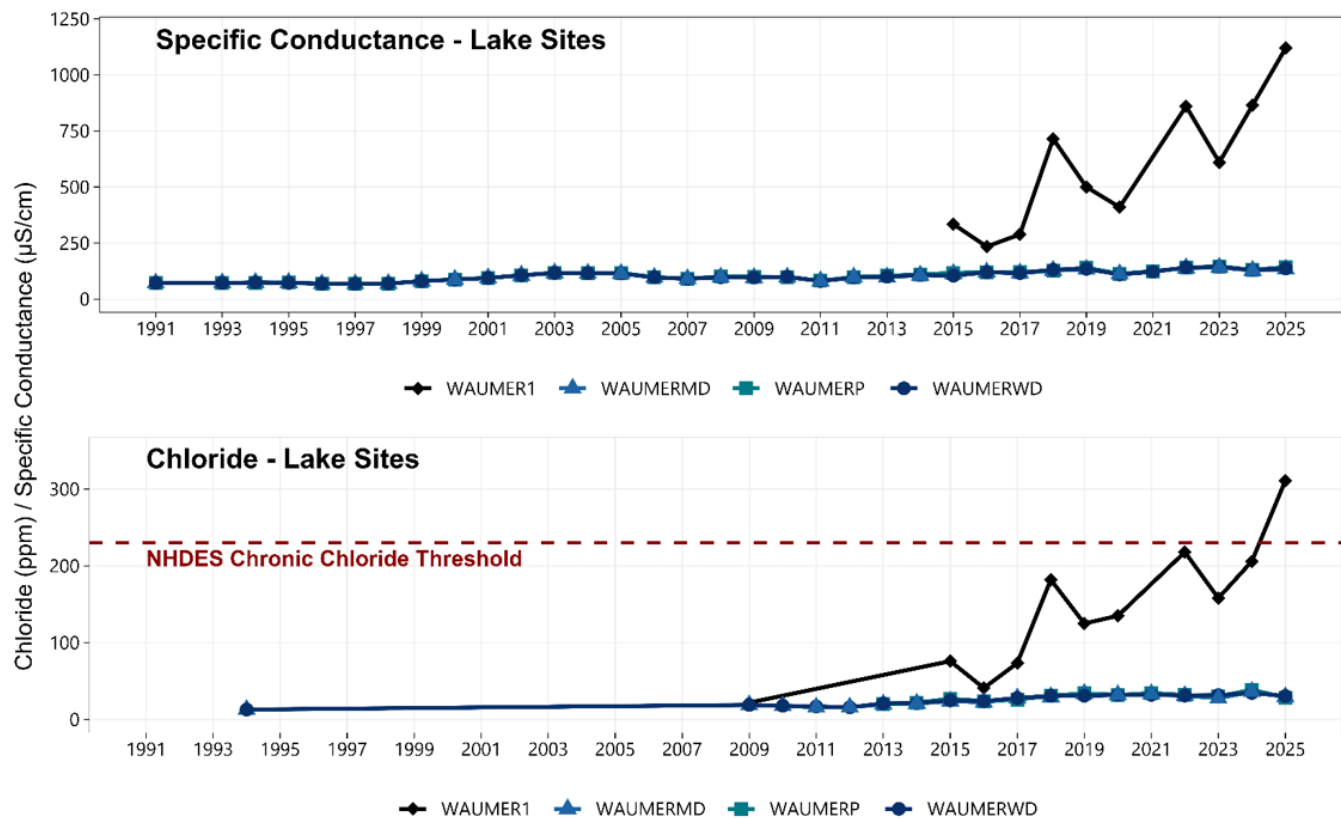


Figure 12. Yearly median specific conductivity (top) and chloride (bottom) concentrations at monitoring locations in Lake Waukegan, including the boat launch (WAUMER1), Perkins Cove (WAUMERP), and the epilimnion of the Winona Station deep spot (WAUMERWD) and the Mayo Station deep spot (WAUMERMD).

Table 3. Median chloride and specific conductance values for New Hampshire lakes and in the epilimnion of Lake Waukegan and Lake Winona deep spots and select shallow sites on Lake Waukegan for the period 2016-2025.

Parameter	New Hampshire	Lake Waukegan – Winona Deep Spot (Epilimnion)	Lake Waukegan – Mayo Deep Spot (Epilimnion)	Lake Winona Deep Spot (Epilimnion)	Lake Waukegan – Perkins Cove	Lake Waukegan – Boat Launch
Chloride (Median)	5 mg/L	32 mg/L	31 mg/L	17 mg/L	31 mg/L	135 mg/L
Specific Conductivity (Median)	42.3 μ S/cm	129 μ S/cm	127 μ S/cm	81 μ S/cm	130 μ S/cm	510 μ S/cm

Specific conductivity shows an increasing (worsening) trend in epilimnion and hypolimnion layers at the Lake Waukegan and Lake Winona deep spots between 1982 and 2025 (Figure 13 and Figure 14), suggesting that salt impacts to the lakes have worsened over time. This overall increasing trend was detected despite occasional periods of decreasing specific conductivity in both lakes. Chloride in the epilimnion is also statistically increasing (worsening) at all three sites, while chloride samples from hypolimnion depths are too sparse to detect a trend.

The increasing trends indicate that chloride from winter salting practices in the watershed, water softeners, and seepage from septic systems may be contaminating the lakes. Applying de-icing road salts is a common practice in New Hampshire for maintaining road safety during the winter months, and there is no natural process that uses or breaks down chloride (NHDES, 2021). Chloride levels may also be increasing due to the use of water softeners within the watershed. In a water softening system, salts are often added to remove calcium and magnesium from household water. The result is a salty byproduct that enters the wastewater treatment system, and septic systems are traditionally not designed for salt removal (NH Lakes, 2024). Another potential source of chloride and specific conductivity is sediment loading from eroding, unpaved roads throughout the watershed. Steep slopes located in some areas of the watershed may make it more susceptible to soil loss and road erosion. Other sources of pollution that may increase chloride and specific conductivity levels include inputs from fertilizers and agricultural runoff.

Specific conductivity and chloride levels have increased sharply over the past ten years at the boat ramp site, reaching levels very close to or exceeding chronic toxicity to aquatic life at that site in recent years. For example, specific conductivity reached 1,121 μ S/cm and chloride reached 311 mg/L in 2025 at the Lake Waukegan boat launch (WAUMER1), exceeding the chronic chloride threshold of 230 mg/L. The sharp chloride increase there may be due to a relatively recent, large, and localized source of chloride pollution. Examples include altered deicing materials or patterns along roads, driveways, or parking lots; uncovered salt storage leading to salt-laden runoff and infiltration; or a building-related source such as a water softener or septic system effluent. Chloride is likely traveling through groundwater due to summer sampling dates, and thus the pollution source(s) may be some distance upgradient and/or discharging

into the ground. All potential sources of chloride in that area should be urgently investigated and prompt actions taken until causes are identified, corrected, and in-lake data show success. While not an immediate concern at other lake sites, chronic chloride toxicity will likely become an issue in the future without a proactive reduction in salt use in the watershed.

The chloride concentration in Lake Waukegan and Lake Winona 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 de-icing 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.



FBE sampling Lake Waukegan in 2024. © FBE

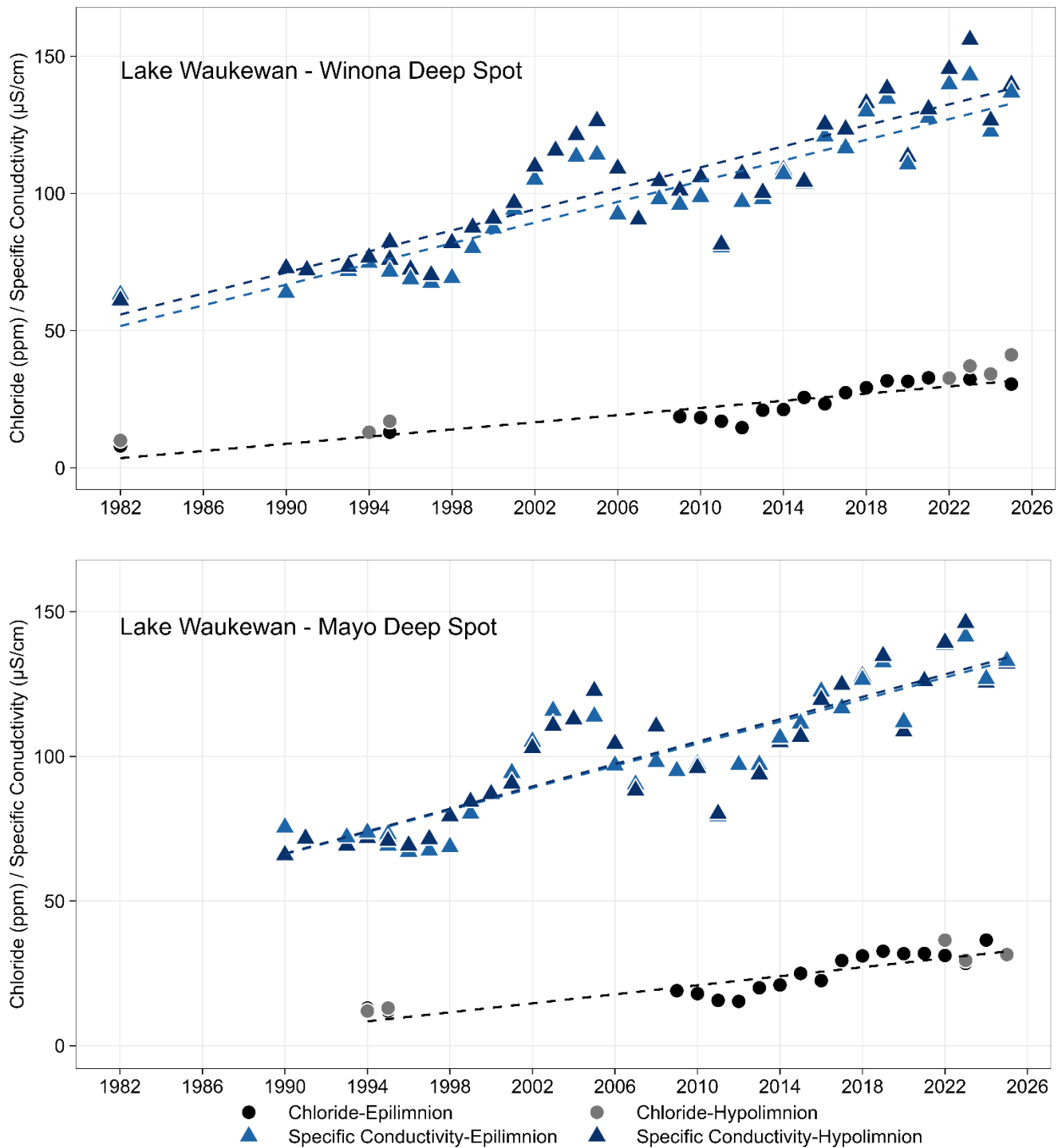


Figure 13. Yearly median of monthly medians for chloride and specific conductivity in the Winona (top) and Mayo (bottom) deep spots of Lake Waukewan. Dashed lines indicate a statistically significant increasing (worsening) trend. There are insufficient hypolimnion chloride data for trend analysis.

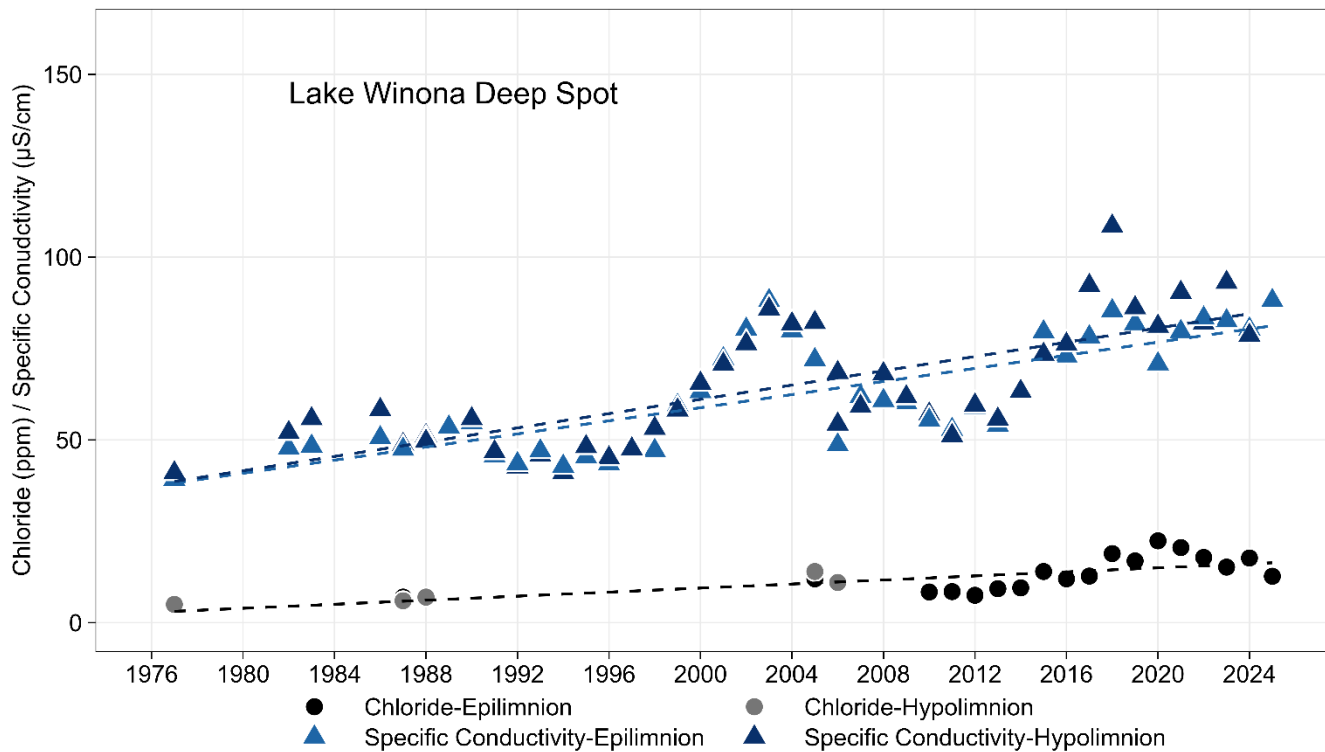


Figure 14. Yearly median of monthly medians for chloride and specific conductivity in the Lake Winona deep spot (WINNWHD). Dashed lines indicate a statistically significant increasing (worsening) trend. There are insufficient hypolimnion chloride data for trend analysis.

2.1.8 pH

The pH of a waterbody 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 15).



Figure 15. Graphic of the pH scale, indicating the zone which supports aquatic life.

Median pH in the epilimnion at the two deep spots of Lake Waukegan (WAUMERWD; WAUMERMD) and the deep spot of Lake Winona is occasionally below a pH of 6.5, which is the lower (more acidic) end of the acceptable range set by NHDES (Figure 16). pH tends to be improving in New Hampshire lakes as they recover from the impacts of acid rain. New Hampshire lakes tend to have naturally low alkalinity, meaning there is little natural resilience to acid rain impacts.

Across the depth zones from 2016-2025, pH has generally been higher (less acidic) in the epilimnion than in the metalimnion or hypolimnion (Figure 16). This pattern is expected as photosynthesis in the photic zone consumes carbon dioxide and raises pH, while respiration at greater depths has the opposite effect

resulting in acidifying conditions. The pH may be lowest in the hypolimnion due to organic matter settling and decomposing, increasing respiration and acidity. The hypolimnion has a median pH value below the NHDES guideline range for supporting aquatic life (Figure 16). Low pH can stress aquatic organisms, and extreme low pH can also mobilize iron and aluminum-bound phosphorus from lake sediments, degrading water quality.

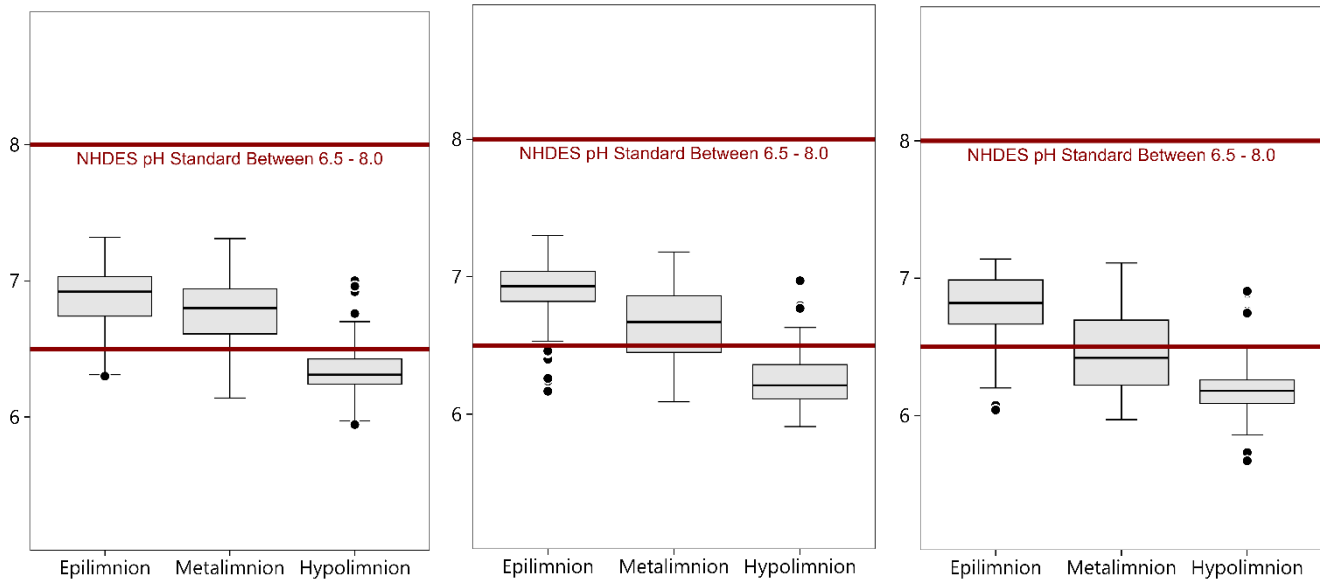


Figure 16. Boxplots showing the median pH in the epilimnion, metalimnion, and hypolimnion of the Winona Station deep spot (WAUMERWD) (left) and Mayo Station deep spot (WAUMERMD) (middle) of Lake Waukegan and the deep spot of Lake Winona (WINNWD) (right) for the past 10 years, 2016-2025. Values were converted to the concentration of hydrogen ions before being summarized and logarithmically transformed to the pH scale.

2.1.9 Enhanced 2024 Monitoring

In 2024, FBE received a grant in collaboration with the Town of Meredith from the NHDES Drinking Water and Groundwater Bureau to conduct intensive cyanobacteria monitoring in Lake Waukegan. The goal of the project was to inform a cyanobacteria monitoring and response plan (FBE, 2025b). Enhanced monitoring included the deployment of a real-time water quality buoy and weather station, biweekly sampling for a broader suite of parameters than typical VLAP monitoring, and monthly phytoplankton and zooplankton samples.

Results of the expanded sampling were summarized in the *Source Water Assessment Report: Lake Waukegan* (FBE, 2025a). The study found that cyanobacteria abundance is low in Lake Waukegan, which corresponds with low cyanotoxin concentrations in raw water taken for treatment. *Dolichospermum* and *Aphanocapsa* were the most common visible cyanobacteria found in the lake. *Aphanocapsa* are not typically associated with forming nuisance blooms. Genetic analysis showed that picocyanobacteria, which are small (less than two microns), unicellular bacteria that are often abundant in high-quality waters, comprised over 90% of the cyanobacteria community. The rest of the phytoplankton community was dominated by diatoms and golden-brown algae, and there was a highly biodiverse and balanced zooplankton community. Phytoplankton biomass and overall productivity was low from May to

December of 2024. Fluorescence measurements of pigments related to cyanobacteria, including chlorophyll-*a* and phycocyanin, were low throughout the entire monitoring period. The Winona Station deep spot (WAUMERWD) experienced anoxia below 2 ppm beginning in late July, which worsened until lake turnover in mid-October. This anoxia corresponded with internal loading, as evidenced by increasing concentrations of total phosphorus, total dissolved phosphorus, total iron, and total manganese in the hypolimnion. Iron can be a limiting micronutrient that can fuel cyanobacteria growth in iron-depleted lakes (Dengg, et al., 2022). Monitoring results from 2024 showed that the lake is strongly phosphorus limited, and suggested that total dissolved phosphorus and total iron concentrations in the epilimnion may be drivers of algal growth at the low levels of biomass observed in Lake Waukewan. Refer to the *Source Water Assessment Report: Lake Waukewan* (FBE, 2025a) for a more in-depth discussion of monitoring results from 2024.

2.1.10 Sediment Analysis

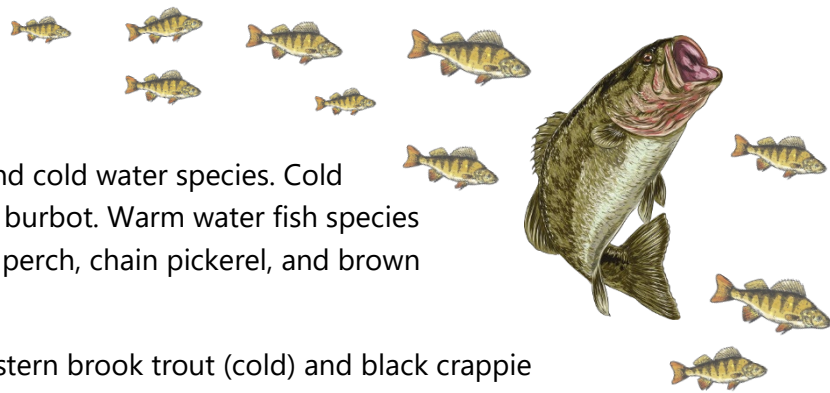
WWAC hired FBE, with assistance from the NHDES, to conduct sediment sampling and analysis on Lake Waukewan in 2023. Sediment cores were collected from five locations on the lake. Results suggested that Lake Waukewan is vulnerable to internal loading due to low elemental ratios of aluminum to iron and aluminum to phosphorus for all five sampled sites, which included both shallow and deep sites. They also suggest that there may be maximum phosphorus release from lake sediments at the deep spot under high pH conditions—these conditions are not present at either deep spot of Lake Waukewan. Refer to the *Lake Waukewan Sediment Analysis* (FBE, 2023) for a more detailed summary of sediment results.

2.1.11 Fish

Fish are important in ecosystem food webs and for providing recreational opportunities. Lake Waukewan supports populations of both warm and cold water species. Cold and cool water species include rainbow trout and burbot. Warm water fish species include smallmouth bass, largemouth bass, white perch, chain pickerel, and brown bullhead.

Lake Winona has similar fish species as well as eastern brook trout (cold) and black crappie (warm). Rainbow trout are stocked annually in both lakes. Lake Winona is also stocked with eastern brook trout.

The non-indigenous green sunfish was first identified in Lake Waukewan in 2023. This invasive species can outcompete native fish and disrupt the lake food web by over-eating small aquatic animals. They are well-suited to survive poor water quality conditions and low oxygen levels.



2.1.12 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 Lake Winnepesaukee in 1979 and has found its way to numerous upstream lakes/ponds. Milfoil has not established in Lake Waukegan nor Lake Winona due in part to community efforts to educate lake users about invasive plants and Lake Hosts to inspect each boat prior to launching. Volunteer and paid Lake Hosts operate at the Lake Waukegan boat launch and provide voluntary boat and trailer inspections and inform the public about invasive species. The WWAC coordinates these Lake Hosts with funding support from the neighboring watershed towns. Continuing boat inspection efforts are needed to prevent variable milfoil and other invasive species from establishing in Lake Waukegan and Lake Winona in 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 criteria are based on specific thresholds for different water quality levels. 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 oligotrophic lakes such as Lake Waukegan, water quality criteria are set at 8 ppb for total phosphorus and 3.3 ppb for chlorophyll-*a* (Table 4; Table 5). Assessment results show that Lake Waukegan meets the Tier 2 High Quality Water threshold for both phosphorus and chlorophyll-*a* at both sites (Table 6).

For mesotrophic lakes such as Lake Winona, water quality criteria are set at 12.0 ppb for total phosphorus and 5.0 ppb for chlorophyll-*a* (Table 4; Table 5). Assessment results show that Lake Winona meets the Tier 2 High Quality Water threshold for both phosphorus and chlorophyll-*a* (Table 6).

Table 4. 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-<i>a</i> (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 5. Decision matrix for aquatic life integrity designated use assessment in New Hampshire. Chlorophyll-*a* is a surrogate measure for algae.

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

Table 6. Assimilative capacity analysis results for Lake Waukegan and Lake Winona deep spot sites using oligotrophic (for Lake Waukegan) or mesotrophic (for Lake Winona) 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
Lake Waukegan Winona Station South Deep Spot [WAUMERWD]	Total phosphorus	7.2	6.4	+0.8	Tier 2: High Water Quality
	Chlorophyll- <i>a</i>	3.0	1.9	+1.1	
Lake Waukegan Mayo Station North Deep Spot [WAUMERMD]	Total phosphorus	7.2	5.7	+1.5	Tier 2: High Water Quality
	Chlorophyll- <i>a</i>	3.0	2.3	+0.7	
Lake Winona Deep Spot [WINNWDH]	Total phosphorus	11.6	7.8	+3.8	Tier 2: High Water Quality
	Chlorophyll- <i>a</i>	4.8	4.7	+0.1	

* Existing water quality data truncated to May 24-September 15 in the previous 10 years (2016-2025) 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:



Watershed
boundaries



Land
cover



Point
sources



Septic
systems



Waterfowl



Rainfall



Volume and
surface area



Internal
loading

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 Lake Waukewan and Lake Winona LLRM is provided in the *Lake Waukewan and Lake Winona Lake Loading Response Model Report* (FBE, 2026b).

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.

Lake Waukewan Characteristics

Surface area	=	959 acres
Shoreline	=	10.3 miles
Maximum depth	=	70.2 feet (21.4 meters)
Volume	=	24,430,147 cubic meters
Areal water load	=	5.44 feet per year (1.66 meters per year)
Flushing rate	=	0.864 times per year

Lake Winona Characteristics

Surface area	=	159 acres
Shoreline	=	3.8 miles
Maximum depth	=	47.9 feet (14.6 meters)
Volume	=	3,189,552 cubic meters
Areal water load	=	13.16 feet per year (4.01 meters per year)
Flushing rate	=	2.648 times per year

There are ten identified dams in the watershed historically or currently controlling water flow (NHDES, 2022). Flow out of Lake Waukewan into Meredith Bay of Lake Winnepesaukee is regulated by the Lake Waukewan Dam. Other dams include the Meredith Reservoir Dam, the Mayo Farm Pond Dam, the Hawkins Pond Dam, and two dams on the tributary between Hawkins Pond and Lake Winona. While Lake Waukewan flushes 0.86 times per year and Lake Winona flushes 2.6 times per year, flushing is not consistent throughout the year, and it 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 Lake Waukegan and Lake Winona 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 *Lake Waukegan and Lake Winona Lake Loading Response Model Report* for more details on methodology. The watershed as a whole is 85% forested/natural (5,777 acres); 7% developed (737 acres); 2% agricultural (111 acres); and 6% wetlands/open water (442 acres, excluding the lakes).

Figure 17 shows the breakdown of land cover by major category and the corresponding total phosphorus load. Although developed areas for Lake Waukegan and Lake Winona make up only 7% of the watershed, developed areas contribute 68% 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 18 for a map of land cover in the watershed.

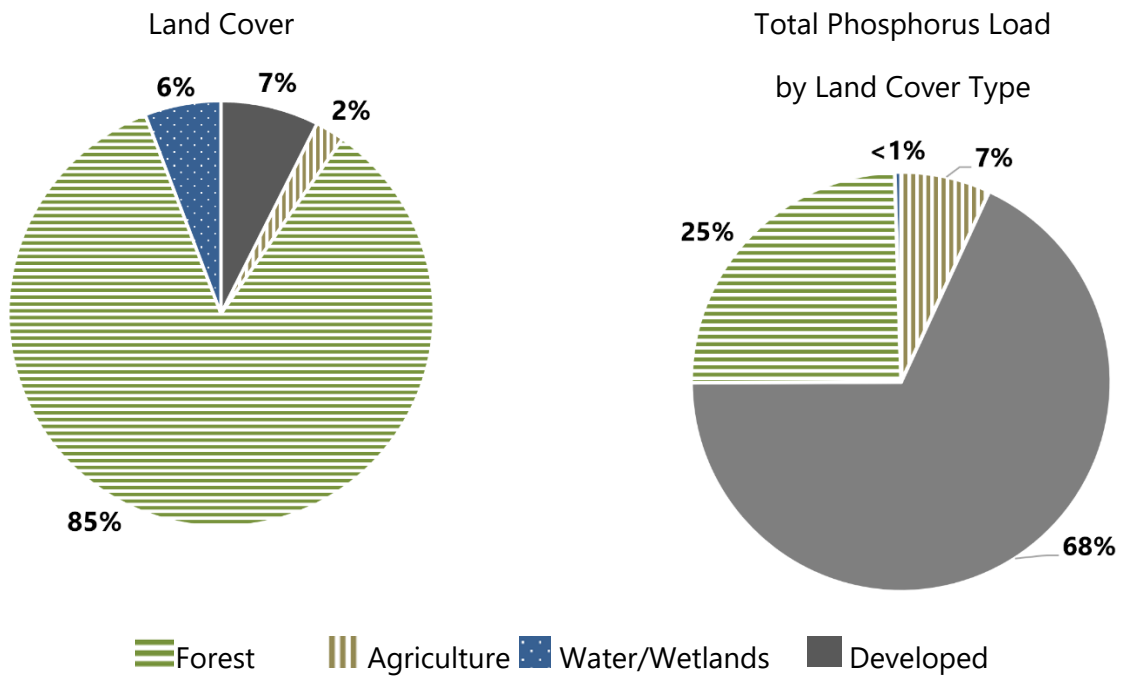
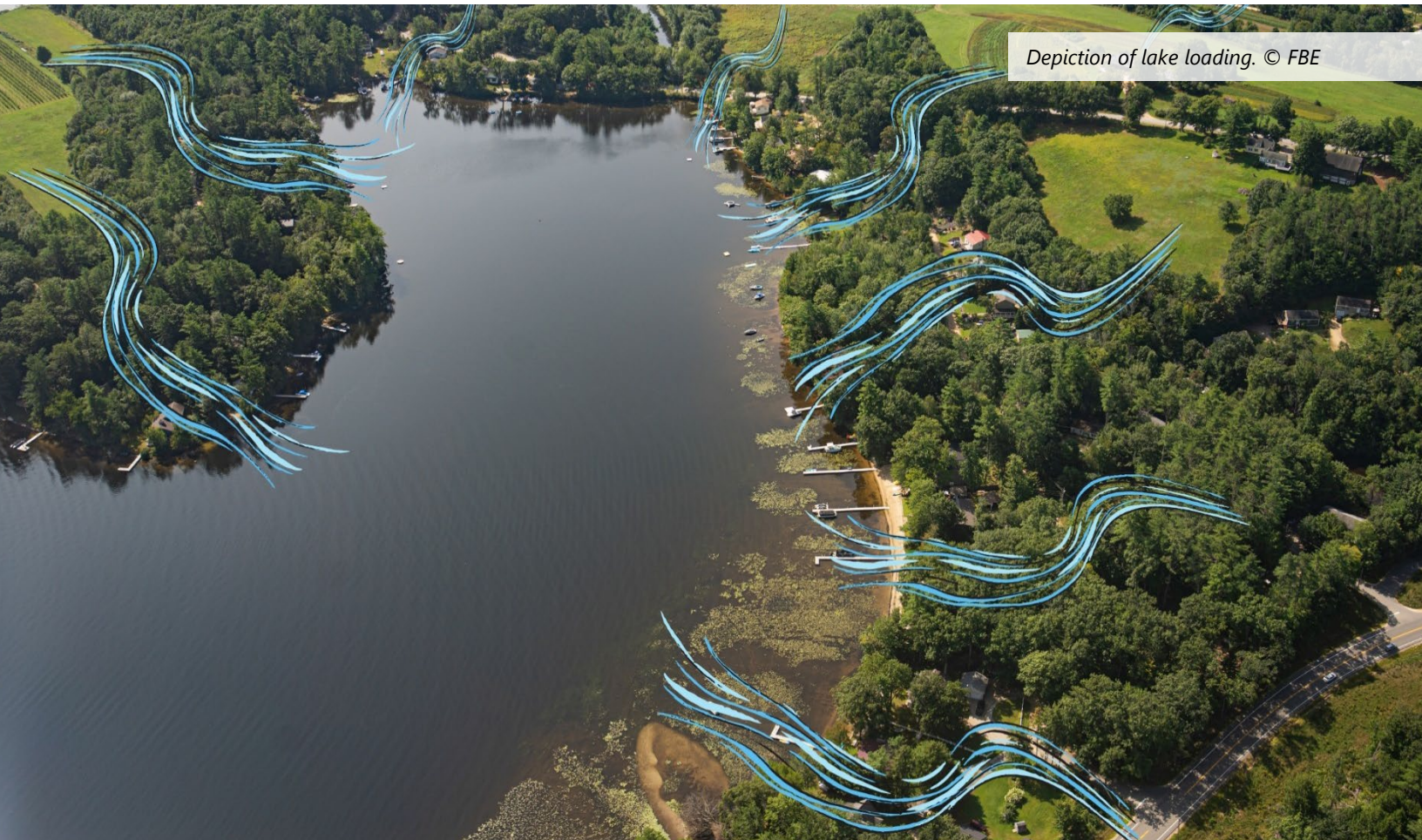


Figure 17. Land cover area by major category (left) and total phosphorus watershed load by major land cover category (right) for the Lake Waukegan & Lake Winona watershed. The water/wetlands category does not include the lake areas.



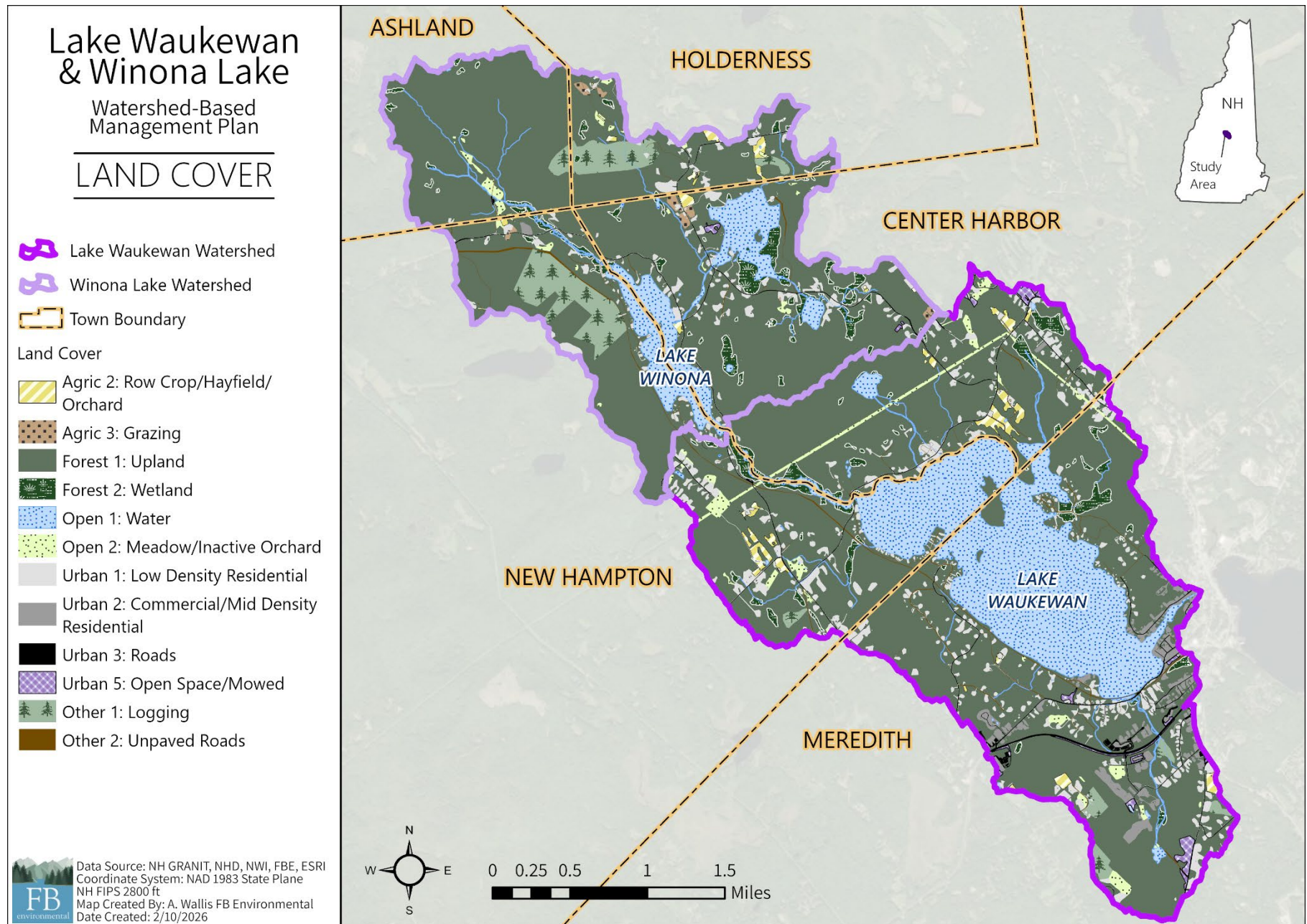


Figure 18. Land cover in the Lake Waukewan and Lake Winona watershed.

2.3.1.3 Watershed and Subwatershed Boundaries

Watershed and tributary drainage area (sub-watershed) boundaries are needed to determine both the amount of water flowing into a surface waterbody and the area of different land cover types contributing to nutrient loading. FBE re-delineated the watershed and sub-watersheds for Lake Waukegan and Lake Winona after this inspection of the original sub-watershed boundaries from the 2016 watershed restoration plan (Figure 19). FBE's updated workflow consisted of desktop aerial watershed delineation using digital elevation models from the United States Geological Survey. FBE then used Light Detection and Ranging derived two-foot contours provided by New Hampshire's data clearinghouse to further refine the watershed boundary. The two-foot contours were not available during the development of the original WRP and FBE did not have access to the spatial analyst hydrology geospatial toolbox. The updated watershed boundary is smaller than the watershed boundary used for the 2016 WRP by 109 acres, mostly in the southwestern portion of the Lake Winona watershed and a small area on the southeast side of the Lake Waukegan watershed.

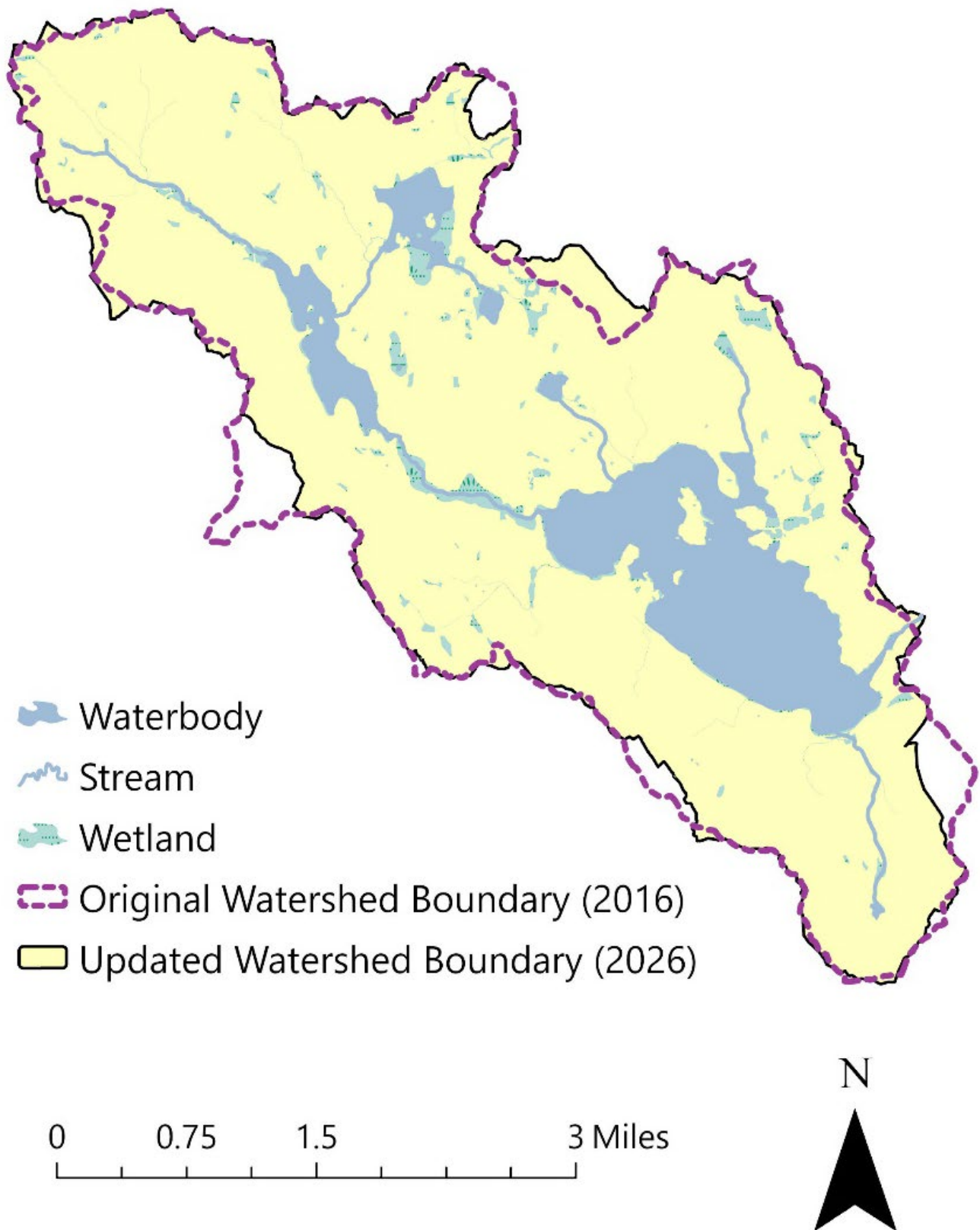


Figure 19. Differences between the watershed boundary for Lake Waukewan and Lake Winona watersheds from the original watershed restoration plan (maroon dotted line) and the updated watershed restoration plan (yellow with black outline).

2.3.1.4 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 spots of the lakes. Dissolved oxygen and temperature profiles taken at the deep spots of each waterbody 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 spots of each waterbody, 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.

For Lake Waukegan, internal loading estimates were refined further from an in-depth data collection effort in 2024 that included biweekly dissolved oxygen profiles and total phosphorus sampling at various depths throughout the water column. Refer to FBE (2025a) for methodology.

Based on current data, internal loading represents 5% of the total phosphorus load to each 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.

2.3.1.5 Lake Loading Response Model Results

Overall, model predictions for Lake Waukegan and Lake Winona were in good agreement with observed data for total phosphorus (percent difference between model predictions and data for Lake Waukegan and Lake Winona, respectively: less than 1% and 1%), chlorophyll-*a* (10% and 21%), and Secchi disk transparency (30% and 21%) (Table 7). It is important to note that the LLRM does not explicitly account for all the biogeochemical processes occurring within a waterbody that contribute to overall water quality. As a result, the model is less accurate at predicting chlorophyll-*a* and Secchi disk transparency. For example, chlorophyll-*a* is estimated strictly from nutrient loading, but other factors strongly affect algae growth, including transport of phosphorus from the sediment-water interface to the water column by cyanobacteria, low light from suspended sediment, grazing by zooplankton, presence of heterotrophic algae, and flushing effects from high flows. There were insufficient data available to evaluate the influence of these other factors on observed chlorophyll-*a* concentrations and Secchi disk transparency readings.

Watershed runoff combined with baseflow was the largest phosphorus loading contribution across all sources to Lake Waukegan. The watershed load accounts for 70% of the total phosphorus load in Lake Waukegan. This includes the watershed loads from both the direct Lake Winona (14%) and Lake Waukegan (56%) watersheds (Table 8; Figure 20). Atmospheric deposition (11%), septic systems (8%), waterfowl (6%), and internal loading (5%), were smaller sources. Lake Winona had a similar breakdown, with the watershed load making up 75% of the total phosphorus load. Septic systems (11%) were the

second largest source of phosphorus to Lake Winona (Table 8). Development in the watershed is most concentrated along the shorelines of each lake and near the Lake Waukegan outlet which has dense single-family homes and commercial land uses. Phosphorus loading can occur with dense shoreline development in unsewered areas where septic systems or holding tanks are located within a short distance to the water, leaving little horizontal (and sometimes vertical) space for proper filtration of wastewater effluent. Improper maintenance or siting of these systems can cause failures, which leach untreated, nutrient-rich wastewater effluent to the lake. Part of Lake Waukegan's southern shoreline is serviced by the municipal sewer system, which also represents a potential vulnerability if the sewer systems are old or damaged and leaking wastewater into groundwater near the lake. Note that septic systems are a relatively small source of the total phosphorus load to Lake Waukegan because 1) the estimate is only for those systems directly along the shoreline of Lake Waukegan and Winona Lake that are potentially short-circuiting minimally treated effluent to the lake, 2) part of the shoreline area is serviced by sewer which does not contribute any phosphorus loading in the model since the assumption is that the sewer lines are not leaking, and 3) shoreline septic systems for Lake Winona are included in that lake's watershed load (see Table 8 for a breakdown). The load from septic systems throughout the rest of the watershed is inherent to the coefficients used to generate the watershed load.

Internal loading is currently a relatively small source of phosphorus to Lake Waukegan and Lake Winona, though data from the 2025 *Lake Waukegan Source Water Assessment Report* (FBE, 2025a) suggests that internal loading has been relatively stable over the past ten years, with the time around lake turnover being the only time of year when internal loading has worsened in the past ten years. The model predicts zero bloom days (Table 7) for Lake Waukegan and 19 bloom days per year for Lake Winona.



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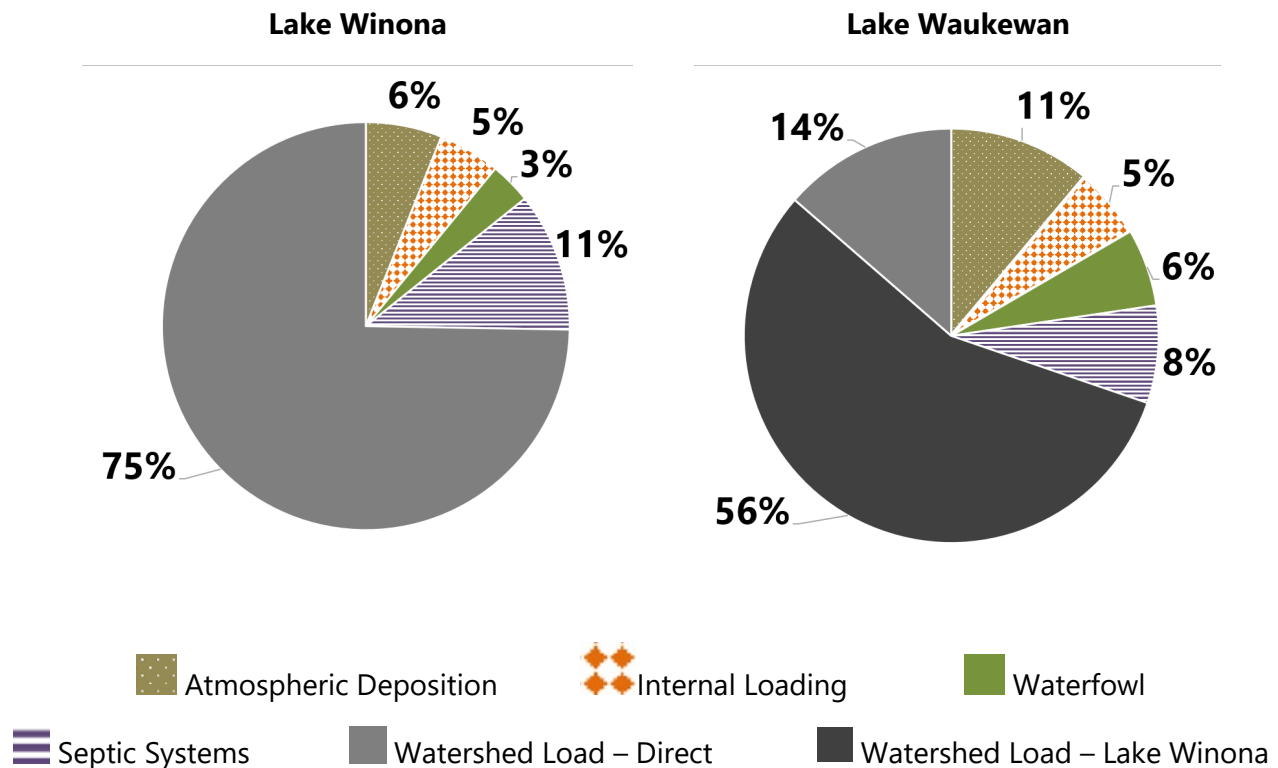


Figure 20. Summary of total phosphorus loading by major source for Lake Winona (left) and Lake Waukegan (right).

Normalizing for the size of a sub-watershed (i.e., accounting for the watershed annual discharge and direct drainage area) better highlights sub-watersheds with elevated pollutant export relative to their drainage area. The sub-watershed with the highest phosphorus mass exported per area was the Waukegan Street tributary with 0.26 kg/ha/yr. This sub-watershed and other sub-watersheds with moderate-to-high phosphorus mass exported by area in the range of 0.10 – 0.20 kg/ha/yr generally had more development (Table 9, Table 10, Figure 21). These drainages make up most of the Lake Waukegan direct sub-watershed, which includes much of the more densely developed shoreline and commercial areas. Lake Winona sub-watersheds had lower phosphorus mass export per area, though the Winona East Tributary had a higher export compared to other sub-watersheds in the Lake Winona watershed.

Once the model is calibrated for current in-lake phosphorus concentration, we can then manipulate land cover and other factor loadings to estimate pre-development loading scenarios (e.g., what in-lake phosphorus concentration was prior to human development or the best possible water quality for the lake). Refer to Attachment 2: Estimating Pre-Development Phosphorus Load in (FBE, 2026b) for details on methodology. Comparing the pre-development scenario to current conditions showed that total phosphorus loading to Lake Waukegan increased by 225%, from 118.2 kg/yr prior to European settlement to 384.6 kg/yr under current conditions (Table 8). For Lake Winona, total phosphorus loading increased from 42.2 kg/yr to 116.9 kg/yr (177%) across the two scenarios. These additional phosphorus sources under current conditions are coming from development in the watershed, septic systems, atmospheric dust, and internal loading (Table 8). Water quality prior to settlement was predicted to be excellent with extremely low phosphorus and chlorophyll-*a* concentrations and high water clarity (Table 7).

We also manipulated land cover and other factors to estimate future loading scenarios (e.g., 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 2026 *Lake Waukegan Watershed Build-out Analysis Report* (FBE, 2026c) for details on methodology. Note that the future scenario did not assume the estimated 10% increase in precipitation over the next century (National Oceanic and Atmospheric Administration (NOAA), 2013). Models for the region predict more intense and less frequent rain events. Higher precipitation can reduce the in-lake phosphorus concentration through dilution; however, high precipitation may also exacerbate erosion of phosphorus-laden sediment to surface waters and therefore could increase in-lake phosphorus concentration. This change cannot be incorporated into the future scenario estimation because the model does not consider the rate and distribution of the projected increase in precipitation.

Future loading estimation showed that total phosphorus loading to Lake Waukegan may increase by 82.4%, from 384.6 kg/yr under current conditions to 701.7 kg/yr at full build-out (2130) under current zoning (Table 8). For Lake Winona, phosphorus loading may increase from 116.9 kg/yr to 324.2 kg/yr (177%). Additional phosphorus will be generated from more development in the watershed, greater atmospheric dust, more septic systems, and enhanced internal loading (Table 8, Table 9, Table 10). Some of the largest increases will come from sub-watersheds with the highest build-out potential, such as those in Center Harbor. These include the Hawkins Pond Direct, Bear Pond Direct, Winona East – Hawkins Tributary, EE Brook, Otter Pond Direct, Piper Hill Tributary, North Waukegan Tributary, and parts of the Lake Winona Direct, North Winona Tributary, Winona East Tributary, Snake River, East Waukegan Tributary, and Waukegan Direct sub-watersheds (Table 9, Table 10). The Lake Waukegan model predicted higher (worse) phosphorus concentration of 12.9 µg/L, higher (worse) chlorophyll-*a* concentration of 4.4 µg/L, lower (worse) water clarity of 3.2 m, and an increase from 0 to 27 cyanobacteria bloom days compared to current conditions for the lake (Table 7). Predicted future water quality was similarly poor for Lake Winona with a total phosphorus concentration of 23.9 µg/L, a chlorophyll-*a* concentration of 10.6 µg/L and 226 days of cyanobacteria blooms during the year (Table 7).

Table 7. In-lake water quality predictions for Lake Waukegan and Lake Winona. TP = total phosphorus. Chl-*a* = chlorophyll-*a*. SDT = Secchi disk transparency. Bloom Days represents average annual probability of chlorophyll-*a* exceeding 8 ppb.

Parameter/ Model Scenario	Lake Waukegan (pre-development)	Lake Winona (pre-development)	Lake Waukegan (2025)	Lake Winona (2025)	Lake Waukegan (2130)	Lake Winona (2130)
Median total phosphorus (ppb)	no data	no data	7.1*	8.5*	no data	no data
Predicted Median total phosphorus (ppb)	2.2	3.1	7.1	8.6	12.9	23.9
Mean chlorophyll- <i>a</i> (ppb)	no data	no data	2.2	5.0	no data	no data
Predicted mean chlorophyll- <i>a</i> (ppb)	0.2	1.5	2.0	4.0	4.4	10.6
Mean Secchi disk transparency (meters)	no data	no data	6.9	5.5	no data	no data
Predicted mean Secchi disk transparency (meters)	12.7	9.7	5.1	4.4	3.2	2.0
Predicted Bloom days	0	0	0	19	27	226

*Represents estimate of average annual total phosphorus concentration; this is different from the existing median total phosphorus concentration from summer epilimnion data used for the assimilative capacity analysis.

Table 8. Total phosphorus (TP) and water loading summary by source for modeled waterbodies in the Lake Waukegan watershed. *Includes watershed load from Lake Winona.

Lake	Measurement	Atmospheric	Internal	Waterfowl	Septic System	Watershed Load	Total Load To Lake
Lake Waukegan <i>(pre-development)</i>	TP (kg/yr)	27.2	0	23.3	0	67.8*	118.2
	Percent	23	0	20	0	57*	100
	Water (cubic meters per year)	4,636,557	0	0	0	16,538,001*	21,174,558
Lake Winona <i>(pre-development)</i>	TP (kg/yr)	4.5	0	3.9	0	33.9	42.2
	Percent	11	0	9	0	80	100
	Water (cubic meters per year)	781,096	0	0	0	7,665,837	8,446,933
Lake Waukegan <i>(2025)</i>	TP (kg/yr)	42.7	21.2	23.3	29.2	268.2*	384.6
	Percent	11	5	6	8	70*	100
	Water (cubic meters per year)	4,636,557	0	0	24,517	16,454,361*	21,115,434
Lake Winona <i>(2025)</i>	TP (kg/yr)	7.1	5.7	3.9	12.9	87.3	116.9
	Percent	6	5	3	11	75	100
	Water (cubic meters per year)	781,096	0	0	10,762	7,654,278	8,446,136
Lake Waukegan <i>(2130)</i>	TP (kg/yr)	97.0	39.5	23.3	34.8	507.9*	701.7
	Percent	14	6	3	5	72*	100
	Water (cubic meters per year)	4,636,557	0	0	31,502	16,334,197*	21,002,256
Lake Winona <i>(2130)</i>	TP (kg/yr)	16.0	16.7	3.9	16.6	272.0	324.2
	Percent	5	5	1	5	84	100
	Water (cubic meters per year)	781,096	0	0	15,361	7,597,146	8,393,603

Table 9. Summary of current land area, water flow, and total phosphorus concentration and loading by sub-watershed for Lake Waukewan. Land area does not include the area of the lakes.

Sub-Watershed	Land Area (hectares)	Water Flow (cubic meters per year)	Calculated Phosphorus Concentration (parts per million)	Measured Phosphorus Concentration (parts per million)	Phosphorus Mass (kilograms per year)	Phosphorus Mass by Area (kilograms per hectare per year)
East Waukewan Tributary	99.6	624,476	0.015	<i>none</i>	9.7	0.10
EE Brook	25.7	171,945	0.008	0.009	1.4	0.06
North Waukewan Tributary	135.4	849,311	0.022	<i>none</i>	18.8	0.14
Otter Pond Direct	85.5	538,855	0.008	<i>none</i>	4.3	0.05
Piper Hill Tributary	42.3	284,584	0.019	0.008	5.4	0.13
Reservoir Brook	329.2	1,961,516	0.029	<i>none</i>	57.0	0.17
Sayward Brook	188.2	1,190,972	0.020	0.014	23.6	0.13
Snake River	201.1	1,116,341	0.015	0.008	17.0	0.08
Waukewan Direct	412.7	2,783,275	0.025	<i>none</i>	68.7	0.17
Waukewan Street Tributary	26.7	177,657	0.040	<i>none</i>	7.0	0.26
Winona Shores Tributary	38.7	262,649	0.011	<i>none</i>	3.0	0.08

Table 10. Summary of current land area, water flow, and total phosphorus concentration and loading by sub-watershed for Lake Winona. Land area does not include the area of the lakes.

Sub-Watershed	Land Area (hectares)	Water Flow (cubic meters per year)	Calculated Phosphorus Concentration (parts per million)	Measured Phosphorus Concentration (parts per million)	Phosphorus Mass (kilograms per year)	Phosphorus Mass by Area (kilograms per hectare per year)
Bear Pond Direct	189.2	1,338,714	0.012	0.010	16.6	0.09
Hawkins Pond Direct	233.7	1,198,773	0.014	0.017	16.7	0.07
North Winona Tributary	432.5	2,821,938	0.008	0.010	22.0	0.05
South Winona Tributary	27.4	190,054	0.009	0.013	1.7	0.06
Winona East – Hawkins Tributary	37.9	199,238	0.016	0.017	3.3	0.09
Winona East Tributary	139.4	197,768	0.017	<i>none</i>	17.2	0.12
Lake Winona Direct	215.4	196,287	0.013	<i>none</i>	20.0	0.09

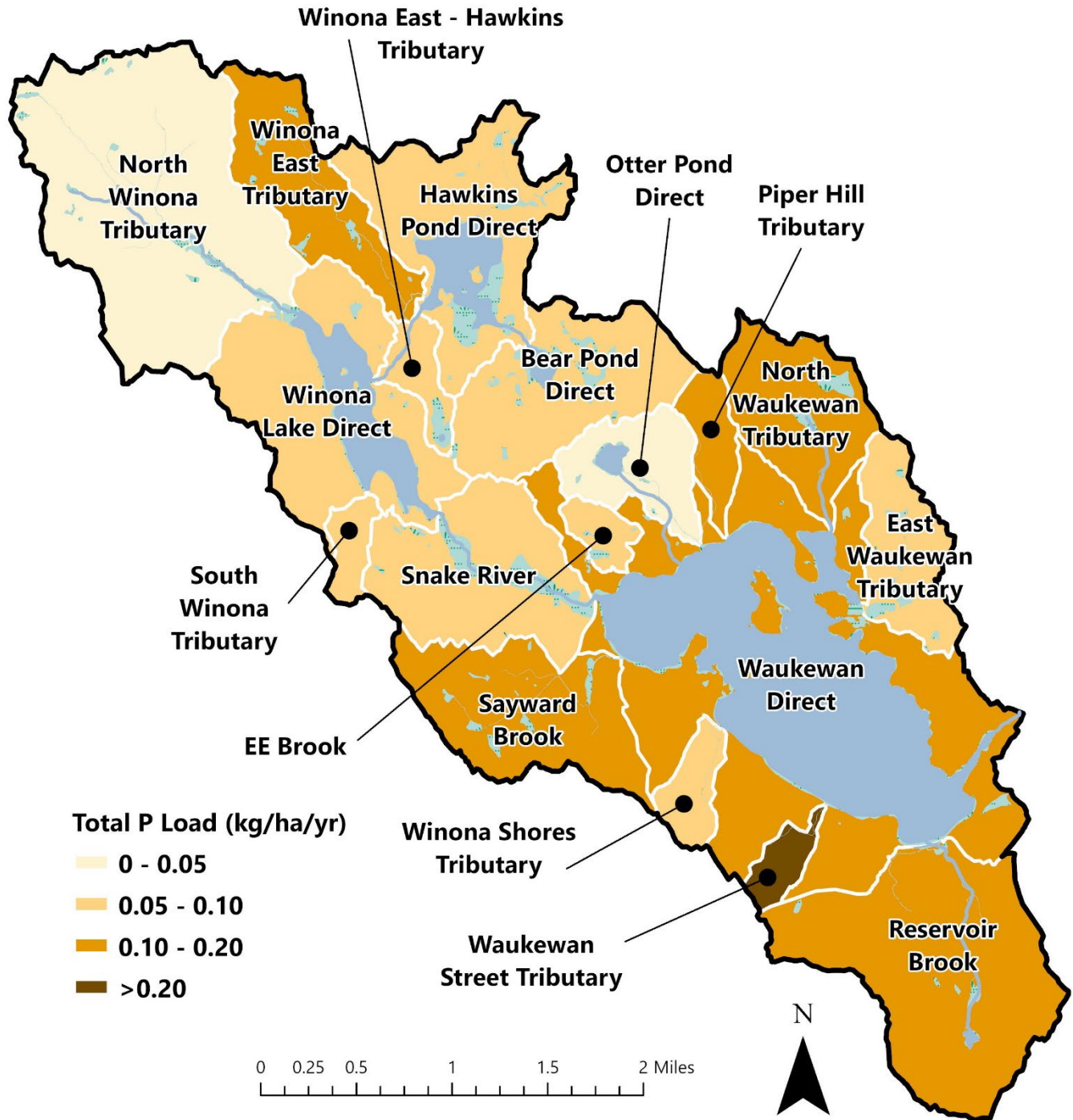


Figure 21. Map of current total phosphorus load per unit area (kilograms per hectare per year = kg/ha/yr) for each sub-watershed in the Lake Waukegan and Lake Winona watershed. Higher phosphorus loads per unit area are concentrated in the more developed direct shoreline areas.

2.3.2 Build-out Analysis

A full build-out analysis was completed for the Lake Waukegan and Lake Winona watershed as part of the watershed restoration plan update process; detailed methods and results are provided in (FBE, 2026c). 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 22). Existing buildings also reduce the capacity for new development.

The build-out analysis showed that 48% (3,143 acres) of the study area is still considered buildable under current zoning regulations (Table 11; Table 12; Figure 23). Within the Lake Waukegan and Lake Winona watershed, 70%, 54%, and 61% of the land within Holderness, Center Harbor, and New Hampton is still buildable, while only 37% and 10% of the land within Meredith and Ashland is still buildable.

FBE identified 957 existing principal buildings within the Lake Waukegan and Lake Winona watersheds, and the build-out analysis projected that an additional 1,568 buildings could be constructed in the future, resulting in a total of 2,525 buildings in the two watersheds (Table 12; Figure 24). As most of Lake Waukegan’s shoreline parcels are already developed, and Meredith has only 37% remaining buildable land within the watershed, most of the projected buildings fall within Center Harbor (857). The portion of

Holderness within the watershed allows a very large increase in buildings compared to existing conditions, with a projected increase of 1,643% at full build-out. Additional roadways would need to be built throughout the watershed for these projected buildings to be accessible.

A build-out analysis was first conducted in 2015 for the Lake Waukegan and Lake Winona watershed. The analysis only included data for the three largest towns in the watershed: Center Harbor, New Hampton, and Meredith, NH. In 2015, the Center Harbor, New Hampton, and Meredith portions of the watershed contained 2,729 acres of buildable land and 924 existing buildings. Additionally, the size of the delineated Lake Waukegan watershed has decreased by 112 acres from the 2015 analysis to the 2025 analysis, likely attributed to recently collected light detection and ranging-derived topographic mapping in New Hampshire.

In the 2025 analysis, the total buildable area for only Center Harbor, New Hampton, and Meredith within the Lake Waukegan watershed amounts to 2,660 acres with 942 existing buildings (5% increase in number of buildings from 2015 to 2025). The 2015 build-out analysis projected 769 additional buildings can be supported within the study area under 2015 zoning regulations. In 2025, 1,184 buildings, 415 more, were projected, representing a 54% increase in projected build-out in these three towns. Generally, increases in buildable area may result from an increase in the level of detail of the input data layers used for the development constraints and/or changes in zoning regulations. The increase in projected buildings in this case is likely due to a change in zoning regulations within the watershed that greatly increased allowable building density in one town, as described below:

Both New Hampton and Meredith show a decrease in the number of projected buildings estimated by the build-out analysis from 2015 to 2025 (by 11% and 44% respectively). This decrease is expected; if zoning regulations remain the same, or change only slightly, as more homes are built, there will be fewer future buildings projected by the model. However, Center Harbor shows an increase of 368% in the number of projected buildings modeled in 2015 to 2025. In the 2015 build-out analysis, there was only one zoning district in Center Harbor (Agricultural and Rural), which had a minimum lot size of 5 acres. In the 2025 build-out analysis, Center Harbor had two zones, and both had minimum lot sizes of 40,000 square feet (0.92 acres). This reduction in minimum lot size allows for a greater density of development, and therefore a greater number of projected buildings, accounting for the large increase in the projected development compared to the 2015 build-out analysis.

Table 11. Amount of buildable land by town and zone in the Lake Waukegan and Lake Winona watershed by zone for each town. Total area does not include waterbodies (lakes and ponds).

Zone	Total Area (acres)	Buildable Area (acres)	Percent Buildable Area
Ashland	713	68	10%
Rural Residential (RR)	713	68	10%
Center Harbor	2,174	1,185	54%
Agricultural and Rural District (AR) - Class 3	2,098	1,146	55%
Commercial and Light Industry (CI) - Class 3	76	39	51%
Holderness	592	415	70%

Zone	Total Area (acres)	Buildable Area (acres)	Percent Buildable Area
Rural Residential (RR)	592	415	70%
New Hampton	1,440	878	61%
General Residential (GR) + Waukegan Watershed Overlay (WWO) District	1,440	878	61%
Meredith	1,632	597	37%
Business and Industrial District (BI) - Classes 1-3 - WWOD	215	131	61%
Central Business District (CB) - non-waterfront - Class 1 - WWOD	13	3	25%
Central Business District (CB) - non-waterfront - Class 2 - WWOD	1	0	0%
Central Business District (CB) - non-waterfront - Class 3 - WWOD	27	9	33%
Commercial District-Route 3 South (CS) – non-waterfront - Class 3 - WWOD	10	10	94%
Forestry and Rural District (FR) - non-waterfront - Class 3	270	157	58%
Residential District (R) - non-waterfront - Class 1	108	27	25%
Residential District (R) - non-waterfront - Class 2	70	1	1%
Residential District (R) - non-waterfront - Class 3	442	154	35%
*Residential District (R) & Business and Industrial District (BI) - Class 1	7	7	99%
*Residential District (R) & Business and Industrial District (BI) - Class 3	13	11	85%
*Residential District (R) & Forestry and Rural District (FR) - Class 3	216	17	8%
Shoreline District (S) - waterfront - Class 1 - Waukegan	11	0	0%
Shoreline District (S) - waterfront - Class 2 - Waukegan	12	0	0%
Shoreline District (S) - waterfront - Class 3 - Waukegan	95	17	18%
Shoreline District (S) - non-waterfront - Class 1	1	0	0%
Shoreline District (S) - non-waterfront - Class 2	17	10	59%
Shoreline District (S) - non-waterfront - Class 3	57	21	36%
*Shoreline District (S) & Forestry and Rural District (FR) - Class 3	1	0	0%
*Shoreline District (S) & Forestry and Rural District (FR) - waterfront - Class 3	42	22	53%
Total	6,551	3,143	48%

Table 12. Number of existing and projected buildings by town and zone in the Lake Waukegan and Lake Winona watershed.

Zone	No. Existing Buildings	No. Projected Buildings	Total No. Buildings	Percent Increase
Ashland	1	49	50	4,900%
Rural Residential (RR)	1	49	50	4,900%
Center Harbor	189	752	941	398%
Agricultural and Rural District (AR) - Class 3	162	737	737	455%

Zone	No. Existing Buildings	No. Projected Buildings	Total No. Buildings	Percent Increase
Commercial and Light Industry (CI) - Class 3	27	15	42	56%
Holderness	14	230	244	1,643%
Rural Residential (RR)	14	230	244	1,643%
New Hampton	172	279	451	162%
General Residential (GR) + Waukegan Watershed Overlay District	172	279	451	162%
Meredith	581	153	734	26%
Business and Industrial District (BI) - Classes 1-3	30	41	71	137%
Central Business District (CB) - non-waterfront - Class 1	5	1	6	20%
Central Business District (CB) - non-waterfront - Class 2	2	0	2	0%
Central Business District (CB) - non-waterfront - Class 3	12	1	13	8%
Commercial District-Route 3 South (CS) - non-waterfront - Class 3	1	2	3	200%
Forestry and Rural District (FR) - non-waterfront - Class 3	33	29	62	88%
Residential District (R) - non-waterfront - Class 1	148	3	151	2%
Residential District (R) - non-waterfront - Class 2	59	1	60	2%
Residential District (R) - non-waterfront - Class 3	113	47	160	42%
Residential District (R) & Business and Industrial District (BI) - Class 1	1	1	2	100%
Residential District (R) & Business and Industrial District (BI) - Class 3	1	4	5	400%
Residential District (R) & Forestry and Rural District (FR) - Class 3	12	2	14	17%
Shoreline District (S) - waterfront - Class 1	34	0	34	0%
Shoreline District (S) - waterfront - Class 2	23	0	23	0%
Shoreline District (S) - waterfront - Class 3	79	8	87	10%
Shoreline District (S) - non-waterfront - Class 1	2	0	2	0%
Shoreline District (S) - non-waterfront - Class 2	9	2	11	22%
Shoreline District (S) - non-waterfront - Class 3	15	8	23	53%
Shoreline District (S) & Forestry and Rural District (FR) - Class 3	1	0	1	0%
Shoreline District (S) & Forestry and Rural District (FR) - waterfront - Class 3	1	3	4	300%
Total	957	1,463	2,420	153%

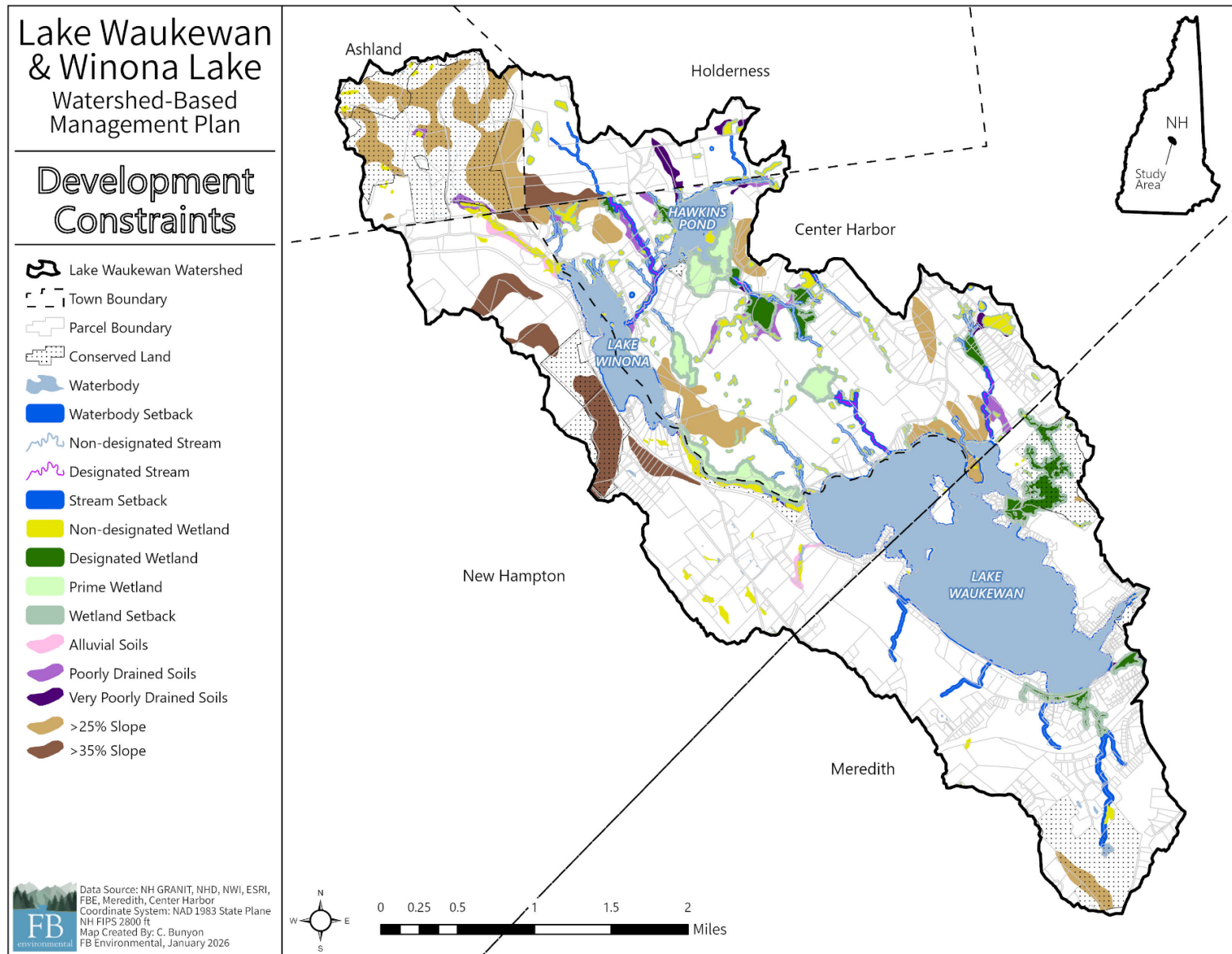


Figure 22. Development constraints in the Lake Waukegan and Lake Winona watershed. Note that two additional conservation parcels were identified and are not reflected on this map.

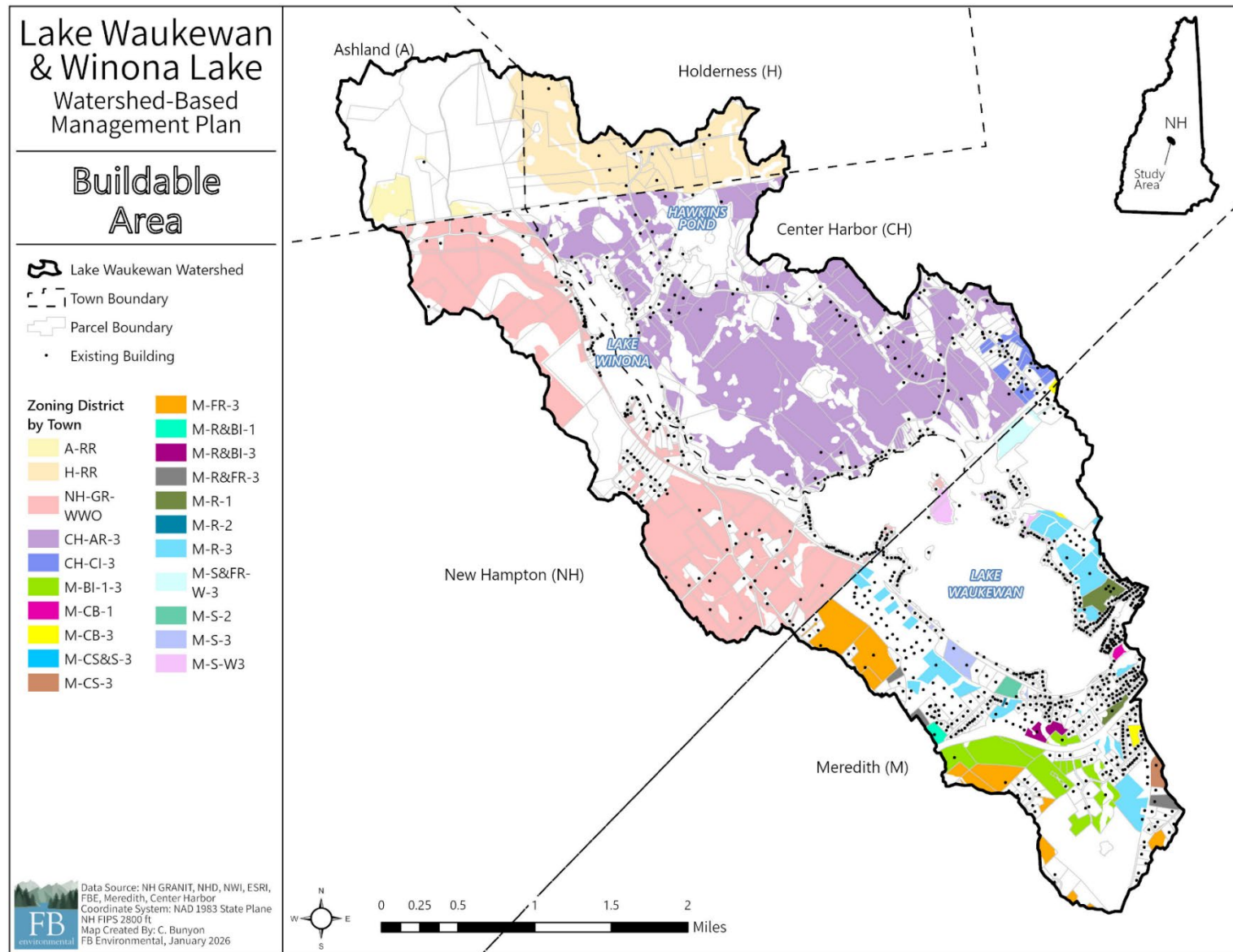


Figure 23. Buildable area by zoning district for each town within the Lake Waukewan and Lake Winona watershed. Refer to Appendix A for an acronym key. Note that two additional conservation parcels were identified and are not reflected on this map. Removing these parcels would reduce the buildable area in the CH-AR-3 zone by approximately 148 acres.

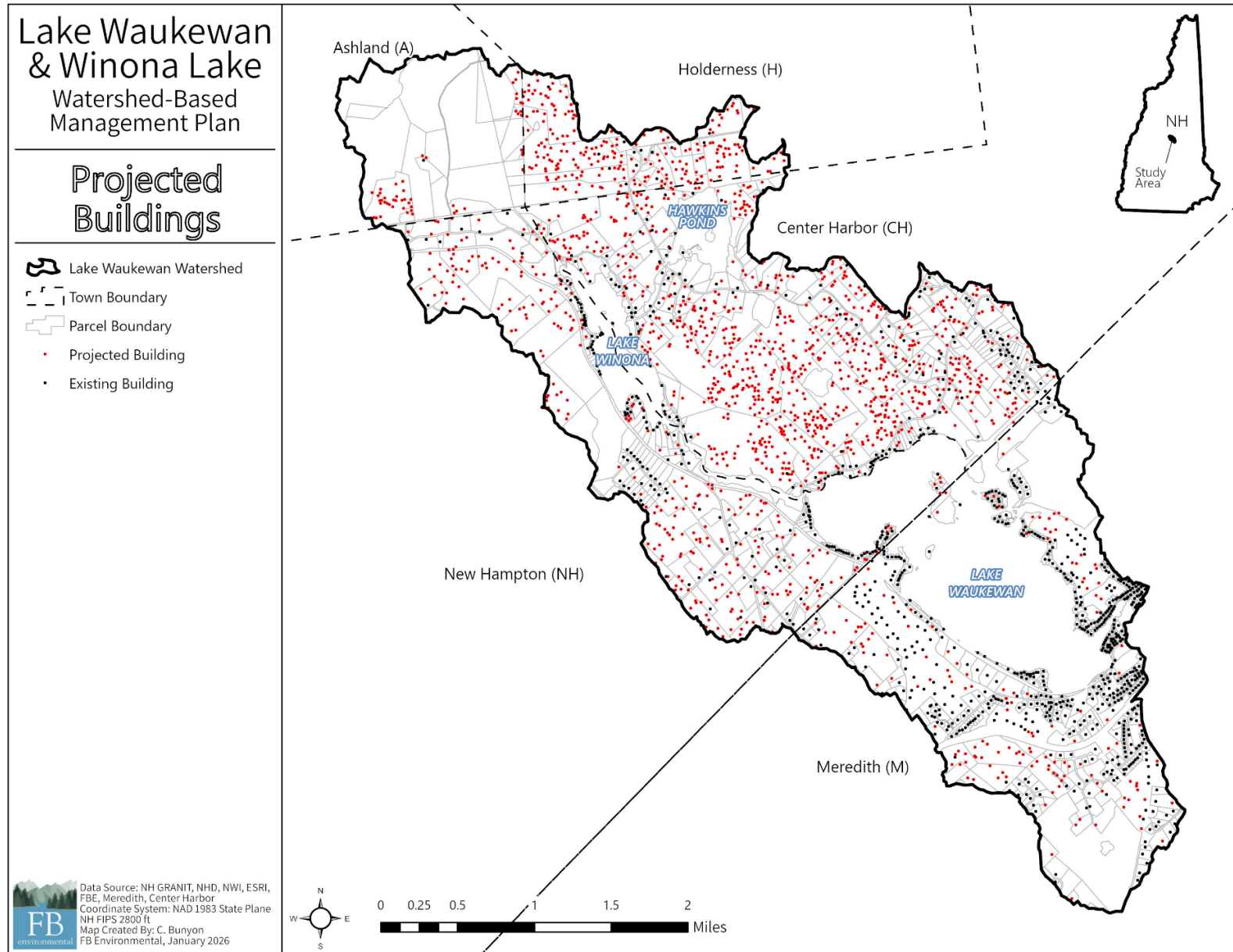


Figure 24. Existing and projected buildings within the Lake Waukewan and Lake Winona watershed. Note that two additional conservation parcels were identified and are not reflected on this map. Removing these parcels would remove 105 projected buildings from the map.

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 20 years, 30 years, and 50 years of decadal census data (from 2000-2020, 1990-2020, and 1970-2020) (Table 13). It is important to note that future growth rates may vary from historical growth rates.

Table 13. Compound annual growth rates (CAGR) for the towns in the Lake Waukegan and Lake Winona watershed, used for the TimeScope Analysis. Data from the U.S. Census Bureau.

Town Populations	30 Year CAGR (1990-2020)	20 Year CAGR (2000-2020)	10 Year CAGR (2010-2020)
<i>New Hampshire (for reference)</i>	0.72%	0.54%	0.45%
Ashland	0.04%	-0.04%	-0.69%
Center Harbor	0.14%	0.22%	-0.52%
Holderness	0.56%	0.19%	-0.50%
New Hampton	1.32%	0.99%	0.94%
Meredith	1.07%	0.57%	0.65%
Towns Combined	1.20%	0.94%	0.24%

For the Lake Waukegan and Lake Winona watersheds, full build-out is projected to occur in 2425 at the 10-year CAGR, 2130 at the 20-year CAGR, and 2107 for the 30-year CAGR (Figure 25). This analysis showed that if the towns within the watershed continue to grow at the rates identified, and current zoning and other development constraints remain the same, full build-out could occur within the next one hundred years depending on growth and development patterns.

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 municipalities. If areas closer to the bay within each municipality develop faster than more inland areas, watershed full build-out conditions may occur sooner. Also note that the population growth rate in these municipalities is decreasing, so the 10-year estimate could be considered more likely than the 30-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.

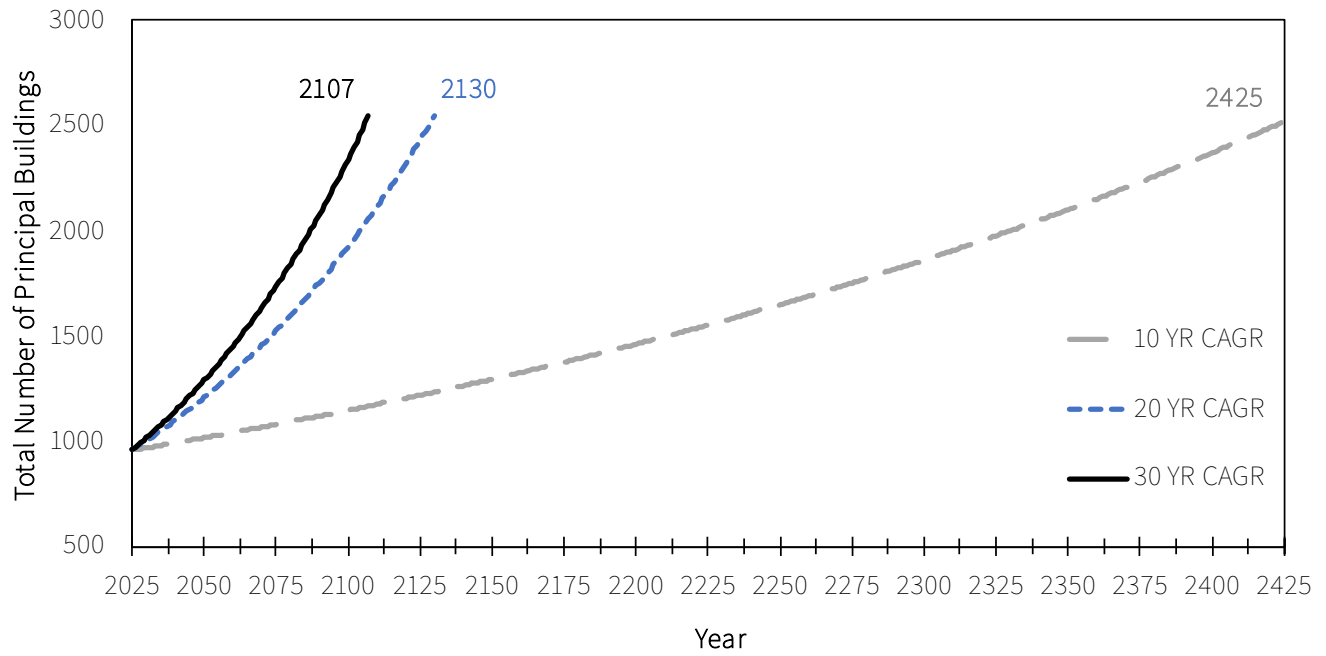


Figure 25. Full build-out projections for the Lake Waukewan and Lake Winona watershed (based on compound annual growth rates; CAGR).



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2.4 WATER QUALITY GOAL AND OBJECTIVES

2.4.1 Original Water Quality Goal

In the 2016 Lake Waukegan and Lake Winona Watershed Restoration Plan (LWA & FBE, 2016), the observed summer in-lake total phosphorus concentrations for Lake Waukegan and Lake Winona were 5.6 µg/L and 7.2 µg/L, respectively. For chlorophyll-*a*, the observed summer in-lake concentrations were 2.5 µg/L and 3.0 µg/L. Recent water quality data for Lake Waukegan and Lake Winona show summer total phosphorus concentrations of 6.1 µg/L and 7.8 µg/L and summer chlorophyll-*a* concentrations of 2.1 µg/L and 4.7 µg/L. Recent data suggest that total phosphorus concentrations have risen in both lakes, though chlorophyll-*a*, which is the response indicator to phosphorus, has only increased in Lake Winona. Numerous other factors such as light, nitrogen, micronutrients, and water temperature may impact chlorophyll-*a*.

The 2016 Lake Waukegan and Lake Winona Watershed Restoration Plan (LWA & FBE, 2016) set a water quality goal that reduced the in-lake total phosphorus concentration by 10% for both lakes, which would achieve 5.3 µg/L for Lake Waukegan and 6.5 µg/L for Lake Winona by 2025. Water quality data collected since the original WMP show that neither lake has met this goal, with Lake Waukegan and Lake Winona's predicted total phosphorus concentrations increasing by 1.5 µg/L or 27% and 1.3 µg/L or 18%, respectively, based on comparison of the original and updated lake models. Observed data collected from the lake epilimnions in the summer show that in-lake total phosphorus concentrations have increased by 0.5 or 9% and 0.6 or 8% for Lake Waukegan and Lake Winona, respectively. Despite some great work that has been accomplished since 2016 to address issues in the watershed, it appears that the addition of new sources of phosphorus from aging infrastructure and new development over the last decade has outpaced the reduction of existing sources of phosphorus in the watershed. However, model predictions indicate that the increase in phosphorus load and in-lake phosphorus concentration in both lakes could have been two to three times greater without local efforts.

2.4.2 Updated Water Quality Goal

A water quality goal was updated based on the data and modeling described in previous sections. The model estimated changes in total phosphorus loading and in-lake total phosphorus concentrations from pre-development through future conditions. Results show that in-lake concentrations have already more than doubled under current development and are projected to exceed the NHDES oligotrophic reserve capacity threshold if "business-as-usual" development continues, placing the long-term water quality of Lake Waukegan and Lake Winona at risk. Additionally, the increasing prevalence of cyanobacteria blooms in Lake Winona indicates that there may not be reserve capacity for the lake to assimilate additional nutrients.

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 Lake Winona is experiencing cyanobacteria blooms and both lakes are threatened by new development, it is highly recommended that strong objectives be established to protect the water quality of the lakes. Current in-lake total phosphorus and chlorophyll-*a* concentrations indicate that Lake Waukegan is currently oligotrophic and Lake Winona is currently mesotrophic. To improve water quality

and move toward oligotrophic conditions, strong management objectives must be established to protect and improve the lakes' condition over the long term, especially given the recent cyanobacteria blooms, ongoing development pressures, and the use of Lake Waukegan as a public drinking water supply.

Based on discussions with the Steering Committee, the following water quality goal and objectives were set for the updated Lake Waukegan and Lake Winona WRP. It is important to note that meeting or surpassing an oligotrophic chlorophyll-*a* criterion may not be sufficient to prevent cyanobacteria blooms, as external factors such as heavy precipitation with droughts in between or rain-on-snow events, and a shorter period of ice cover can influence bloom dynamics. Additional data and continued evaluation of Lake Waukegan and Lake Winona's water quality response to environmental stressors are recommended to refine and, if necessary, adjust this water quality goal.

The goal of the Lake Waukegan and Lake Winona WRP update is to improve water quality such that both lakes meet state water quality standards for the protection of aquatic life integrity and primary contact recreation, while substantially reducing the likelihood of harmful cyanobacteria blooms. This goal will be achieved through the implementation of the following objectives. More detailed action items to achieve these objectives are provided in the updated Action Plan.

Objective 1

Reduce phosphorus loading from existing development by 10% (33 kg/yr) to Lake Waukegan and by 7% (8 kg/yr) to Lake Winona to improve the average in-lake summer or annual total phosphorus concentration to 5.4 ppb and 7.2 ppb, respectively, and annual chlorophyll-*a* concentration to 1.8 ppb and 4.4 ppb, respectively.

Objective 2

Mitigate (prevent or offset) phosphorus loading from future development by 31.7 kg/yr to Lake Waukegan and 20.7 kg/yr to Lake Winona to maintain average summer in-lake total phosphorus concentration in the next 10 years.

Reality Check

The watershed survey identified 77 sites impacting the lake. Remediating these sites could prevent up to 16.5 kg/yr of phosphorus from entering Lake Waukegan and 2.7 kg/yr from entering Lake Winona. Upgrading the 71 shoreline systems older than 25 years around Lake Waukegan and the 53 shorefront septic systems older than 25 years around Lake Winona is estimated to reduce the phosphorus load to Lake Winona and Lake Waukegan by 7.1 kg/yr and 5.3 kg/yr, respectively.

In sum, treating existing pollutant sources identified as coming from the external watershed load could reduce the phosphorus load to Lake Waukegan and Lake Winona by 23.6 kg/yr and 8.0 kg/yr, respectively, which meets 72% and 100% of Objective 1 for Lake Waukegan and Lake Winona, respectively. An updated shoreline survey was not conducted for Lake Waukegan and Lake Winona as part of this WRP update, though additional phosphorus load reductions can still be expected

from improved shoreline conditions. The Lake Winnepesaukee Alliance (LWA) conducted an updated shoreline survey for Lake Waukegan outside of the WRP update effort on 7/23/2026. These results have not been thoroughly reviewed by FBE and thus will be used to represent an additional load reduction opportunity beyond those stated above. Data from Lake Winona's original 2014 shoreline survey suggest that treating shoreline sites could reduce the phosphorus load to Lake Winona by 0.9 kg/yr¹ from six low impact sites (disturbance score between 7-8). Data from LWA's updated shoreline survey of Lake Waukegan suggest that treating shoreline sites could reduce the phosphorus load to Lake Waukegan by 2.3 kg/yr² from two high impact sites (disturbance score 11+), 3.5 kg/yr³ from twelve medium impact sites (disturbance score between 9-10), and 7.4 kg/yr from 51 low impact sites. **These additional load reduction opportunities bring the total external watershed load reduction opportunities to 36.8 kg/yr for Lake Waukegan and 8.9 kg/yr for Lake Winona, which meets 112% and 111% of Objective 1 for Lake Waukegan and Lake Winona, respectively.**

Objective 2 can be met through ordinance revisions that implement **low impact development** strategies and encourage cluster development with open space protection and/or through conservation of key parcels of forested and/or open land.

The interim benchmarks for each water quality objective allow flexibility in reassessing objectives following more data collection and expected increases in phosphorus loading from future development in the watershed over the next ten or more years (Table 14). Comparing observed water quality changes to predicted water quality changes with no action can help guide adaptive changes to interim benchmarks (e.g., actions are meeting objectives or actions are falling short of objectives). If the benchmarks are not met due to lack of funding or other resources for implementation projects rather than due to increases in phosphorus loading from new development outpacing reductions in phosphorus loading from improvements to existing development, then this creates different conditions from which to adjust interim benchmarks. For each interim benchmark year, stakeholders should review water quality data, then assess why benchmarks are or are not being met. Stakeholders can then decide how to adjust the interim benchmarks to better reflect water quality conditions and any practical limitations to implementation.

¹ Based on PLET model bank stabilization estimate for fine sandy loams, using 50 feet (length) by 3 feet (height) and moderate lateral recession rate of 0.1 feet per year.

² Based on PLET model bank stabilization estimate for fine sandy loams, using 200 feet (length) by 3 feet (height) and moderate lateral recession rate of 0.1 feet per year.

³ Based on PLET model bank stabilization estimate for fine sandy loams, using 100 feet (length) by 3 feet (height) and moderate lateral recession rate of 0.1 feet per year.

Table 14. Summary of interim benchmarks for tracking progress towards achieving the water quality objectives for Lake Waukewan and Lake Winona. Interim benchmarks are cumulative.

Interim Goals / Benchmarks	Lake	2028	2030	2035
Objective 1 Reduce phosphorus loading from existing development by 10% (33 kg/yr) to Lake Waukewan and 7% (8 kg/yr) to Lake Winona to improve the average in-lake summer total phosphorus concentration to 5.4 ppb and 7.2 ppb, respectively.	Waukewan	Achieve 2% (7 kg/yr) reduction in total phosphorus loading.	Achieve 5% (17 kg/yr) reduction in total phosphorus loading; re-evaluate water quality and track progress.	Achieve 10% (33 kg/yr) reduction in total phosphorus loading; re-evaluate water quality and track progress.
	Winona	Achieve 1% (1 kg/yr) reduction in total phosphorus loading.	Achieve 4% (4 kg/yr) reduction in total phosphorus loading; re-evaluate water quality and track progress.	Achieve 7% (8 kg/yr) reduction in total phosphorus loading; re-evaluate water quality and track progress.
Objective 2 Mitigate (prevent or offset) phosphorus loading from future development by 31.7 kg/yr to Lake Waukewan and 20.7 kg/yr to Lake Winona to maintain average summer in-lake total phosphorus concentration in the next 10 years.	Waukewan	Prevent or offset 6 kg/yr in total phosphorus loading from future development.	Prevent or offset 16 kg/yr in total phosphorus loading from future development; re-evaluate water quality and track progress.	Prevent or offset 31.7 kg/yr in total phosphorus loading from future development; re-evaluate water quality and track progress.
	Winona	Prevent or offset 4 kg/yr in total phosphorus loading from future development.	Prevent or offset 10 kg/yr in total phosphorus loading from future development; re-evaluate water quality and track progress.	Prevent or offset 20.7 kg/yr in total phosphorus loading from future development; re-evaluate water quality and track progress.

3 POLLUTANT SOURCE IDENTIFICATION

This section describes sources of excess phosphorus to Lake Waukegan and Lake Winona. 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, leaky sewer lines, boat discharges, fabric softeners and detergents in greywater, fertilizers, and pet, livestock, and wildlife waste. The externally loaded phosphorous can then circulate within the lakes, 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 Watershed Survey

Overview

As part of the original WRP, FBE conducted a watershed survey in 2014 that identified sixty-one (61) non-point source pollution sites. Since the original watershed survey, WWAC and the Meredith Department of Public Works have partnered to remediate numerous sites along town roads. FBE conducted a re-survey of the watershed in July 2025 to revisit sites from the original watershed survey and identify other areas contributing to pollutant loads. Before fieldwork, input was gathered from the Steering Committee, and the Meredith Department of Public Works, who met in-person with FBE staff prior to the survey. Aerial imagery and geographic information services data were analyzed to target likely problem sites such as unpaved roads, beaches, and impervious areas. Meredith Department of Public Works director Craig Hale participated in the survey alongside FBE staff. Results were summarized in (FBE, 2026d).

Seventy-seven (77) problem sites were identified during the watershed survey, primarily involving road and ditch erosion and buffer clearing (Figure 26). Of these, forty-four (44) previous sites had their recommendations updated (some sites were combined, resulting in a revised total of 39 sites), 17 sites were removed from the site list, and 38 new sites were documented during the survey. NPS sites were assessed as having either a “Direct” or “Limited” impact on water quality based on field observations. Sites with a “direct” impact on water quality are sites where stormwater and/or sediment was directly flowing into Lake Waukegan, Lake Winona, another lake/pond, a tributary, or stormwater infrastructure that discharges directly to surface waters (ex. catch basins). Key findings from the survey are outlined in (FBE, 2026d) below and site locations are shown in Figure 27. A *Municipal Stormwater Control Measures Handbook* (FBE, 2026a) was created to guide implementation of many of these sites.

Key Statistics:

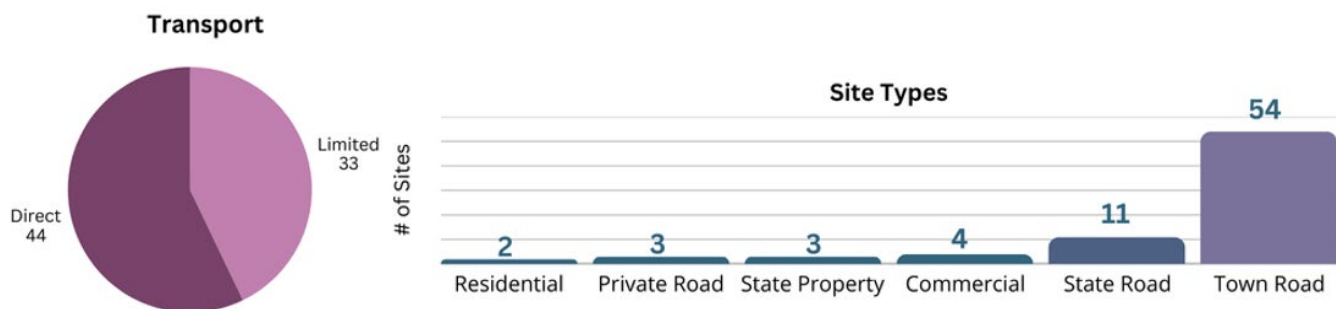


Figure 26. Transport to waterbody (left) and property type (right) category totals for NPS sites. Note that some sites were on two types of property, but only the main type is shown. See each site description for more details.

Priority Sites

The five highest-priority sites for Lake Waukegan and three highest-priority sites for Lake Winona, based on pollutant load, transport to waterbody, feasibility, cost-effectiveness, and community input 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 and the SCM Matrix (Appendix A).



Boat ramp (top) and adjacent park (bottom).

Lake Waukegan Priority Site #1 3-01: Lake Waukegan Boat Launch (Meredith)

Location (latitude, longitude): 43.6496, -71.5054 Transport: Direct

Observations: Polluted stormwater is entering the lake through the boat ramp; both the boat ramp and the adjacent park are eroding. Stormwater travels directly down the boat ramp from the north. There are signs in the park that a buffer was established as part of a past NHDES grant project, but the buffer has deteriorated and there is little vegetation in the park.

Recommendations: Consult an engineer to redesign the boat ramp. Divert runoff from the street into the park with a broad-based dip. Add a rain garden to the park to direct the stormwater into. Re-grass all other areas of the park. Potentially add storm drains to the road north of the boat ramp; directing stormwater to the park area is preferred to infiltrate stormwater. Revegetate the buffer along the shoreline of the park. Collaborate with the Meredith gardening club to maintain buffer and rain gardens.

Note: A 10% engineering design that includes more detailed recommendations was created by HW for this site as part of the WRP process. See Appendix B for more information.



Washed out check dams caused gullies to form in the road ditch.



Large disturbed area with sediment built up (top) and scouring on the road shoulder (bottom).

Lake Waukewan Priority Site #2 2-05: Opposite Side of 36 Forest Hill Road (Meredith)

Location (latitude, longitude): 43.6539, -71.5360 Transport: Direct

Observations: The check dams installed at the site have been washed out, causing a gully to form in the road ditch. Several additional rills on the road surface lead into the gully which has caused a buildup of sediment at the culvert inlet. The culvert outlet drains to a wetland in a vegetated channel. The outlet is not visible, so evidence of erosion or sediment deposition could not be determined.

Recommendations: Improve the check dams and ensure maintenance after storm events. Reshape the road ditch into a U-shape and armor it with rip rap. Consider installing a larger check dam near the culvert inlet or using a plunge pool to capture stormwater before it enters the culvert. In cases where a check dam may not be suitable, consider using a silt sock.

Lake Waukewan Priority Site #3 3-08: Winona Shore Road & Indian Trail Intersection #1 (Meredith)

Location (latitude, longitude): 43.6584, -71.5337 Transport: Limited

Observations: The ditch at this site is heavily eroded and the road shoulder is completely bare. There has been substantial sediment transport downhill due to the lack of vegetation. Given the proximity, the disturbance may be associated with power line maintenance.

Recommendations: Revegetate the road shoulder. Stabilize with rip rap if needed. Ensure all areas that are disturbed due to maintenance are revegetated, and that temporary erosion and sediment control practices are used during construction.



*Sediment deposits in the forest (top)
and road shoulder erosion (bottom).*



*Large gully beginning at 2 Pollard
Shores Road.*

Lake Waukewan Priority Site #4 2-02: Robin Way (Meredith)

*Location (latitude, longitude): 43.6474, -71.5310 Transport:
Limited*

Observations: Little has changed at the site since the 2014 watershed survey. The road shoulders on both sides of Robin Way are eroding, with large gullies leading to a culvert. The culvert likely leads to a small stream on the southwest side of Lake Waukewan. Some runoff is directed to a wooded area where there are large sediment piles.

Recommendations: Install U-shaped road ditches that are lined with rip rap to prevent further erosion and improve stormwater management. Install check dams and turnouts along the ditch to divert stormwater into the forest. A level spreader may be used to disperse the channelized stormwater at the end of each turnout. Remove the accumulated sediment and revegetate the area, if possible.

Lake Waukewan Priority Site #5 3-07A & 3-07B: Pollard Shores Road (Meredith)

*Location (latitude, longitude): 43.6458, -71.5149 Transport:
Limited*

Observations: A gully starts on the driveway of 2 Pollard Shores Road and continues down the road for about 230 feet to the railroad crossing, widening as it approaches the railroad, then leads to a culvert. Stormwater passing through the culvert discharges to a wetland along the railroad. There is a similar gully on the opposite side of the road (site B).

Recommendations: Armor the ditch with rip rap and vegetate the road shoulder. Install check dams and turnouts to divert stormwater into the wooded area to slow and disperse flow.



Large gully along the road shoulder.

Lake Winona Priority Site #1 2-15: Lambert Road (Ashland)

Location (latitude, longitude): 43.6932, -71.5921 Transport: Direct

Observations: Lambert Road is a long, unpaved road that has two large hills at either end. There is a stream crossing at the low point of the road, between the two hills. There are gullies along the length of each hill on each side of the road (four gullies total). There is no buffer directly around the culvert on either side, allowing sediment to be transported directly into the stream, which is the main tributary to Winona Lake.

Recommendations: Add check dams to the ditches on both sides of the road and turnouts into the meadow, which can be used to infiltrate stormwater before it reaches the stream.



Lake Winona Priority Site #2 2-19: Intersection of Piper Hill Road & Hawkins Pond Road (Center Harbor)

Location (latitude, longitude): 43.6859, -71.5628 Transport: Direct

Observations: A gully has formed in the road ditch at the site, and sediment has built-up within each gully signaling that sediment is traveling down the road and into one of the catch basins. Sediment from the road intersection island transports to another catch basin. Winter sand likely also accumulates in this catch basin.

Recommendations: Vegetate the road shoulder and stabilize the ditch. Add check dams and turnouts to the woods if necessary/possible. Add a filter bag to the catch basin in the roadway. Remove sediment from catch basins and shoulder. Increase vegetation in the road intersection island and remove the sandy gravel. Evaluate if the entire impervious area is needed for car travel and consider replacing with a smaller right-angle tee intersection without an island and with much less asphalt surface area; remove excess impervious cover and replace it with vegetation where possible.



A gully full of sediment leads to a catch basin (top). Road intersection island with catch basin in roadway (bottom).



Boat launch (top) with slight gullying from the parking lot (bottom).

Lake Winona Priority Site #3 2-12A & 2-12B: Winona Lake Outlet Canoe Launch (Center Harbor)

Location (latitude, longitude): 43.6715, -71.5615 Transport: Direct

Observations: There were few changes at the site since 2014, in which sediment was observed to wash into the lake via the boat ramp with some small gullies directly down the ramp. The parking lot appears to be a loose material that could be easily mobilized. The culvert under the road was noted as an issue in the 2014 survey, but that issue appears to be resolved.

Recommendations: Regrade the parking lot to divert water to small wetland at foot of parking area instead of boat ramp. If the size of the parking lot can be reduced at all, increase the width of the vegetated area by the wetland. If the launch area is only for small boats and kayaks, reduce the boat launch footprint and consider vegetating it or using interlocking pavers. Add more vegetation around the launch and/or cease mowing the grass. If mowing is necessary, keep to four inches minimum.



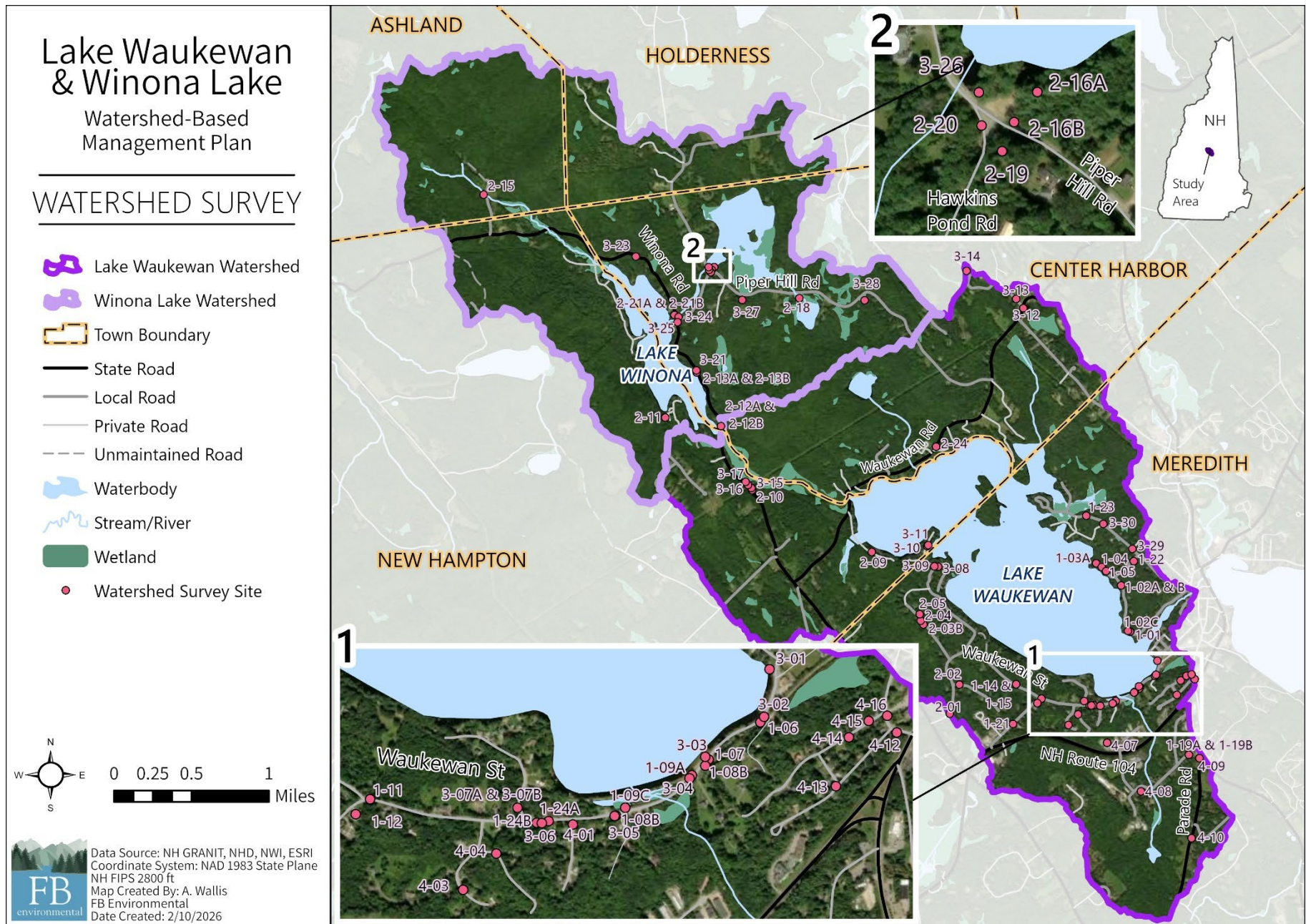


Figure 27. Location of identified nonpoint source pollution sites in the Lake Waukegan and Lake Winona watershed.

3.1.2 Shoreline Survey

As part of the original 2016 WRP for Lake Waukewan and Lake Winona, a shoreline survey was conducted during which FBE technical staff and volunteers boated the shorelines of both lakes and rated the condition of the shoreline for each parcel. The survey used 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. A re-survey was not conducted as part of this WRP update. However, LWA and volunteers from WWC conducted a shoreline survey outside of the WRP update effort in July 2026 to provide a more up to date understanding of shoreline conditions. The survey included every parcel along the Lake Waukewan shoreline except for roughly 80 parcels near the lake outlet. A mid-summer survey every five years is recommended to monitor evolving conditions.

A total of 223 parcels were evaluated along the shoreline of Lake Waukewan. The average Shoreline Disturbance Score for the lake is 5.2, with 30% of parcels (67) scoring 7 or higher, indicating potentially detrimental shoreline conditions such as inadequate buffers, exposed soil, and erosion. The average Shoreline Vulnerability Score was 4.3, with 55% of parcels (122) scoring 4 or higher, indicating most homes were built within 150 feet of the shoreline on moderate to steep slopes, which are more prone to erosion regardless of buffer quality (Table 15; Figure 28).

Table 15. Average scores for each evaluated condition criterion which comprise the average Shoreline Disturbance Score and the average Shoreline Vulnerability Score for Lake Waukewan and Lake Winona. Lower values indicate shoreline conditions that are effective at reducing erosion and keeping excess nutrients out of the lake. Totals may not equal the sum of individual components due to rounding.

Lake	Evaluated Condition	Average Score
Lake Waukewan	Buffer (1-5)	2.5
	Bare Soil (1-4)	1.5
	Shoreline Erosion (1-3)	1.3
	Shoreline Disturbance Score (3-12)	5.3
	Distance (0-3)	2.2
	Slope (1-3)	2.2
	Shoreline Vulnerability Score (1-6)	4.3

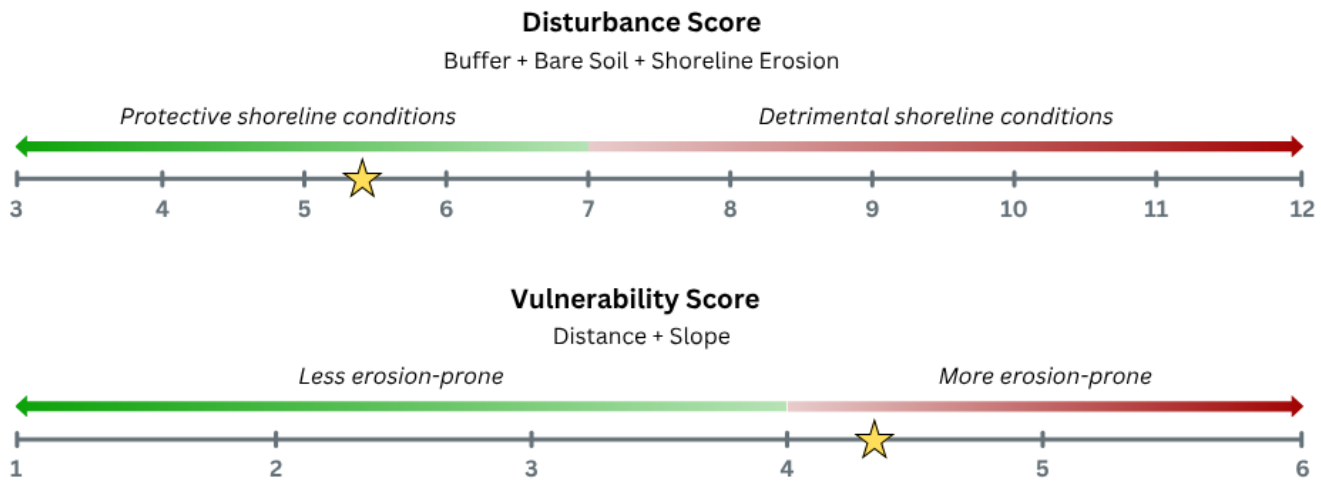


Figure 28. Lake Waukegan survey disturbance and vulnerability scores from LWA’s shoreline survey in 2026. Averages are indicated by a yellow star for Lake Waukegan.

Pollutant loading estimates are based on Shoreline Disturbance Scores. For Lake Waukegan, the 67 parcels with scores 7-11 contribute an estimated 26.3 kilograms of phosphorus annually. Implementing SCMs at 50% efficiency on these properties could reduce phosphorus by 13.2 kilograms per year. For Lake Winona, results from the original 2014 shoreline survey suggest the six parcels with scores 7-8 (low impact sites) contribute an estimated 1.8 kilograms of phosphorus annually. Implementing SCMs at 50% efficiency on these properties could reduce phosphorus by 0.9 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.

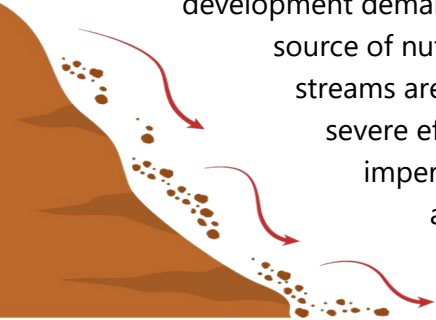
Overall, Lake Waukegan’s shoreline conditions are good (average disturbance score of less than 7). However, 30% of parcels assessed during LWA’s shoreline survey (67) need runoff and erosion management along Lake Waukegan. According to the original 2014 watershed survey, shoreline condition appears to be a lesser issue on Lake Winona, with only six parcels identified to be having a low impact on water quality. Still, improvements can likely be made to all shoreline properties to better manage stormwater and prevent phosphorus loading to the lake. 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.



3.1.3 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).

According to the United States Geological Survey Statewide Aquifer Transmissivity data layer provided through the NH Geographically Referenced Analysis and Information Transfer System, 104 acres (2%) of the Lake Waukegan watershed is mapped as having high-yielding aquifers. This area covers the Snake River and its wetlands, spanning from the outlet of Lake Winona to the inlet at Lake Waukegan. There are 205 (6%) acres mapped as high-yielding aquifers beneath the land surface of the Lake Winona watershed. These areas cover the southern shoreline of Lake Winona, the Hawkins Pond shoreline, and the area immediately surrounding the northern inlet to Lake Winona.

3.1.3.2 Soils and Erosion Hazard

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

- 1** Tunbridge-Lyman-Becket complex, very stony (36% of watershed area) – this is a well-drained soil formed from glacial till. Bedrock may be deep or shallow depending on the site. Runoff potential is moderate to high due to shallow bedrock and till.
- 2** Skerry fine sandy loam, very stony (13%) – this is well-drained soil that formed over sandy till and are very deep to bedrock. Parent material is often rocky and gravelly. Runoff potential is high due to compacted parent material that can impede water movement.
- 3** Tunbridge-Lyman Rock outcrop complex (11%) – this is an excessively well-drained soil formed from glacial till over shallow bedrock. There is high runoff potential due to the shallow bedrock and steep slopes that are associated with these soils.
- 4** Becket fine sandy loam, very stony (9%) – this soil is well-drained and formed over dense, compacted till, which means runoff potential can be high during large storms (NRCS, 2024).
- 5** Marlow fine sandy loam, very stony (6%) – this soil is deep, well drained and formed over lodgment till. Runoff potential is low because bedrock and dense till are located deep in the soil profile.

All other soil series each compose less than 4% of the watershed area. Shallow to bedrock soils are scattered throughout the watershed and mucky soils tend to be located in and around wetlands (Figure 30).

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 9% slight, 66% moderate, 14% severe, and 10% very severe. A small portion of the watershed (less than 1%) is not rated (Figure 29; Figure 31; Figure 32). Very high erosion hazard areas are restricted to the upper Lake Winona watershed in Ashland, the southwestern shoreline of Lake Winona, and the northern shoreline of Perkins Cove on Lake Waukegan.

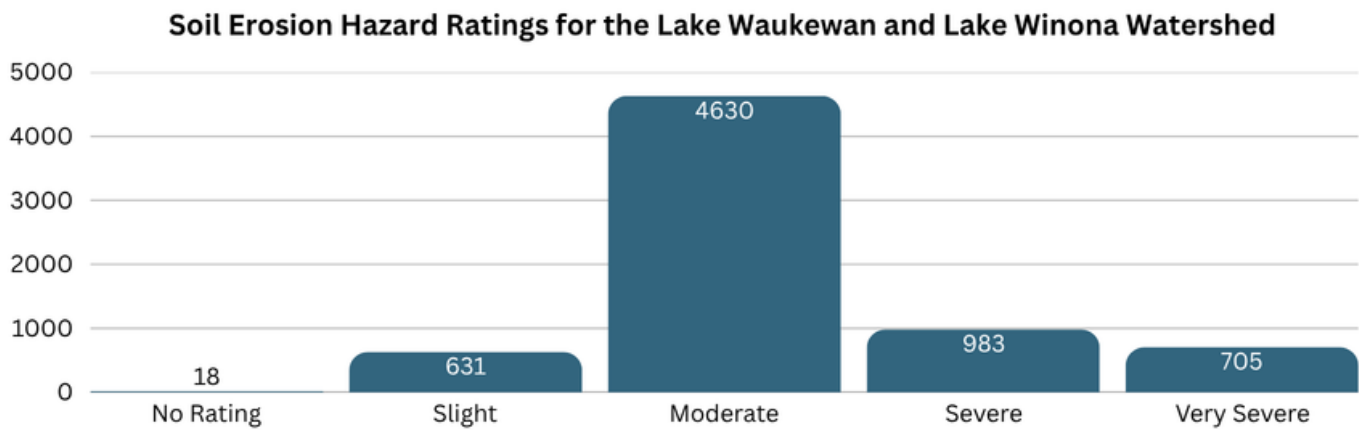


Figure 29. Soil erosion hazard ratings for the Lake Waukegan and Lake Winona watershed based on Natural Resources Conservation Service soil maps.

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.

Lake Waukegan and Lake Winona are 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 NHDES Dam Bureau sets the dam operation schedule, and the Town of Meredith, WWAC, and WWC are generally aware of the timing of dam release. If there is a suspected bloom, WWAC typically alerts the dam operator so that the bloom does not migrate into Meredith Bay. Generally, water level is maintained at 540 feet above sea level during the summer from June 15 to Labor Day and drawn down to 538.5 feet above sea level by late October.

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 lakes.

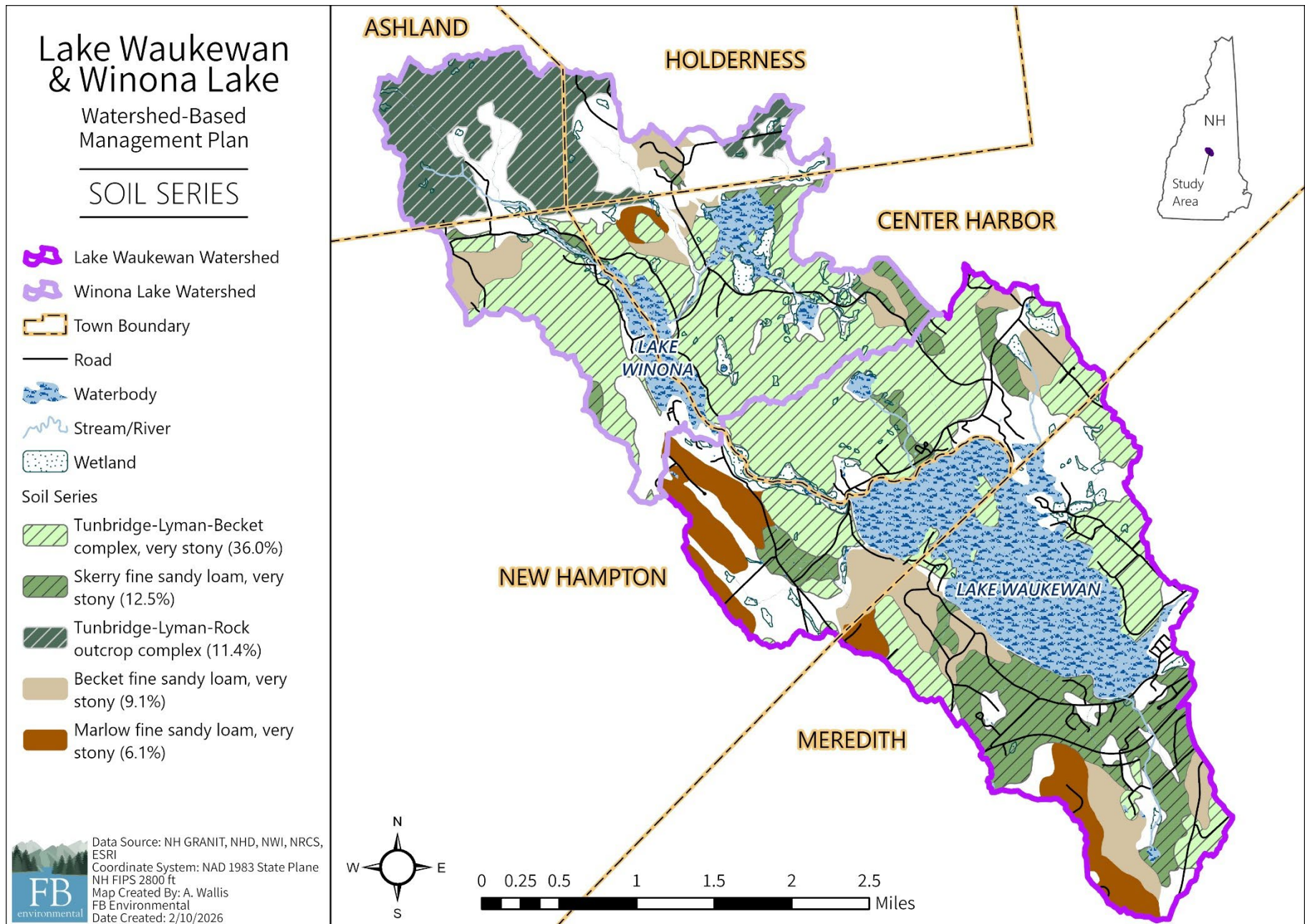


Figure 30. Soil series from the Natural Resources Conservation Service for the Lake Waukewan and Lake Winona watershed.

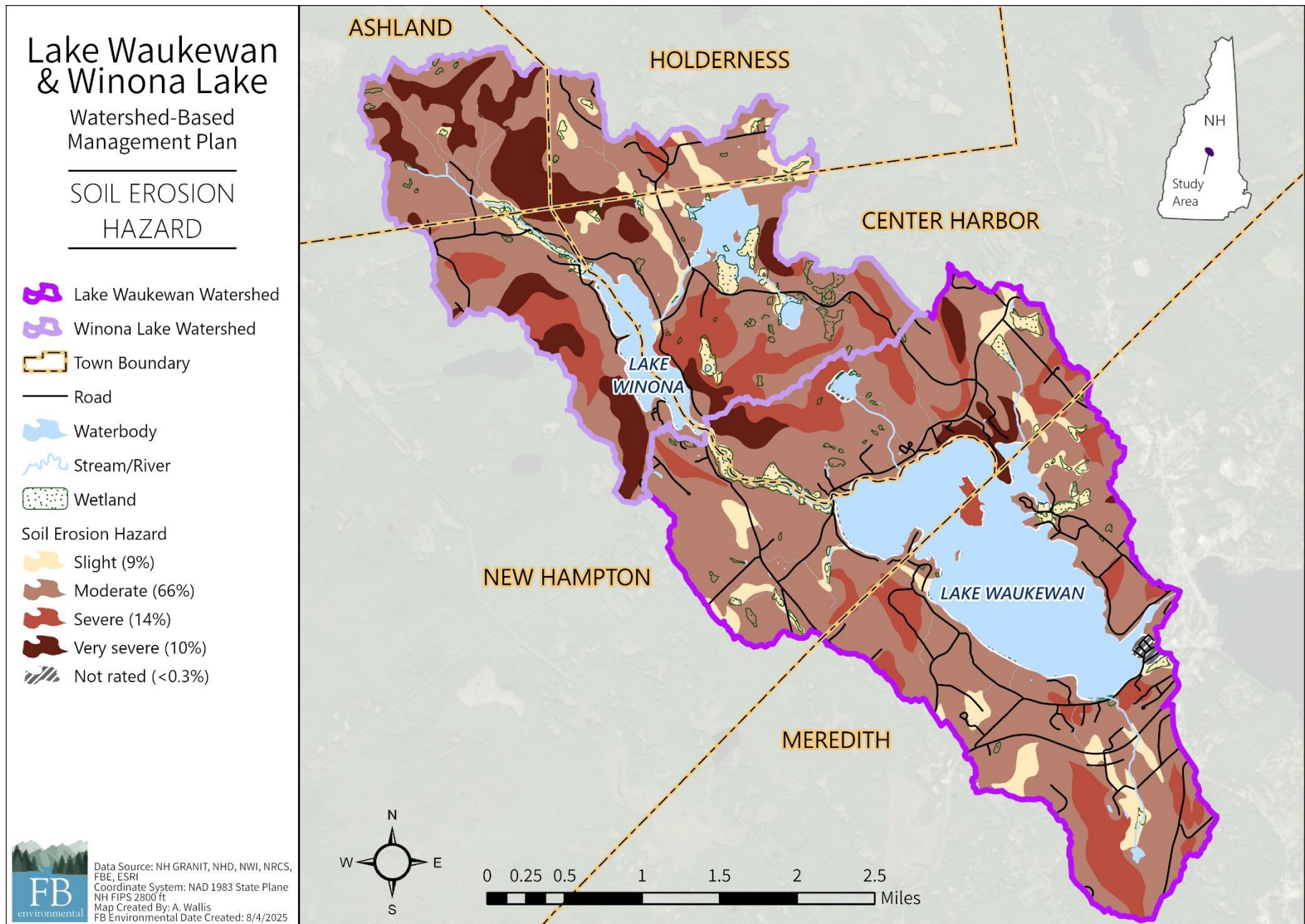


Figure 31. Soil erosion hazard in the watershed for Lake Waukewan and Lake Winona.

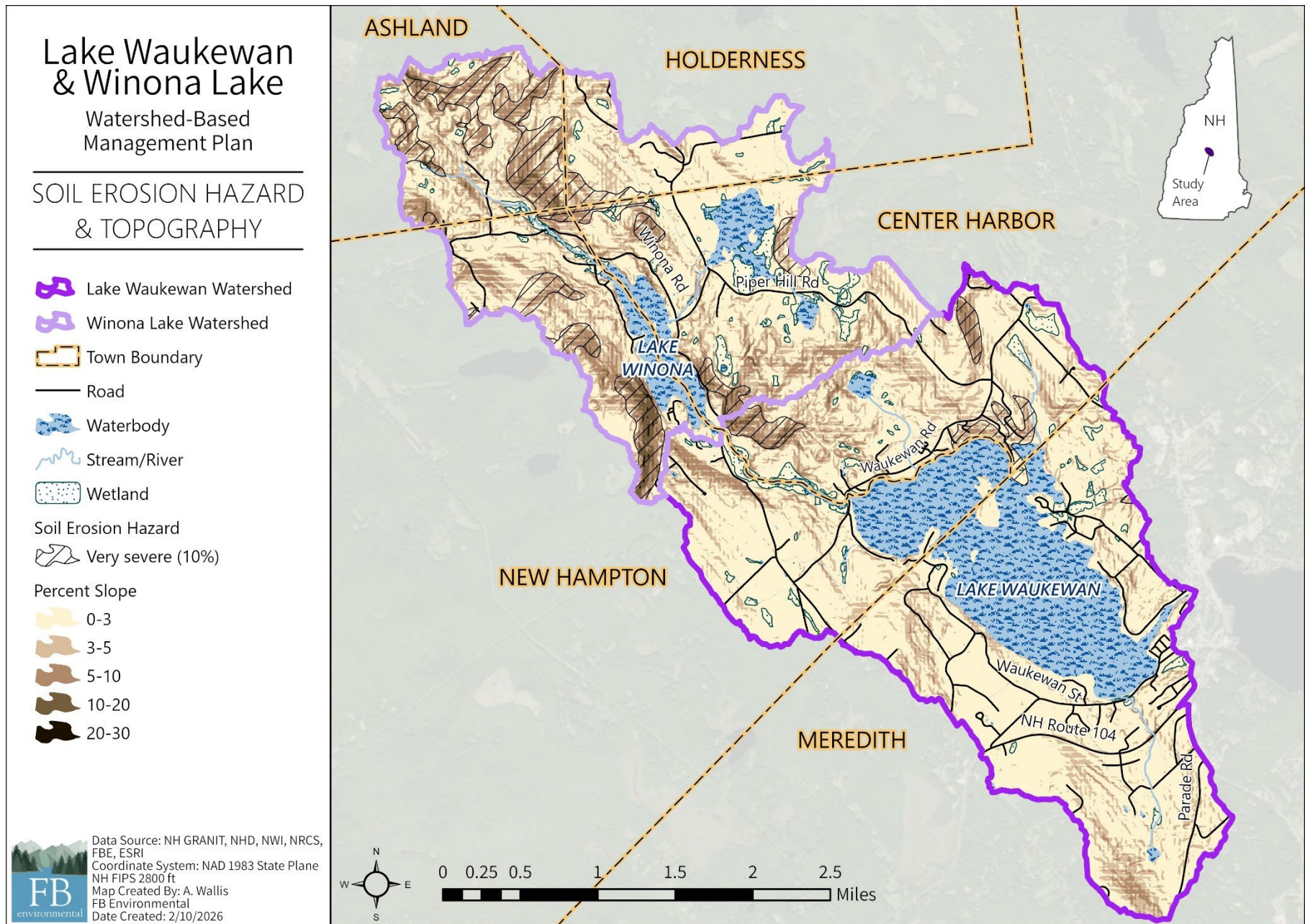
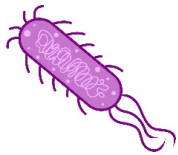


Figure 32. Terrain slope in the watershed for Lake Waukewan and Lake Winona.

3.1.4 Wastewater

3.1.4.1 Septic Systems

Most homes in the Lake Waukegan and Lake Winona watershed treat wastewater with septic systems. Homes in the southern and southeastern portion of the Lake Waukegan watershed are serviced by sewer. 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.



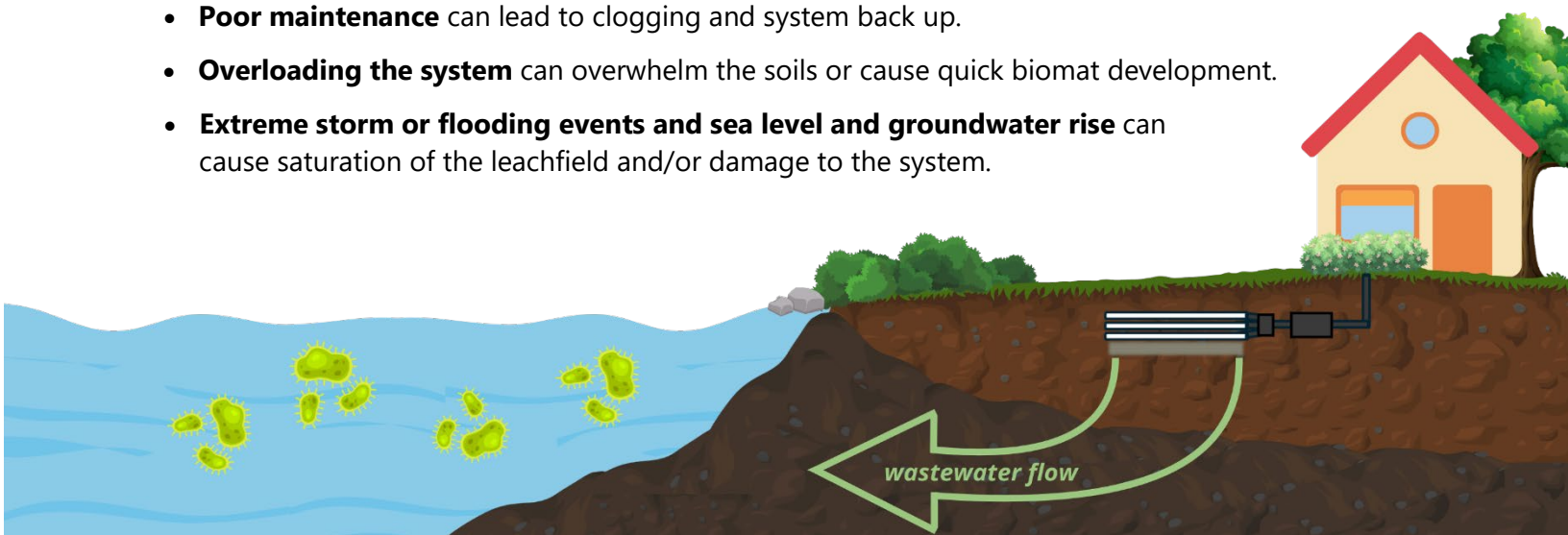
Nitrogen in wastewater can be removed into gaseous form through denitrification. Native soils beneath the leachfield are not effective at removing nitrogen (typically <40% removal), though additional denitrification can occur in groundwater, especially if anoxic conditions exist. Advanced septic system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

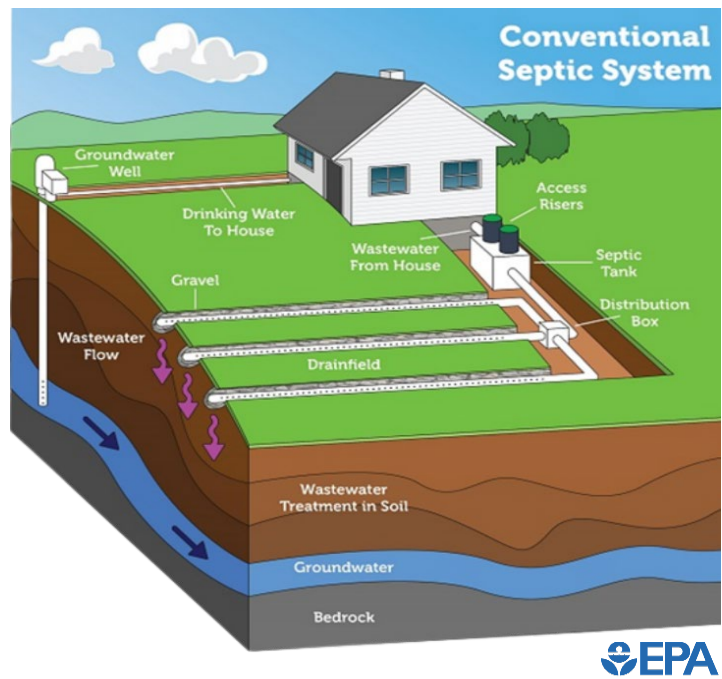


Diagram of a septic system and the wastewater flow through the ground to reach surface waters.

In 2024, [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.

In Meredith, New Hampton, and Center Harbor, septic systems must be inspected following installation, and a site assessment must occur when a property is sold within 250 feet of the shoreline. Septic systems must have a 100-foot setback from prime wetlands and waterbodies. These systems are regulated based on the soil type beneath the leachfield. For more information, see Section 4.2.2, Table 16. In Meredith, septic systems within 250 feet of the Lake Waukegan shoreline are subject to the Regulations Pertaining to Certain Subsurface Wastewater Disposal Systems in the Lake Waukegan Watershed, which were approved in 2012. With the purpose of protecting lake water quality, these regulations require a septic system replacement in cases where the homeowner intends to increase the number of bedrooms, expand the living space, or add a new structure and there is no septic system approval on file. It also requires all properties without a valid septic system approval on file to receive an inspection from the Health Officer to verify that the system is not failing. The regulations provide an evaluation form for these inspections. These inspections and a list of properties without approvals on file are maintained by the Health Officer, though there has been difficulty continuing enforcement of the regulations in recent years due to staff capacity. FBE created a septic system database for septic systems within 250 feet of Lake Waukegan and Lake Winona by using the NHDES Subsurface Applications Status Query. The database identified that

roughly 56% (71 systems) and 45% (53 systems) of septic systems within 250 feet of Lake Winona and Lake Waukegan, respectively, are older than twenty-five years old.

3.1.4.2 Sewer Lines

Sewer lateral lines connect private properties to the main sewer line (Figure 33). Lateral lines are owned and maintained by the property owner, but the sewer district may test these lines to identify potential leaks or issues when buildings are demolished. The Meredith Water Department jets and inspects approximately 10-15% of sewer lines annually to prevent sewer leaks and identify them quickly when they occur. This maintenance largely occurs in spring and fall. The outskirts of the sewer system, some of which are within the Lake Waukegan watershed, tend to have more issues and thus are inspected more frequently. Each year, the water department is expanding the inspection program and aims to assess the condition of all sewer infrastructure throughout Meredith. The water department is currently working on a Sewer Asset Management Plan and has identified numerous places where sewer lines may be replaced in the near future. Additional capacity exists to expand sewer service in the future if needed. While the Meredith Water Department's efforts focus on the main sewer lines, the current condition of lateral sewer lines is unknown.

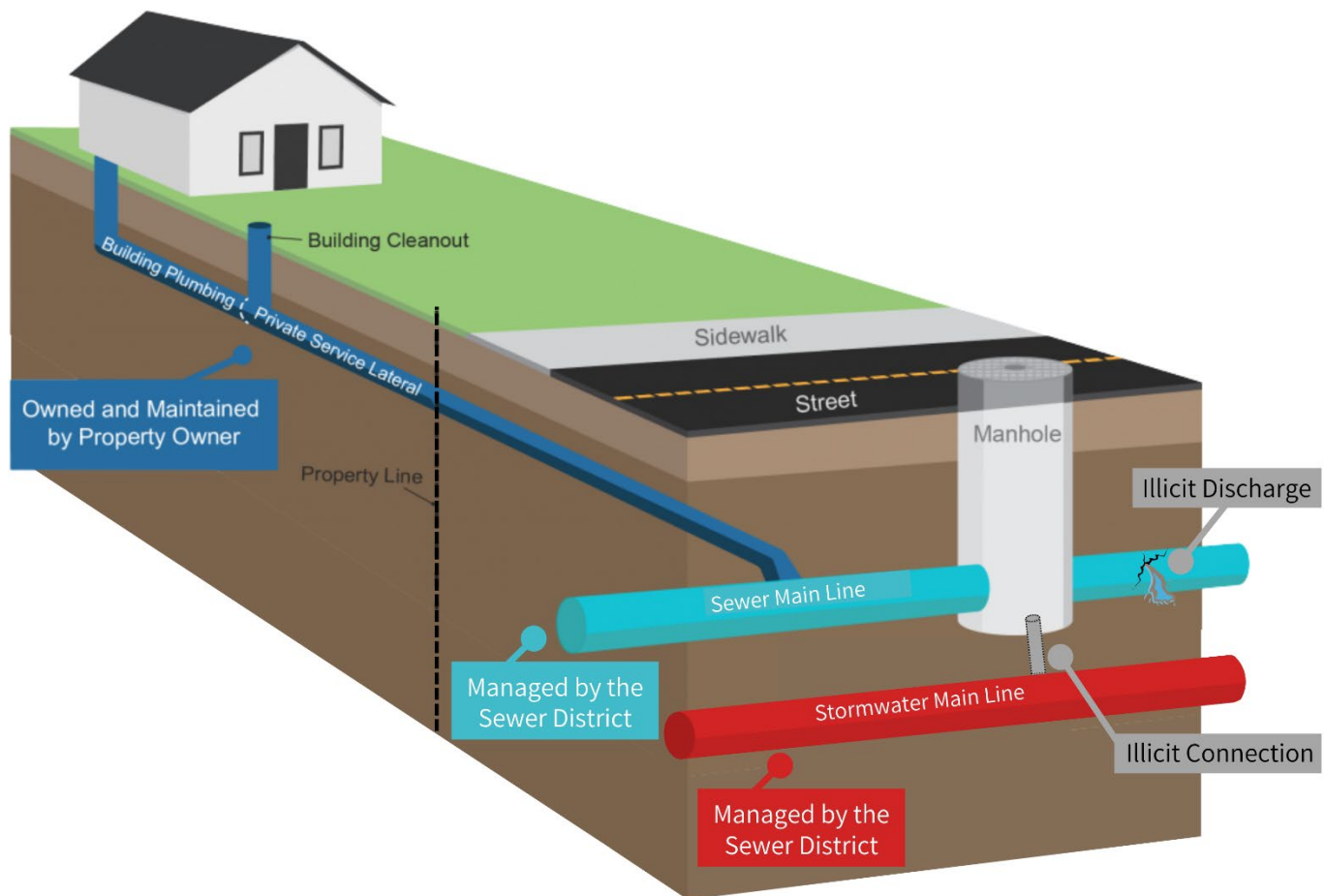


Figure 33. Schematic of a private sewer lateral line connection to the main sewer line. Adapted from Clean Water Shreveport.

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 Lake Waukegan and Lake Winona watershed primarily includes cropland, hayfields, and grazing areas. The LLRM results showed that agriculture covers 2% of the Lake Waukegan and Lake Winona watershed and contributes 7% of the total phosphorus load to the lakes (Figure 17).

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 Meredith, Center Harbor, and New Hampton has increased by an estimated 3,380 residents from 1970 to 2020 (Figure 34). It is important to note that much of the population is seasonal and the turnover rate of seasonal and rental homes is high.

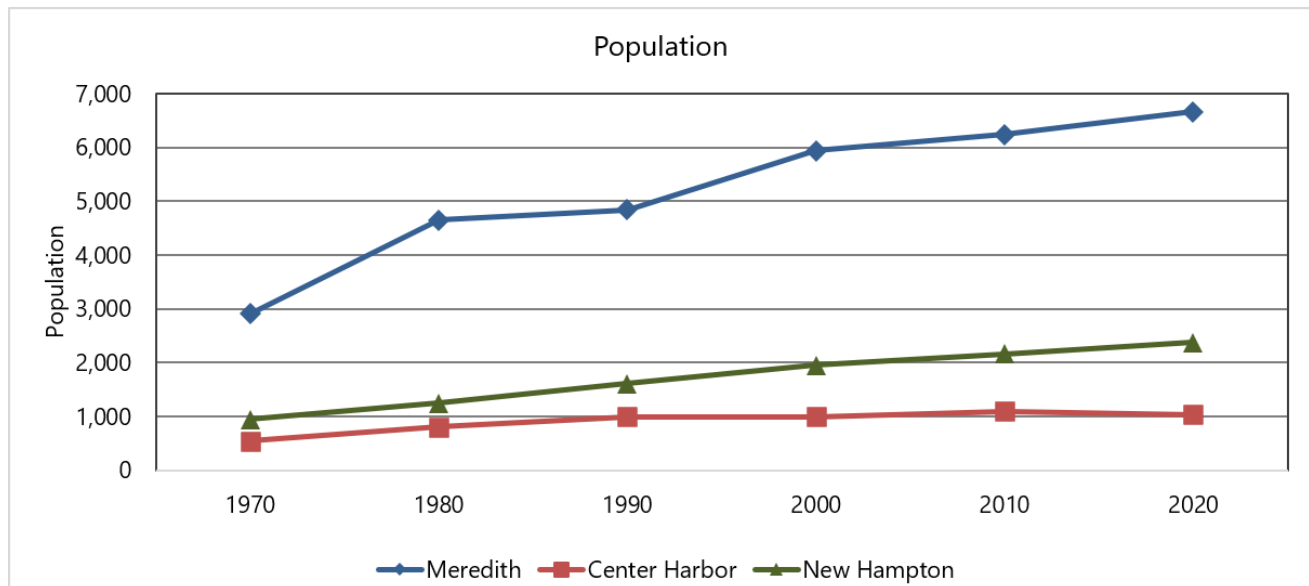


Figure 34. Cumulative population of Meredith, Center Harbor, and New Hampton, NH. Data from the U.S. Census Bureau.

The Meredith area has long been treasured as a recreational haven for both summer vacationers and year-round residents. The Winnepesaukee Region is among the oldest summer vacation spots in New Hampshire and offers fishing, hiking, boating, sailing, canoeing, kayaking, and swimming in the summer, and ice fishing, cross-country skiing, snowshoeing, and snowmobiling in the winter. The desirability of Meredith and the greater Lake Winnepesaukee area as a recreational destination will likely stimulate continued population growth in the future. 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 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.

Based on this database, potential point sources in the watershed include above and underground storage tanks, a solid waste facility, hazardous waste generators, local potential contamination sources, and remediation sites (Figure 35).

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 watersheds. There are 3 underground storage tanks, all located within the Lake Waukegan watershed. All three are affiliated with a commercial business located off of Reservoir Road in Meredith.

3.2.2 Solid Waste Facilities

There is one solid waste facility within the Lake Waukegan watershed located off Waukegan Road. This is the Fisher Property Landfill, which is no longer operating but remains 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. One hazardous waste generating facility is located in the Lake Winona watershed, and 5 within the Lake Waukegan watershed. Facilities are classified as either inactive (three) or declassified (three).

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. There are thirteen local potential contamination sources within the Lake Waukegan watershed, 12 of which are in Meredith and one in Center Harbor. Many are located along or near NH Route 104.

3.2.5 Remediation Sites

There are 20 remediation sites present within the Lake Waukegan watershed. These sites include formerly leaking storage facilities that contain fuel or oil, hazardous waste, underground injection control of wastewater or other fluids, fuel-oil-related contamination, and reported spills requiring initial response. The one remediation site in the Lake Winona watershed was a heating oil spill at a residence in 2000.

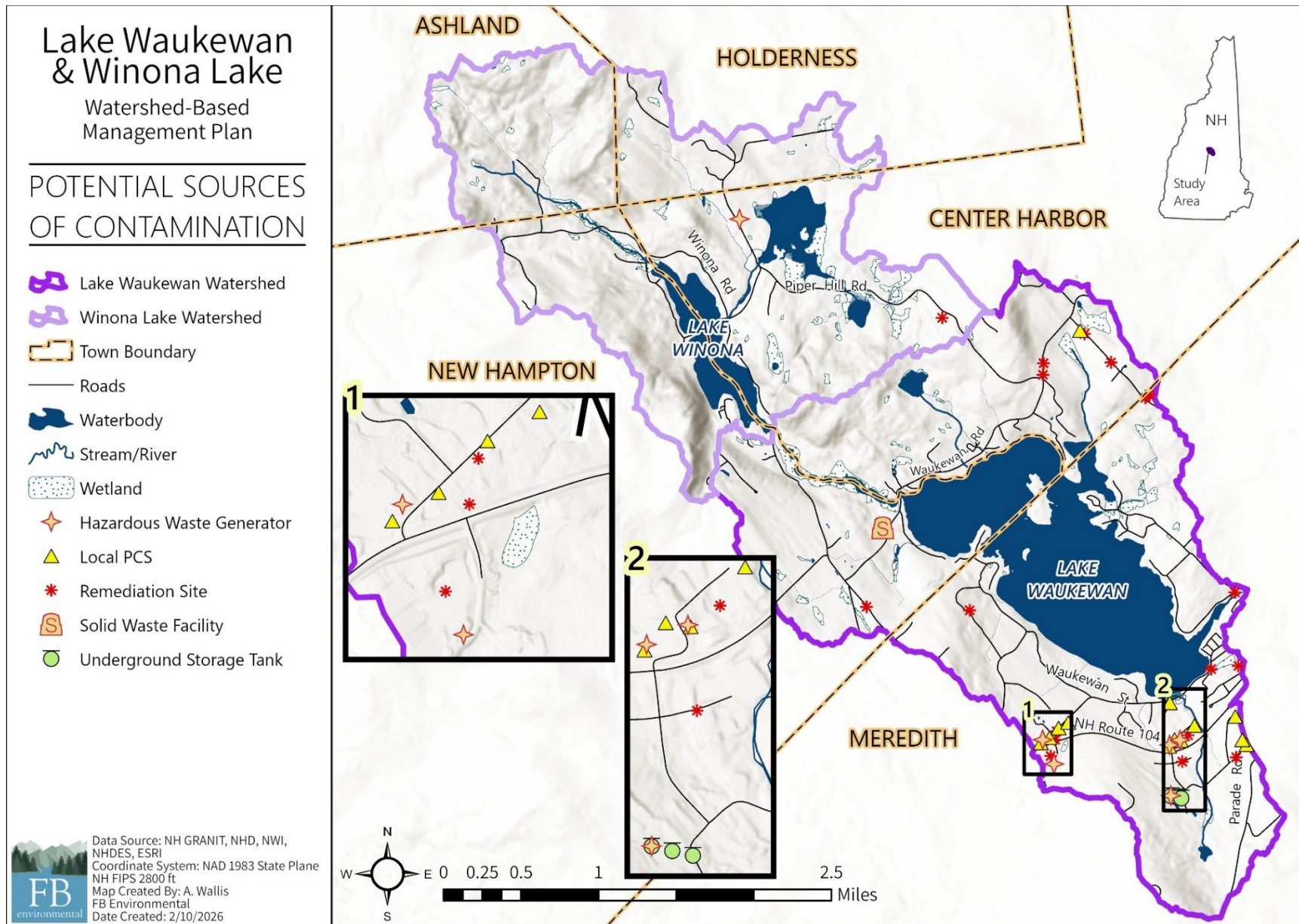


Figure 35. Potential contamination sources in the watershed for Lake Waukewan and Lake Winona.

3.3 WILDLIFE

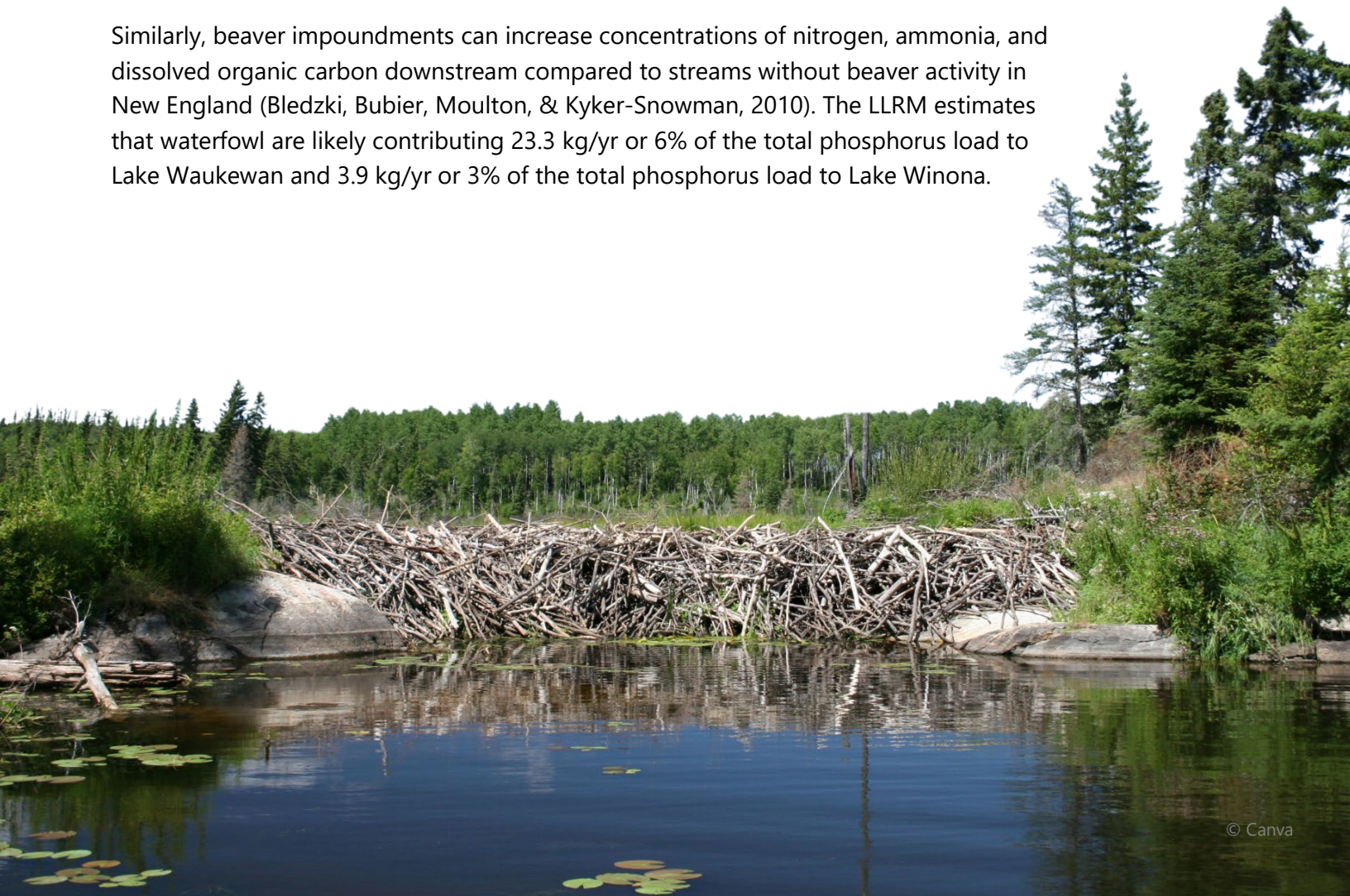
Fecal matter from wildlife such as geese, gulls, ducks, and beaver may be a significant source of nutrients in some watersheds. This is particularly true when human activities, including the direct and indirect feeding of wildlife and habitat modification, result in the congregation of wildlife (CWP, 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 23.3 kg/yr or 6% of the total phosphorus load to Lake Waukewan and 3.9 kg/yr or 3% of the total phosphorus load to Lake Winona.



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. Additionally, Hill et al. (2014) projected U.S. stream temperatures to rise by 0.6°C ($\pm 0.3^\circ\text{C}$) 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.

Ice-out data provided by NHDES show that the ice-out dates on Lake Waukegan may be getting earlier (Figure 36), though additional statistical analysis is needed to determine whether the trend is significant. Lake Waukegan has consistent ice-out data since 2002. Ice-out data on Lake Winona are too sparse to determine whether the duration of ice cover is changing (Figure 36).



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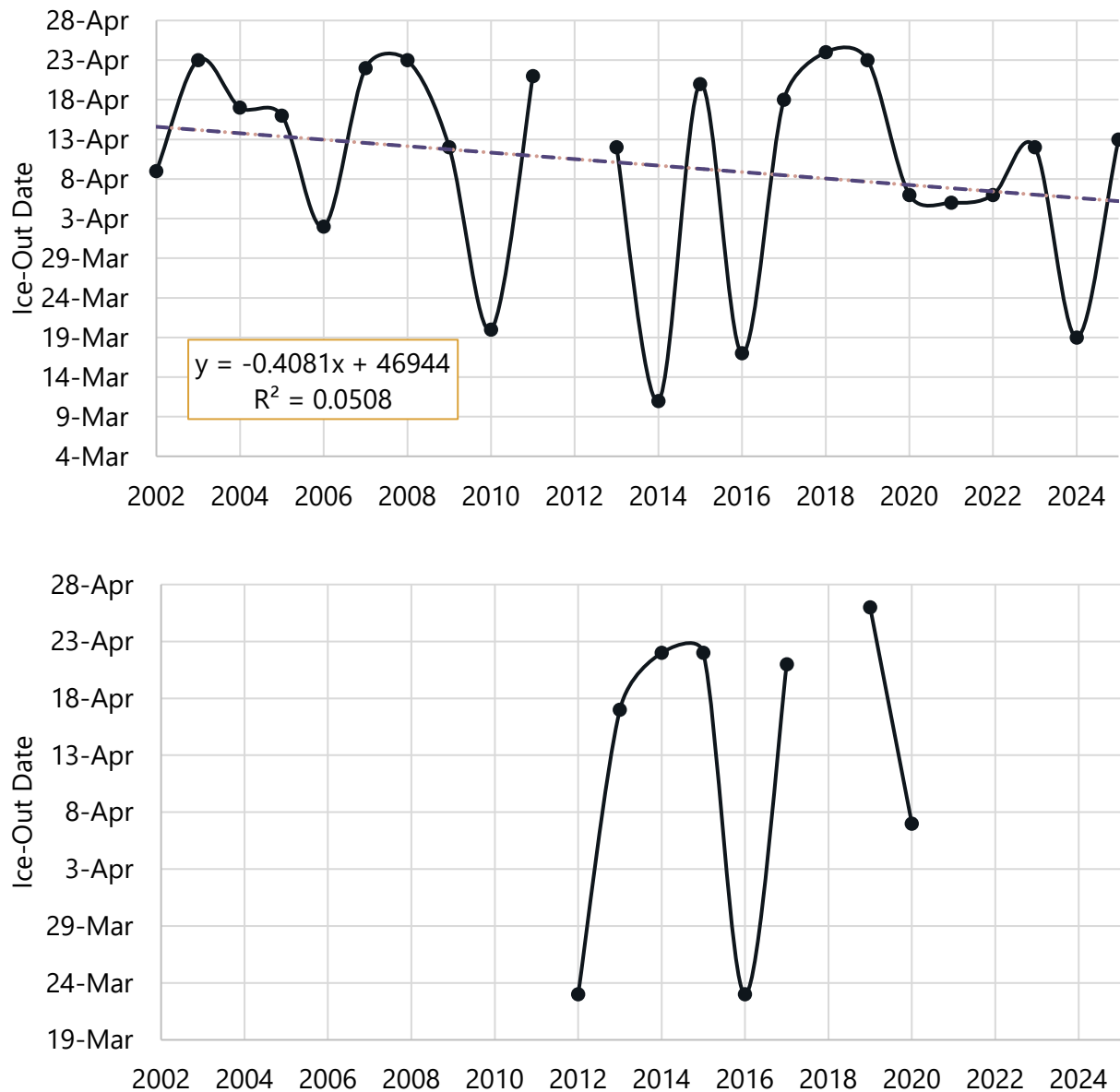
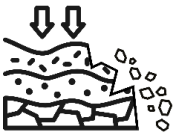


Figure 36. Ice-out dates for Lake Waukegan (top) and Lake Winona (bottom) from 2002-2025. Dashed lines indicate a linear trendline with the equation displayed. A trendline is not shown for Lake Winona as there are insufficient data.

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 structural 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 77 sites remain to be addressed from the 2014 and 2025 watershed surveys, and 16 high/medium impact rated shoreline properties on Lake Waukegan from LWA's 2026 shoreline survey were documented to have some impact on water quality through the delivery of phosphorus-laden sediment (refer to Sections 3.1.1-3.1.2). As such, structural SCMs to reduce the external watershed phosphorus load are a necessary and important component for water quality protection.

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

- Implement SCMs at the Lake Waukegan Boat Launch site, which is the top rated site in the 2026 watershed survey and already has a 10% conceptual engineering design completed as part of this project (Appendix B). This action would reduce phosphorus loading to Lake Waukegan by 0.8 kg/yr, or 2% of Objective 1.
- Provide technical assistance and/or implementation cost sharing to four high impact shoreline properties identified during LWA's 2026 shoreline survey on Lake Waukegan. Encourage

landowners to implement SCMs on the 12 medium impact shoreline properties identified during LWA's 2026 shoreline survey. Workshops and tours of demonstration sites can help encourage landowners to utilize SCMs on their own property, including the 51 low impact properties on Lake Waukegan. Conduct an updated shoreline survey on Lake Winona and repeat regular shoreline surveys to continue prioritizing properties for technical follow-up.

For the proper installation of structural SCMs in the watershed, the WWAC and other stakeholders should work with the towns' departments of public works and/or experienced professionals on sites that require a high level of technical knowledge (engineering). The *Municipal Stormwater Control Measures Handbook* (FBE, 2026a) created for this WRP was reviewed by engineers at HW and should be used to help guide implementation. 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 and the handbook.

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) for standard road design and maintenance best practices.

Even though none of the 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 and training for residents and municipal staff all of which are aimed at minimizing polluted runoff to surface waters.

4.2.2 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 a preliminary ordinance review of natural resource protections for the municipalities of Meredith, New Hampton, Center Harbor, Ashland, and Holderness (Table 16), which comprise all watershed towns. These towns play a critical role in influencing land use, shoreline development, and water quality conditions within the lakes. 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.

The commissions and ordinances in these watershed towns that aid in protecting the health and natural resources of the Lake Waukegan and Lake Winona watershed are as follows:



Conservation Commissions



Fertilizer and pesticide control



Shoreland and floodplain development



Impervious cover restrictions



Aquifer protection



Septic system approval regulation

FBE completed a preliminary ordinance review of natural resource protections for the Towns of Meredith, New Hampton, Center Harbor, Ashland, and Holderness (Table 16). All watershed towns have already incorporated several important regulations into their ordinances. Recommendations are only presented for Meredith, New Hampton, and Center Harbor, which share the shorelines of either Lake Waukegan or Lake Winona. A more robust review of these ordinances is encouraged for more specific recommendations for improving ordinances and regulations related to natural resource protection. The towns should also consider its staffing capacity to enforce existing and proposed regulations.

Table 16. Ordinance review of regulatory and non-regulatory tools for natural resource protection in the towns of Meredith, New Hampton, Center Harbor, Ashland, and Holderness. Recommendations are only provided for Meredith, New Hampton, and Center Harbor, which are the only watershed towns with land area along the shorelines of Lake Waukegan or Lake Winona.



Regulatory Tools

Strategy	Meredith	New Hampton	Center Harbor	Ashland	Holderness
Zoning districts addressing environmental protection.	Existing: Article V D-1 Forestry and Conservation District, D-2 Forestry and Rural District, D-2(a) Meredith Neck District, D-4 Shoreline District, D-9 Water Resources Conservation Overlay District, D-10 Lake Waukegan Watershed Overlay District, D-5 Business and Industry District. Recommendation: Expand Conservation Districts to include buffer zones around all significant water bodies and wetlands, and incorporate mandatory riparian buffers to reduce runoff and protect aquatic habitats.	Existing: Flood Hazard Overlay District, Pemigewasset Overlay District (PO), Lake Waukegan Watershed Overlay District, Sewage Disposal Requirements, Land Spreading/Application of Septage, Buffers, Lot Coverage Limits, Agricultural Use Restrictions, Waterbody Setbacks. Recommendation: Consider writing a wetland overlay district to better protect wetlands	Existing: Water Resources Conservation Overlay District, Use of Shorefront Lots, Flood Management Ordinance Recommendation: Consider writing a wetland overlay district to better protect wetlands	Existing: Shoreland Zoning, Waterfront Parcels, Cluster Development, Wetlands Protection, Groundwater Protection, Steep Slope Protection, Septic Regulations.	Existing: Pemigewasset River Overlay District, Holderness Flood Hazard District, FEMA Special Flood Hazard Areas, Groundwater Protection Overlay District, Steep Slopes Ordinance, Shoreland Protection, Setback Requirements from Wetlands and Waterbodies, Septic Setback Regulations

Strategy	Meredith	New Hampton	Center Harbor	Ashland	Holderness
Shoreland zoning	Existing: Shoreland District (D-4) protects water quality and shoreline character. Waterfront lots have a minimum lot size of 40,000 square feet with 150 feet of lake frontage, a 65 foot shoreline setback. Non-waterfront lots have a 25,000 – 40,000 square foot minimum lots size. Single-family residences, short term rentals, home occupations are permitted uses. Other uses such as two-family homes, marinas, camps, and small-scale commercial permitted by special exception. Recommendation: Consider increasing shoreline setback to 80 feet and require 75% natural vegetative cover in the setback.	Existing: The Lake Waukegan Watershed Overlay District imposes additional density limits and development restrictions to protect drinking water and water quality. Shoreline parcels must have 150 feet of lake frontage, 35 foot setbacks from the road, and lot coverage limited to 50%. Recommendation: Maintain existing setbacks but add a cap of 15% maximum impervious cover within 250 feet of the shoreline to reduce runoff and require shoreline planting plans for any new development. Reduce maximum lot coverage to 40%.	Existing: Section 10.4.3. Shoreland Zone requires a setback of 250 feet from the reference line. There is an impervious cover maximum of 30%, with greater than 20% triggering stormwater controls (10.4.3.2.2). There is a Natural Woodland Buffer of 150 ft (10.4.3.3) and a Waterfront Buffer of 50 ft (10.4.3.4). Recommendation: Reduce impervious limit to 20% in entire shoreland zone and require native vegetation restoration for any disturbed buffer areas.	Existing: No shoreline on Lake Waukegan or Lake Winona.	Existing: No shoreline on Lake Waukegan or Lake Winona.

Strategy	Meredith	New Hampton	Center Harbor	Ashland	Holderness
Cluster development and/or open space provisions for subdivisions.	Existing: According to Article XXI of the zoning ordinance, 50% of the parcel must be held as open space, and less than 50% of the open space can be wetlands or steep (greater than 25%) slopes. Open space excludes septic, developed shoreline, and roads. There is a density bonus of up to 20% for public access, view protection, or added open space. Recommendation: Require a higher percentage of preserved open space for cluster developments near water bodies and encourage integration of natural filtration features like rain gardens and wetlands.	Existing: Cluster Development is listed as an allowed use by Conditional Use Permit in several zoning districts, including the General Residential, Mixed Use, and Business Commercial districts. Recommendation: Require a higher percentage of preserved open space for cluster developments near water bodies and encourage integration of natural filtration features like rain gardens and wetlands.	Existing: Sections 14.1, 14.2, 14.9, 14.11 describe that cluster development must preserve 50% of buildable land and 80% of non-buildable land. Steep slopes and floodplains should be avoided. Recommendation: Require 100 foot riparian buffers in open space and limit impervious surfaces in preserved land to less than 5%.	Existing: Cluster development is permitted and must meet combined lot size requirement for the zoning district and excludes wetlands and slopes greater than 25%.	Existing: Clustered Residential Development allowed in all districts as permitted use (300.4.1.1, .2.1, .3.1). The purpose is to preserve open space and natural features; specific provisions in Special Provisions section (600.1), may involve Planning Board review and open space dedication.
Protection of wetlands.	Existing: Wetlands are protected through the Water Resources Conservation Overlay District, which sets a	Existing: No wetlands ordinance. Recommendation: Establish a Wetland Protection District that	Existing: No wetlands ordinance. Sections 10.4.2 and 10.4.2.4 of the zoning ordinance require 125-, 75-, and	Existing: Wetlands are excluded from minimum lot size calculations. No septic systems are allowed on	Existing: There is a required 50 foot setback from the edge of a wetland with a natural buffer required.

Strategy	Meredith	New Hampton	Center Harbor	Ashland	Holderness
	150-, 100-, and 50-foot setback around prime, designated, and non-designated wetlands. Septic system setbacks are included in the overlay. Wetlands smaller than 3,000 square feet are not regulated. Wetland delineation may be required by NHDES standards at the cost of the applicant. Recommendation: Increase setbacks from wetlands for all development and establish a no-disturbance buffer zone around all wetlands to better protect against habitat loss and water quality degradation.	regulates natural buffers, setbacks, and limits on impervious cover within a set distance from wetlands. Some ordinances have increased diligence around prime wetlands. We recommend a minimum 75-foot buffer around all wetlands, prohibiting building and significant vegetation removal within that area.	50-foot buffers for prime, designated, and non-designated wetlands. Section 10.6.2.2 prohibits docks in prime wetlands. Recommendation: Increase setbacks from wetlands for all development and establish a no-disturbance buffer zone around all wetlands to better protect against habitat loss and water quality degradation.	wetlands. Steep slope and soil group limitations apply.	Leachfields cannot be within 125 feet of a wetland. Septic tanks cannot be within 75 feet. Removal of material or soil disturbance within 100' of wetlands requires erosion control plan by licensed engineer.
Protection of groundwater.	Existing: Groundwater protections included in Water Resources Conservation Overlay, which prevents groundwater contamination from wastewater, toxics, stormwater; protects	Existing: The Lake Waukegan Watershed Overlay District provides protective measures, including stormwater runoff review and land use restrictions, to safeguard water quality	Existing: Section 10.4.1, 10.8.3. The overlay includes stratified drift aquifers. Prohibits landfills, junkyards, bulk fuel, animal manure, and other similar land uses. Impervious cover greater than 15%	Existing: Section 4.5b requires compliance with NH Water Supply and Pollution Control Commission rules for mobile home parks without town sewer/water.	Existing: Groundwater Protection Overlay District limits or prohibits certain uses such as hazardous materials and underground tanks and requires performance standards, inspections,

Strategy	Meredith	New Hampton	Center Harbor	Ashland	Holderness
	wetland buffer/filter functions. Recommendation: Implement a maximum impervious cover per lot in the Aquifer Protection Overlay District.	in the watershed that drains into the lake, a public drinking water source. Recommendation: Amend the impervious cover restriction from only including paving less than 10% of the lot's surface to include a whole impervious surface percent maximum including buildings.	requires a special exception. Recommendation: Amend the impervious cover restriction from 15% to 10%.		and maintenance plans. The overlay is applicable to all aquifer areas mapped in the ordinance.
Protection of steep slopes.	Existing: No development is permitted on slopes greater than 25% in cluster developments. No separate steep slope ordinance. Recommendation: Establish a Steep Slope Protection Area including all slopes equal to or greater than 15% in which engineered stormwater controls are required. Some ordinances only apply to areas with disturbance is greater	Existing: In the Pemigewasset Overlay District, construction is prohibited on slopes exceeding 15% to prevent erosion and protect sensitive lands Recommendation: Establish a Steep Slope Protection Area including all slopes equal to or greater than 15% in which engineered stormwater controls are required. Some ordinances only apply to areas with disturbance is greater	Existing: Section 10.4.2.3.2 of the zoning ordinance requires Alteration of Terrain permit if disturbance is on slope greater than 25% within 50 feet of water. Recommendation: Establish a Steep Slope Protection Area including all slopes equal to or greater than 15% in which engineered stormwater controls are required. Some ordinances only apply to areas with	Existing: The Soils and Slopes Table restricts development. Slopes greater than 25% are not buildable and excluded from minimum lot size.	Existing: Steep Slopes Ordinance applies to slopes greater than 25%. It requires application, design guidelines, erosion control, and potential performance security; intent is to prevent erosion, protect water quality, and ensure slope stability; additional slope-based lot sizing under subdivision rules.

Strategy	Meredith	New Hampton	Center Harbor	Ashland	Holderness
	than a certain area, and require an engineering plan, SCMs, and exclude extremely steep (greater than 20%) slopes from buildable area.	than a certain area, and require an engineering plan, SCMs, and exclude extremely steep (greater than 20%) slopes from buildable area.	disturbance is greater than a certain area, and require an engineering plan, SCMs, and exclude extremely steep (greater than 20%) slopes from buildable area.		
Septic pump-out ordinance or regulation of septic and sewer systems.	Existing: Health regulations require proof of a valid septic system operational permit to obtain building permits for certain construction types. An inspection is mandated for all systems without an approval on file. Recommendation: Require septic pump outs and inspections every three years within an overlay district, require certain design criteria in sensitive areas.	Existing: No septic regulations. Recommendation: Require septic pump outs and inspections within an overlay district, require certain design criteria in sensitive areas. Recommendation: Require septic pump outs and inspections every three years within an overlay district, require certain design criteria in sensitive areas.	Existing: No septic regulations. Recommendation: Require septic pump outs and inspections within an overlay district, require certain design criteria in sensitive areas. Recommendation: Require septic pump outs and inspections every three years within an overlay district, require certain design criteria in sensitive areas.	Existing: No septic regulations. Recommendation: Require septic pump outs and inspections within an overlay district, require certain design criteria in sensitive areas.	Existing: No septic regulations. Recommendation: Require septic pump outs and inspections within an overlay district, require certain design criteria in sensitive areas.
Nutrient loading analysis required for	Existing: None identified, though the Water Resources Conservation District references preventing	Existing: None identified. Recommendation: Require phosphorus and nitrogen loading	Existing: None identified. Recommendation: Require phosphorus and nitrogen loading	Existing: None identified.	Existing: None identified.

Strategy	Meredith	New Hampton	Center Harbor	Ashland	Holderness
fresh waterbodies.	excessive nutrient release. Recommendation: Require phosphorus and nitrogen loading analysis for any development greater than 1 acre in watershed.	analysis for any development greater than 1 acre in watershed.	analysis for any development greater than 1 acre in watershed.		
Low impact development requirements and standards.	Existing: None identified. Recommendation: Make low impact development strategies mandatory in all developments, including rain gardens, permeable pavements, and green roofs, to reduce runoff and improve water infiltration.	Existing: Ordinances defines impermeable surfaces and includes references to stormwater and drainage management but does not contain dedicated low impact development standards or requirements beyond overlay districts. Recommendation: Make LID strategies mandatory in all developments, including rain gardens, permeable pavements, and green roofs, to reduce runoff and improve water infiltration.	Existing: Stormwater infiltration standards are required if impervious cover is greater than 10% in the Groundwater Protection District. No broader low impact development standards across zoning. Recommendation: Make LID strategies mandatory in all developments, including rain gardens, permeable pavements, and green roofs, to reduce runoff and improve water infiltration.	Existing: None identified.	Existing: None identified.
Environmental Ordinances	Existing: None identified.	Existing: The ordinance includes definitions and	Existing: No green building codes or green	Existing: None identified.	Existing: No green building codes or green

Strategy	Meredith	New Hampton	Center Harbor	Ashland	Holderness
(e.g. green building codes, green infrastructure, tree preservation, limits on impervious surface cover)	Recommendation: Currently uses the 2015 International Building Code, which allows for certain green infrastructure/SCMs such as green roofs and rain harvesting from roofs. Consider updating to the newest standard and adopting other environmental codes and regulations.	some provisions related to impermeable materials and drainage, but does not include specific environmental ordinances like green building codes or tree preservation mandates. Recommendation: Consider adopting the 2021 International Building Code. Consider adopting other environmental codes and regulations.	infrastructure mandates. There is a tree/sapling point system along the shoreline and impervious cover maximums triggering a stormwater control plan. Recommendation: Consider adopting the 2021 International Building Code. Consider adopting other environmental codes and regulations.		infrastructure mandates. There is a tree/sapling point system along the shoreline and impervious cover maximums triggering a stormwater control plan.
Fertilizer and/or pesticide ordinances.	Existing: None identified. Recommendation: Implement a fertilizer ordinance. This may be town-wide or within an overlay district. Stipulations may be made such that natural fertilizers may be allowed, or special types of fertilizers may be used for agricultural purposes, but not residential.	Existing: None identified. Recommendation: Implement a fertilizer ordinance. This may be town-wide or within an overlay district. Stipulations may be made such that natural fertilizers may be allowed, or special types of fertilizers may be used for agricultural purposes, but not residential.	Existing: Only licensed applicators may apply pesticides or herbicides. Only low-phosphorus, slow-release fertilizers are allowed beyond 25 feet of the reference line. Within 25 feet, only lime is allowed.	Existing: Fertilizer is prohibited within the Little Squam Lake and Squam River Overlay District.	Existing: Fertilizer use prohibited within 50 feet of the Pemigewasset River in the overlay district. General curtailment of fertilizer use is required in flood and overlay zones; no town-wide ordinance outside these areas.
Implement and enforce a	Existing: None identified.	Existing: The Lake Waukewan Watershed	Existing: None identified.	Existing: None identified.	Existing: None identified.

Strategy	Meredith	New Hampton	Center Harbor	Ashland	Holderness
Stormwater Management Plan.	Recommendation: Develop a comprehensive stormwater management plan that includes regular maintenance of stormwater infrastructure, monitoring of runoff impacts, and incentives for retrofitting outdated systems.	Overlay District limits development based on stormwater runoff potential, suggesting partial implementation of stormwater management practices, although there is no formal town-wide stormwater management plan referenced. Recommendation: Develop a comprehensive stormwater management plan that includes regular maintenance of stormwater infrastructure, monitoring of runoff impacts, and incentives for retrofitting outdated systems.	Recommendation: Develop a comprehensive stormwater management plan that includes regular maintenance of stormwater infrastructure, monitoring of runoff impacts, and incentives for retrofitting outdated systems.		



Conservation Funding Strategies

Strategy	Meredith	New Hampton	Center Harbor	Ashland	Holderness
Development transfer overlay district.	Existing: None identified.	Existing: None identified.	Existing: None identified.	Existing: None identified.	Existing: None identified.
	Recommendation: Create a Development Transfer Overlay District encompassing infrastructure-dense areas 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 rich in natural resources or are prioritized for conservation.	Recommendation: Create a Development Transfer Overlay District encompassing infrastructure-dense areas 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 rich in natural resources or are prioritized for conservation.	Recommendation: Create a Development Transfer Overlay District encompassing infrastructure-dense areas 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 rich in natural resources or are prioritized for conservation.		
Conservation impact fees.	Existing: None identified.	Existing: None identified.	Existing: None identified.	Existing: None identified.	Existing: None identified.
	Recommendation: Establish an impact fee (\$1,500–\$2,000 per acre disturbed) to fund streambank stabilization, stormwater retrofits, and wetland restoration.	Recommendation: Establish an impact fee (\$1,500–\$2,000 per acre disturbed) to fund streambank stabilization, stormwater retrofits, and wetland restoration.	Recommendation: Establish an impact fee (\$1,500–\$2,000 per acre disturbed) to fund streambank stabilization, stormwater retrofits, and wetland restoration.		

Strategy	Meredith	New Hampton	Center Harbor	Ashland	Holderness
Wetland mitigation funds.	Existing: None identified. Recommendation: Connect with NHDES about Aquatic Resource Mitigation (ARM) funding. There was \$590,101 in ARM funding available for the service area covering Meredith in 2025.	Existing: The Open Space Plan notes that the town benefited from the NHDES Aquatic Resource Mitigation Fund, which provided \$100,000 in grant funding to help acquire a conservation easement on the Snake River. However, this is a state-managed fund, not a local program. Recommendation: Connect with NHDES about Aquatic Resource Mitigation (ARM) funding. There was \$590,101 in ARM funding available for the service area covering New Hampton in 2025.	Existing: None identified. Recommendation: Connect with NHDES about Aquatic Resource Mitigation (ARM) funding. There was \$590,101 in ARM funding available for the service area covering Center Harbor in 2025.	Existing: None identified.	Existing: None identified.
Fee in lieu of land dedication.	Existing: None identified. Recommendation: Implement a fee-in-lieu program where developers can contribute to conservation funds instead of dedicating	Existing: None identified. Recommendation: Implement a fee-in-lieu program where developers can contribute to conservation funds instead of dedicating	Existing: None identified. Recommendation: Implement a fee-in-lieu program where developers can contribute to conservation funds instead of dedicating	Existing: None identified.	Existing: None identified.

Strategy	Meredith	New Hampton	Center Harbor	Ashland	Holderness
	land. Use these funds to acquire high-priority lands for lake and watershed protection.	land. Use these funds to acquire high-priority lands for lake and watershed protection.	land. Use these funds to acquire high-priority lands for lake and watershed protection.		
Stormwater utility district.	Existing: None identified.	Existing: None identified.	Existing: None identified.	Existing: None identified.	Existing: None identified.
	Recommendation: Implement a stormwater utility fee within a Stormwater Utility District. The fee is often a single rate charged to each homeowner within the district at the same time as their property taxes. Stormwater utility fees can generate funds for stormwater infrastructure maintenance, replacement, green infrastructure, and more to prevent or mitigate localized flooding, combined sewer overflows, or infrastructure failure.	Recommendation: Implement a stormwater utility fee within a Stormwater Utility District. The fee is often a single rate charged to each homeowner within the district at the same time as their property taxes. Stormwater utility fees can generate funds for stormwater infrastructure maintenance, replacement, green infrastructure, and more to prevent or mitigate localized flooding, combined sewer overflows, or infrastructure failure.	Recommendation: Implement a stormwater utility fee within a Stormwater Utility District. The fee is often a single rate charged to each homeowner within the district at the same time as their property taxes. Stormwater utility fees can generate funds for stormwater infrastructure maintenance, replacement, green infrastructure, and more to prevent or mitigate localized flooding, combined sewer overflows, or infrastructure failure.		
Open space or non-lapsing conservation fund.	Existing: The Conservation Commission may receive gifts of money	Existing: New Hampton has a Conservation Fund established under RSA	Existing: Center Harbor has a Conservation Fund established under RSA 36-A:5. It receives	Existing: The Conservation Commission receives up to \$5,000 per land	Existing: Conservation Fund referenced in context of land protection through

Strategy	Meredith	New Hampton	Center Harbor	Ashland	Holderness
	and property, but there is no dedicated, non-lapsing conservation fund. Recommendation: Establish an open space of non-lapsing conservation fund.	36-A:5. It receives 50% of the Land Use Change Tax revenue. Recommendation: Consider increasing the allocation to fund conservation projects and acquisitions.	25% of the Land Use Change Tax revenue. Recommendation: Consider increasing the allocation to fund conservation projects and acquisitions.	use change tax to its Conservation Fund.	Conservation Commission and land trusts; encourages non-lapsing conservation efforts.
Has a Land Use Change Tax per RSA 79-A:25.	Existing: None identified. Recommendation: Institute land-use change tax pursuant to RSA 79-A:25 and dedicate a significant percentage to conservation.	Existing: The town has established a Land Use Change Tax under RSA 79-A:25 and dedicates 50% to a conservation fund. Recommendation: Allocate revenues from land use change taxes specifically to projects that protect water quality, such as riparian restoration and erosion control measures.	Existing: The town has established a Land Use Change Tax under RSA 79-A:25 and dedicates 25% to a conservation fund. Recommendation: Consider increasing the allocation to the conservation fund.	Existing: The town has established a 10% Land Use Change Tax under RSA 79-A:25 and dedicates up to \$5,000.	Existing: None identified.
Participate or collaborate with a local watershed association.	Existing: Yes, the WWAC is a volunteer committee appointed by Board of Selectmen and regularly collaborates with WWC. Recommendation: Collaborate with LWIA.	Existing: New Hampton has partnered with the WWAC, WWC, and other towns on watershed protection. efforts. New Hampton provides funds to WWAC to support VLAP monitoring and other lake protection	Existing: Center Harbor has partnered with the WWAC and other towns on watershed protection. efforts. Center Harbor provides funds to WWAC to support VLAP monitoring and other lake protection	Existing: None within the watershed, but the Master Plan encourages collaboration with the Squam Lakes Association.	Existing: None within the watershed, but the town collaborates with the White Oak Pond Watershed Association and the Squam Lakes Association.

Strategy	Meredith	New Hampton	Center Harbor	Ashland	Holderness
		initiatives. Recommendation: Collaborate with LWIA.	initiatives. Recommendation: Collaborate with LWIA.		
Participate or collaborate with a local land trust.	Existing: New Hampshire Land Trust Coalition. Recommendation: Collaborate with the Lakes Region Conservation Trust.	Existing: The town works with groups like the Society for the Protection of NH Forests and Lakes Region Conservation Trust, which hold easements in town. Recommendation: Great work! Consider setting goals, like to protect 50 acres per year of high priority watershed land.	Existing: The Master Plan identifies collaborations with several land conservation organizations, including the Lakes Region Conservation Trust, Squam Lakes Conservation Society, and New England Forestry Foundation. Recommendation: Great work! Consider setting goals, like to protect 50 acres per year of high priority watershed land.	Existing: The town works with the Lakes Region Conservation Trust and Squam Lakes Conservation Society.	Existing: The Squam Lakes Conservation Society operates in Holderness.



Non-regulatory Strategies

Strategy	Meredith	New Hampton	Center Harbor	Ashland	Holderness
Open space plan	Existing: None identified. Recommendation: Seek funding for and	Existing: Yes, an Open Space Plan was written in 2019.	Existing: None identified. Recommendation: Seek funding for and	Existing: While not called a formal "Open Space Plan," the Master Plan identifies	Existing: None identified.

Strategy	Meredith	New Hampton	Center Harbor	Ashland	Holderness
	create an Open Space Plan for the town.	Recommendation: Implement the plan. Update the plan every 10 years, prioritizing acquisition of riparian buffers and upland forested areas that protect water quality.	create an Open Space Plan for the town.	open space protection priorities, encourages conservation easements, and promotes preservation of unfragmented lands, forest, and farmland.	
Master plan addresses natural resources and environmental protection.	Existing: Yes, an updated Community Plan was approved in 2025. Topics relevant to environmental protection include resilient infrastructure and sustainable environment. Recommendation: Implement the plan, especially actions that align with the Action Plan section of this WRP.	Existing: Yes (2025). Environmentally relevant recommendations relate to energy, private road management, culvert replacements, setbacks, and stormwater management. Recommendation: Implement the plan, especially actions that align with the Action Plan section of this WRP.	Existing: Yes, in 2012 with an updated natural resources chapter in 2014. Natural resources are woven throughout the plan. Recommendation: Update the Master Plan an include clear policies and action items in the Master Plan to regulate development, enforce buffer zones, and fund lake conservation projects.	Existing: Yes, (2011), with a dedicated natural resources chapter. Ashland is updating its Master Plan in 2026.	Existing: Yes, (2007), with a dedicated natural resources chapter. Holderness is updating its Master Plan in 2026.
A town-wide natural resources inventory.	Existing: Yes, completed in 2005. Recommendation: Update the Natural Resources Inventory.	Existing: Yes, completed in 2016. Recommendation: Update the Natural Resources Inventory.	Existing: Yes, completed in 2008. Recommendation: Update the Natural Resources Inventory.	Existing: Yes, completed in 2013.	Existing: Yes, completed in 2002.

Strategy	Meredith	New Hampton	Center Harbor	Ashland	Holderness
Smart Growth Plan.	Existing: None identified. Recommendation: Adopt smart growth strategies that limit impervious surfaces near lakes, protect green spaces, and encourage compact, sustainable development.	Existing: None identified. Recommendation: Adopt smart growth strategies that limit impervious surfaces near lakes, protect green spaces, and encourage compact, sustainable development.	Existing: None identified. Recommendation: Adopt smart growth strategies that limit impervious surfaces near lakes, protect green spaces, and encourage compact, sustainable development.	Existing: None identified.	Existing: None identified.
Stormwater system mapping	Existing: In-progress for Meredith as part of sewer and stormwater asset management efforts. Recommendation: Provide digital mapping of stormwater infrastructure, including catch basins, wastewater and stormwater lines, and outfalls.	Existing: None identified. Recommendation: Map stormwater infrastructure, including catch basins, wastewater and stormwater lines, and outfalls.	Existing: A recommendation in Chapter 3 of the Master Plan suggests the town develop a stormwater management plan, especially in the village area near Lake Winnepesaukee. Recommendation: Map stormwater infrastructure, including catch basins, wastewater and stormwater lines, and outfalls.	Existing: None identified.	Existing: None identified.
Consistent Public Outreach and Engagement /	Existing: WWAC collaborates with WWC and other local non-profits to hold regular	Existing: None formalized.	Existing: None formalized.	Existing: None formalized.	Existing: None formalized.

Strategy	Meredith	New Hampton	Center Harbor	Ashland	Holderness
Public education programs	education and outreach events. Recommendation: Continue the public outreach program with topics related to green infrastructure, stormwater management, fertilizer use, winter salt application, and septic system maintenance.	Recommendation: Implement public outreach program for green infrastructure, stormwater management, fertilizer use, winter salt application, and septic system maintenance. The program may include mailers, events, workshops, or pamphlets.	Recommendation: Implement public outreach program for green infrastructure, stormwater management, fertilizer use, winter salt application, and septic system maintenance. The program may include mailers, events, workshops, or pamphlets.		
	Existing: None established.	Existing: None established.	Existing: None established.	Existing: None established.	Existing: None established.
Incentive-based programs for voluntary low impact development implementation.	Recommendation: Create incentives like tax reductions or grants for developers and homeowners who use low-impact development practices, such as rain gardens, permeable pavements, and vegetative buffers.	Recommendation: Create incentives like tax reductions or grants for developers and homeowners who use low-impact development practices, such as rain gardens, permeable pavements, and vegetative buffers.	Recommendation: Create incentives like tax reductions or grants for developers and homeowners who use low-impact development practices, such as rain gardens, permeable pavements, and vegetative buffers.		
Incentive-based programs for stormwater reduction efforts.	Existing: None identified. Recommendation: Offer financial incentives to encourage stormwater reduction efforts, such	Existing: None identified. Recommendation: Offer financial incentives to encourage stormwater reduction efforts, such	Existing: None identified. Recommendation: Offer financial incentives to encourage stormwater reduction efforts, such	Existing: None identified.	Existing: None identified.

Strategy	Meredith	New Hampton	Center Harbor	Ashland	Holderness
	as subsidies for installing rain barrels or implementing infiltration systems that prevent runoff into lakes.	as subsidies for installing rain barrels or implementing infiltration systems that prevent runoff into lakes.	as subsidies for installing rain barrels or implementing infiltration systems that prevent runoff into lakes.		
Have established conservation commission.	Existing: Yes. Recommendation: Empower the Conservation Commission to enforce stricter development regulations near lakes, provide guidance to property owners, and oversee watershed conservation projects.	Existing: Yes. Recommendation: Empower the Conservation Commission to enforce stricter development regulations near lakes, provide guidance to property owners, and oversee watershed conservation projects.	Existing: Yes. Recommendation: Empower the Conservation Commission to enforce stricter development regulations near lakes, provide guidance to property owners, and oversee watershed conservation projects.	Existing: Yes.	Existing: Yes.
Incentivize and/or encourage property owners to implement low impact development stormwater practices.	Existing: None identified. Recommendation: Develop recognition programs or grants to encourage property owners to adopt low-impact practices, such as naturalized landscaping, bioswales, and other stormwater management solutions.	Existing: None identified. Recommendation: Develop recognition programs or grants to encourage property owners to adopt low-impact practices, such as naturalized landscaping, bioswales, and other stormwater management solutions.	Existing: None identified. Recommendation: Develop recognition programs or grants to encourage property owners to adopt low-impact practices, such as naturalized landscaping, bioswales, and other stormwater management solutions.	Existing: None identified.	Existing: None identified.

Strategy	Meredith	New Hampton	Center Harbor	Ashland	Holderness
Encourage property owners to put land into farmland/tree growth programs.	Existing: None identified. Recommendation: Promote state agricultural and forestry programs that convert lake-adjacent lands into protected forests or managed farmland to minimize runoff and stabilize shorelines.	Existing: The Master Plan supports enrollment in the Current Use Taxation Program, which allows reduced property taxes for land in farmland, forest, and wetlands Recommendation: Continue encouraging landowners to take advantage of state agricultural and forestry programs.	Existing: None identified. Recommendation: Promote state agricultural and forestry programs that convert lake-adjacent lands into protected forests or managed farmland to minimize runoff and stabilize shorelines.	Existing: None identified.	Existing: None identified.

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 (Ballesterio, 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 16.

☛ ***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. Also see the *Municipal Stormwater Control Measures Handbook* (FBE, 2026a) for guidance on certain green infrastructure practices.

☛ ***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. See the *Municipal Stormwater Control Measures Handbook* (FBE, 2026a) for guidance on certain green infrastructure practices.

☛ 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.

4.2.3 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, especially in drinking water source areas. For the Lake Waukegan and Lake Winona watershed, 17.7% of the watershed's area (not including Lake Waukegan and Lake Winona) has been classified as conserved land (Figure 37). Major conserved areas include the Preston parcel, Waukegan Highlands Park, Meredith Town Forest, and Pettitt Forest (located at the headwaters of Lake Winona's northern inlet). The Bald Ledge Scenic Vista and the Lake Winona Improvement Association have sizeable parcels within the Lake Winona watershed, which are particularly important because they border parts of the lake shoreline. Some of the conservation parcels preserve land around major tributaries, or include wetland complexes or small bodies of water. The 182.3 acre Waukegan Highlands Park is owned by the Town of Meredith and is designated for drinking water source protection. This parcel is in the southern portion of the Lake Waukegan watershed.

As land conservation is essential to the future of this region, local groups should continue to pursue opportunities for land conservation in the Lake Waukegan and Lake Winona watershed based on the highest valued habitat identified by the New Hampshire Fish and Game Department. The NH 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 Lake Waukewan and Lake Winona watershed is split across three different ecological regions. The Lake Winona watershed is located within the White Mountain Foothills, the Sunapee Uplands, and the Sebago-Ossipee Hills and Plains. The Waukewan watershed is located only within the Sebago-Ossipee Hills and Plains ecoregion (NHFG, 2025). Approximately 1,896 acres (23%) of the Lake Waukewan and Lake Winona watershed are considered Highest Ranked Habitat in New Hampshire, and 700 acres (9%) are classified as the highest ranked habitat in the biological region (Figure 38).

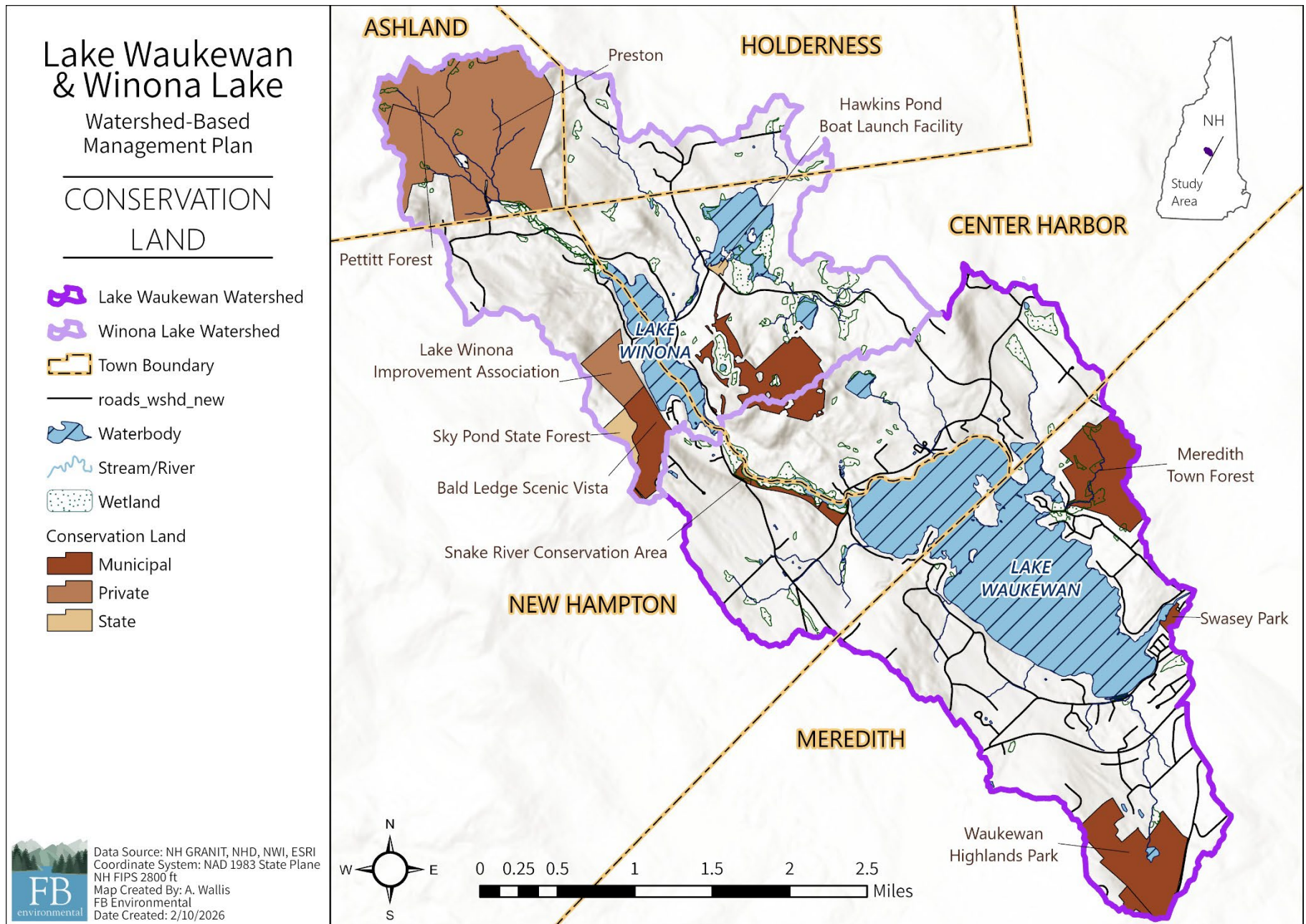


Figure 37. Conserved land by owner type in the watershed for Lake Waukewan and Lake Winona.

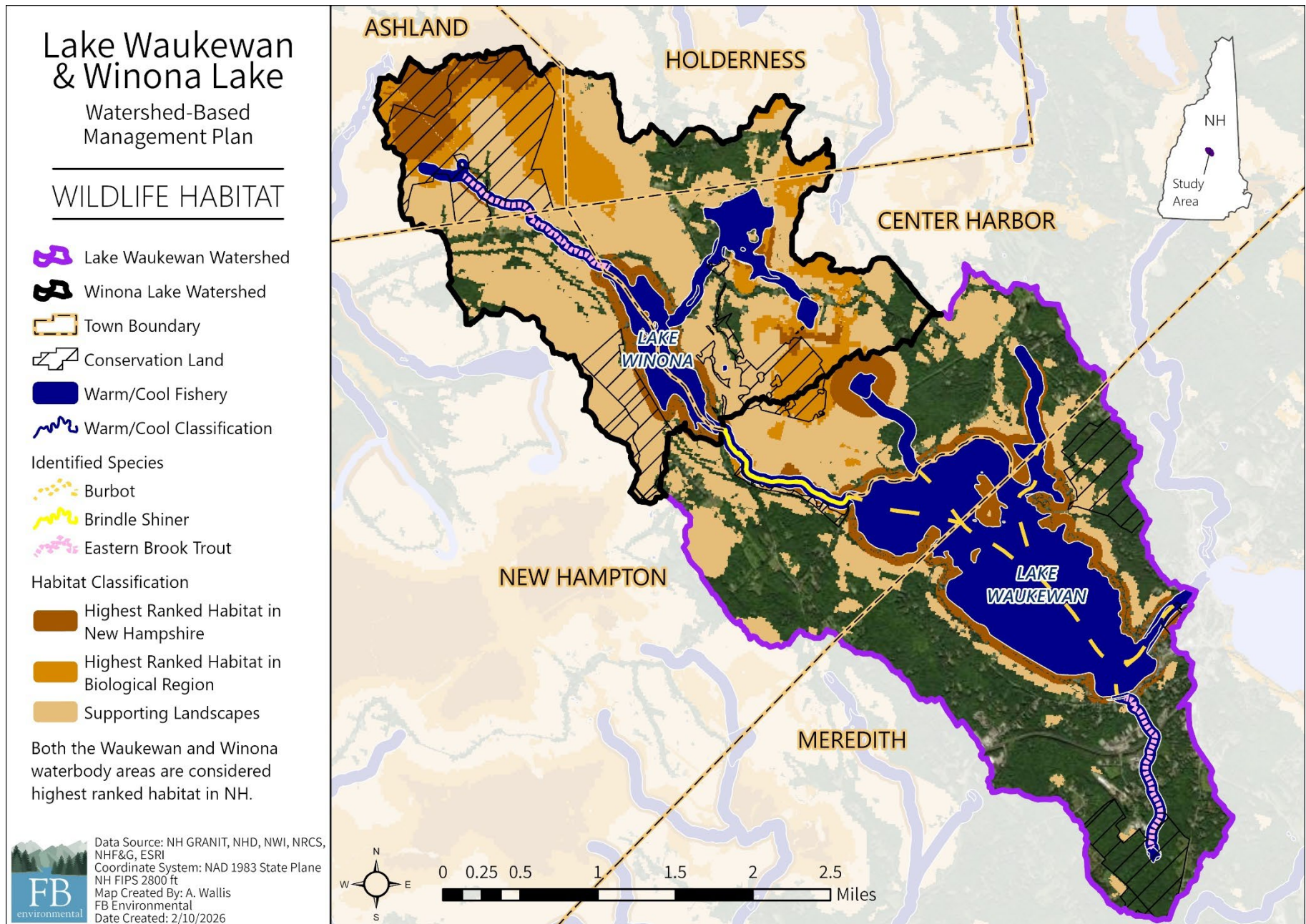


Figure 38. High value habitat in the watershed for Lake Waukewan and Lake Winona according to the 2025 NH Wildlife Action Plan.

4.2.4 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:

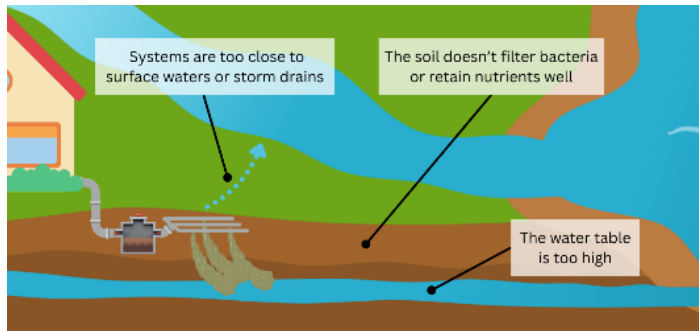
- A. Proper **design** includes adequate evaluation of soil conditions, seasonal high groundwater or impermeable materials, proximity of sensitive resources (e.g., drinking water wells, surface waters, wetlands, etc.).
- B. Proper siting and **installation** mean that the system is installed in conformance 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. 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).

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

Reasons that septic systems fail



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.

4.2.5 Sanitary Sewer System Inspections

Because a portion of the watershed also relies on a municipal sewer system, it is important for municipalities with sewer such as Meredith to develop a program to inspect and evaluate their sanitary sewer system and reduce identified leaks and overflows, especially in areas near waterbodies such as Lake Waukegan. The Meredith Water Department currently jets and inspects approximately 10-15% of sewer lines annually to prevent sewer leaks and identify them quickly when they occur. They also recently completed a Sewer Asset Management Plan and hope to evaluate the conditions of sewer infrastructure throughout town.

4.2.6 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 a surface water. 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%.



4.2.7 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).

NRCS

Belknap County Office

10 Ferry Street, Suite 211

Concord, NH 03301

(603) 223-6023

concord.nrcs.nh@usda.gov

NRCS

Grafton County Office

19 Archertown Road, Suite A

Orford, NH 03777

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orford.nrcs.nh@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 39). 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 17.

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 Lake Waukegan and Lake Winona 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.

Many of the programs offered by the NRCS are implemented confidentially on private lands, and no public information was available regarding practices within the Lake Waukegan and Lake Winona 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.

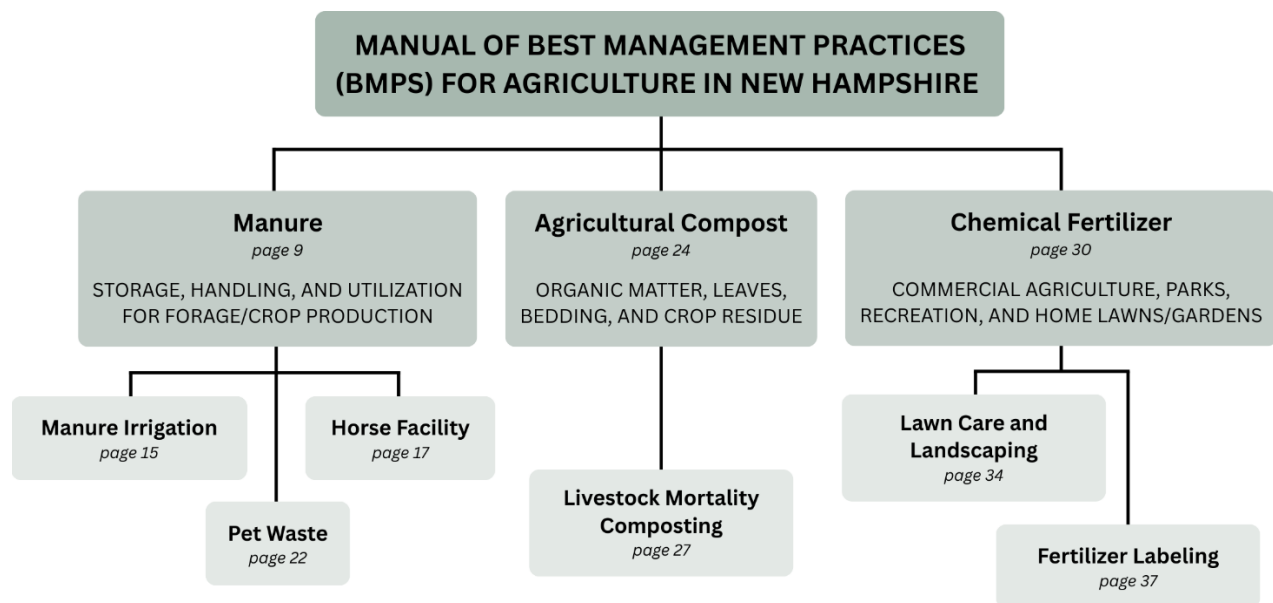


Figure 39. Overview of the major topics covered in the *Manual of BMPs for Agriculture in New Hampshire*, to orient producers to relevant sections. Relevant page numbers from the document are listed in each box.

Table 17. 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.

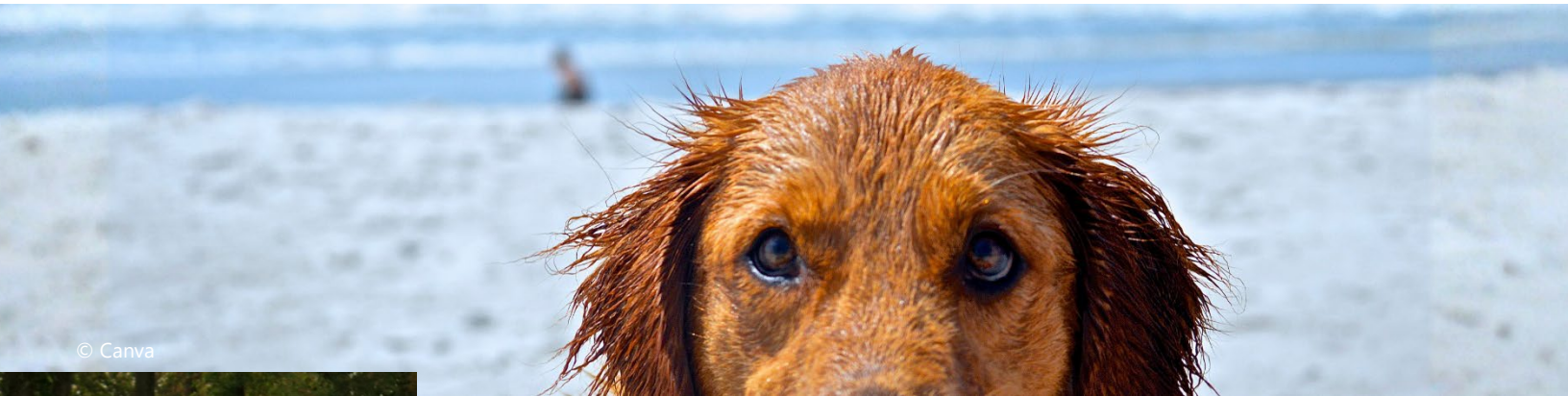
Conservation Practice	Descriptions	N	P	Sed	NRCS Practice #
Cover Crop	Crops, including grasses and legumes for seasonal cover, conservation, and soil health.	Y	Y	Y	340, 328

Conservation Practice	Descriptions	N	P	Sed	NRCS Practice #
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



4.2.8 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.



4.2.9 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 WWAC and WWC are the primary local entities for education and outreach campaigns in the watershed and for development and implementation of the plan. The WWAC has incredible local capacity to carry out protection efforts with 15 committee members comprised of residents from Meredith, Center Harbor, and New Hampton, as well as municipal staff from multiple departments. Initiatives through WWAC typically have funding support from the Town of Meredith, allowing for expanded education and outreach efforts that include in-person workshops with expert guest speakers. These events are usually coordinated with WWC, which has three officers, a Board of Directors, and numerous committees. The WWAC and WWC also maintain an educational kiosk at the public boat launch on Lake Waukegan, which serves as a post for Lake Hosts and contains educational flyers on cyanobacteria and other topics.

The LWIA has a five-person Board of Directors. Their website includes a wealth of educational materials, including topics such as cyanobacteria, aquatic invasive species, septic system maintenance, property-level stormwater management, local shoreline regulations, and phosphate-free household products.

The WWAC, WWC, and LWIA should continue all aspects of their outstanding and robust education and outreach strategies, including clean-up days, workshops, picnics, and summits, and should consider developing new ones or improving existing ones 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 them at various locations and through a variety of means, such as websites, newsletters, social media, community events, or community gathering locations. Additionally, the groups 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, signage, youth programs, and the development of watershed boundary signs on roads entering the watershed can aim to deepen public understanding of watershed issues.

In 2025 and 2026, WWAC and WWC have increased their collaborations with adjacent lake communities, including the Winnisquam Watershed Network, Lake Kanasatka Watershed Association, Newfound Lake Region Association, Squam Lakes Association, and Lake Wicwas Association to include regional summits and workshops with expert guest speakers from NHDES, FBE, and the University of New Hampshire. These regional summits have been extremely successful at generating a large turnout and promoting cross-watershed information sharing. In adjacent watersheds that work in the same municipalities, regional collaboration may increase collective power for advocating to municipal boards or the state for lake-minded regulations. Information and resource sharing may also increase the capacity of WWC and LWIA to implement this WRP, including small-scale SCMs and education and outreach to municipal staff, boards, and private landowners. Finally, adjacent watershed associations may be able to leverage funding (including grants) to accomplish shared goals at a lower overall cost than accomplishing goals separately.

4.4 ADAPTIVE MANAGEMENT APPROACH

The Town of Meredith already has a formal committee to coordinate an adaptive management approach for WRP implementation. We recommend continuing to hold regular WWAC meetings.

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 2016 ACTION PLAN STATUS

Since the development of the [2016 Lake Waukegan and Lake Winona Watershed Restoration Plan](#), the Town of Meredith (through WWAC) and the Lake Waukegan Association have worked to implement Action Plan items listed in the original document. A review of this work was completed as a first step to updating this plan. The following contains a summary of the status of action items in each category. Note that not every individual action item was listed.

Most **education and outreach** items are ongoing initiatives, thus there are eighteen in progress or ongoing, while five are complete and sixteen are incomplete or infeasible. WWAC has achieved numerous education and outreach initiatives. Ongoing initiatives include workshops, educational forums, annual meetings, collaboration among other watershed associations, creation of various brochures, educational signage near SCMs, presentations to local organizations, water department tours, presence on the Town of Meredith website, and quarterly updates presented to the Select Board. Most notably, WWAC and the Town of Meredith have installed a kiosk at the public boat launch which has educational materials about aquatic invasive plants, cyanobacteria blooms, and other water quality related items. Outreach initiatives have been largely successful, reaching several hundred residents over the years. WWAC has geared the outreach to focus on person-to-person connection rather than using mailers. WWAC has facilitated workshops beyond the Lake Waukegan watershed, bringing together folks from adjacent lake associations with shared concerns about water quality. Of note, WWAC held a workshop for contractors in January 2026 about the adequate installation and maintenance of property-level stormwater controls. Incomplete or infeasible action items were often time and resource intensive.

Twelve **ordinances** items are complete in Meredith, with eight in progress and eighteen incomplete. Ordinances are often the most challenging to complete because developing new language or revising existing code requires significant time, multiple legal steps, and formal reviews before adoption. The Town of Meredith was most successful with policy changes, whereas fewer changes occurred in other watershed towns.

One **SCMs** item is complete, with four in progress and three incomplete. Multiple recommendations for SCMs were implemented with great success, including 17 watershed survey site improvements complete in collaboration with Meredith Department of Public Works.

Two **wastewater** items are complete, both relating to municipal sewer. There are four ongoing action items and six incomplete. Difficulty around implementing septic system related action items relates to staffing changes/shortages and the time investment needed to track septic system replacements.

Five **monitoring** items are complete, with five ongoing or in progress and nine incomplete. Lake Waukegan's VLAP volunteers have expanded the lake monitoring program in recent years; incomplete items relate to stream monitoring.

KEY:  Complete  Partially completed or ongoing  Incomplete or infeasible



Education and Outreach

-  The Town of Meredith PWD Installed highly visible SCMs with educational signage, including a rain garden at the Town Beach.
-  WWAC and the Town of Meredith installed an informational kiosk at the Lake Waukegan public boat launch with educational signage posted about cyanobacteria blooms, aquatic invasive plants, and watershed management.
-  WWAC installed educational signs at the kiosk, community center, and beaches about topics such as cyanobacteria blooms, pet waste, and buffer plantings.
-  Updated the "Caring for Lake Waukegan: It Starts at Home" document, which had been created and mailed in 2008.
-  WWAC participated in a perchlorate study investigating the impact of fireworks on Lake Waukegan and communicated results of the study.
-  WWAC hosts numerous outreach events and forums including a multi-lake event, often featuring guest speakers from NHDES or other entities. Events vary in topic from shoreline buffers, stormwater management, road salt management, cyanobacteria, and water quality.
-  WWAC and the Meredith Water Department hosted water department tours, boat ramp and park clean-ups, and cookouts.
-  WWAC has presented at local organizations, such as the Meredith Rotary Club, and hosts workshops for contractors on property level SCMs.
-  WWAC has a presence on the Town of Meredith website, WWAC has established a Facebook page to distribute links to websites such as NH Lakes, and WWAC distributes a virtual newsletter. WWAC also pushes outreach materials through homeowners' associations, local businesses, and local newspapers.
-  WWAC presents quarterly water quality or watershed restoration plan implementation updates to the Select Board.
-  The lake continues to participate in the Lake Host program, sponsored by WWAC and WWAC. The sponsorships funded lake hosts for another day each week. The Town of New Hampton provided funds to expand the lake host program.

-  The Town of Meredith continues to provide portable restrooms across from the boat ramp.
-  WWAC and the Town of Meredith engages with homeowners' associations and hosts events to educate homeowners on lawn care, landscaping, fertilizer use, and buffer plantings.
-  Create a new section to the Meredith website that would provide educational information regarding the protection of waterbodies in the Town and the Lake Waukegan watershed; include link to plan.
-  Locate willing volunteers to "demonstrate" what an ideal shoreline buffer looks like and how it functions. Host an in-person workshop.
-  Develop and send letters to residents in the spring showing before/after photos of implemented SCMs. Digital outreach may be preferred.
-  Develop and send/post on-line a self-assessment quiz to help homeowners determine whether or not they have an erosion problem.
-  Enlist volunteers to go door-to-door to inform neighbors about erosion, SCMs, and programs that can help. Determined to be infeasible due to time-intensity with minimal return on investment due to the number of seasonal properties.
-  Educate homeowners about spill liability, methods of secure storage and spill prevention, how to get tanks inspected, changes in consumption rates, how sump pumps can contaminate water resources, what to do if a leak is found, and permit and code requirements. Determined to be lower priority.
-  Build a donation box, and encourage landowners to donate to watershed restoration efforts. Donations are solicited through other channels; a box may not be secure.
-  Organize an annual discovery cruise/paddle on the lake.
-  Consider forming private road associations in key neighborhoods or heavily-used roads for better management by local stakeholders, and host a workshop for road associations every two years. Some homeowners' associations already exist.
-  Focus outreach on neighborhoods with properties that have no septic systems on town record, focus septic system maintenance education at campgrounds, conduct door-to-door septic education to follow-up on septic survey, and create and distribute a list of septic service providers (create magnets, etc.).
-  Require State-sponsored training for code enforcement officers and ZBAs in watershed towns.
-  Hold educational workshops on conservation easements in the region. Reach out to large landowners to discuss conservation options.



Ordinances

-  ["Regulations Pertaining to Certain Subsurface Wastewater Disposal Systems in the Lake Waukegan Watershed"](#) were passed in 2012, which requires proof of a septic system permit to obtain building permits for properties within 250 feet of Lake Waukegan. It also requires

providing proof to the Code Enforcement Officer that the septic system is functioning if no permit is on file. The regulations may be expanded in the future, but enforcement has already been challenging due to staff availability.

- ✓ Meredith adopted a new 10-year Community Plan which has a focus on natural resource protection and features numerous water quality related action items.
- ✓ Meredith redefined "lot coverage" in the zoning ordinance to include pervious patios and walkways, except for those supporting vegetation.
- ✓ In Meredith, inspections of properties under construction are conducted to ensure temporary sediment and erosion control measures are in place.
- ✓ Meredith updated Subdivision Regulations in 2021 and Site Plan Review Regulations in 2018 to have consistency across requirements.
- ✓ Meredith has recently mapped sewer and stormwater infrastructure throughout the town.
- Meredith has worked to enforce occupancy loads (2 people per bedroom) for short-term rental properties. Enforcement has been difficult due to staff availability.
- Meredith has drafted a new Conservation Subdivision Ordinance to incentivize open space preservation. Due to the large minimum lot size of the zoning districts present within the Lake Waukegan watershed, it may be less applicable.
- A municipal roads guidance document is being created as part of this watershed restoration plan which will inform road maintenance throughout the watershed.
- Currently developing a septic system management plan.
- Street sweeping is an ongoing practice in Meredith.
- A new build-out analysis has been conducted which will inform conservation practices.
- ✗ Develop new policy to require LID for all future development. In Meredith's Site Plan Review Regulations, most residential development is too small to require a Stormwater Management Plan, though LID is encouraged for all developments.
- ✗ Review and lower limits of impervious cover by zone to less than 10-20% imperviousness. Determined to be infeasible as many properties would be able to circumvent this via variances. Most residential properties do not approach 20% impervious and therefore would not be affected.
- ✗ Limit amount of tree removal and/or expand ordinance to include logging. This recommendation was determined to be unfeasible.
- ✗ Continue to develop a watershed overlay district that directs development away from ecologically-sensitive areas, guides construction and development, and prohibits high risk land uses.
- ✗ Require formal construction agreements that specify sequencing, inspections, and reports, for both temporary and permanent controls. Determined to be infeasible.

-  Strengthen Erosion and Sediment Control Regulations by moving it from Site Plan Review and Subdivision Regulations to an Ordinance.
-  Encourage new road designs that limit imperviousness and minimize negative environmental effects.
-  Integrate maintenance agreements into structural SCMs to ensure continued maintenance and proper functioning.
-  Add extra tax to town property bills that goes into a lake protection fund. Develop a subcommittee that determines how the funding is spent.



Stormwater Control Measures

-  WWAC collaborated with Meredith PWD to mitigate numerous NPS sites from the original 2014 watershed survey. Sites were mostly addressed using leftover materials and supplies as staff time allowed.
-  Conduct stakeholder review of the SCM matrix and top prioritized sites to ensure that targeted sites are appropriate for the watershed and local interests.

Work with landowners to stabilize shorelines identified in the 2014 shoreline survey. WWAC and WWC are working with LakeSmart to educate shoreline residents and install shoreline plantings.
-  The Lake Waukegan Association boat ramp has also been upgraded. WWC offers a grant to cover half of the cost (up to \$1,000) to mitigate stormwater runoff on individual properties, though few homeowners have taken advantage of the grant.
-  Conduct a shoreline survey every 5-10 years to track changes in shoreline development over time. The Lake Winnepesaukee Alliance is assisting with a re-survey in 2026.
-  Organize and host an annual spring plant sale. Locally-sourced, native plants can be used for shoreline buffer plantings by landowners. Raffles and discounts have been effective.
-  Though there was success in Meredith, NPS sites from the 2014 watershed survey were not remediated in New Hampton or Center Harbor, and little work was done in the Lake Winona watershed.
-  WWAC has connected with NHDOT for their expertise through an expert panel, but no structural work has been completed on state roads within the watershed.

The number of remediated NPS sites and their associated pollutant load reductions were not tracked. Some sites from the 2014 watershed survey were remediated, but used informal approaches or did not implement SCMs to their full extent, likely leading to a lower pollutant reduction than anticipated. High cost and time are barriers to successful implementation and tracking.
-  Re-survey implemented SCM sites every five years and develop a tracking system to document long-term functionality. Budget is the most limiting factor.

-  Enlist the Youth Conservation Corps (YCC) for implementation and outreach activities throughout the watershed. No contact was made with the YCC and funding may be a limiting factor. This action was de-prioritized.



Wastewater

-  Meredith recently completed a Sewer Asset Management Plan which includes mapping of sewer areas and a list of parcels served by sewer.
-  In conjunction with the Sewer Asset Management Plan, Meredith PWD mapped stormwater infrastructure and outfalls.
-  Continue to enforce the "Regulations pertaining to certain subsurface wastewater disposal systems in the Lake Waukegan watershed" that requires inspections and maintenance of septic systems for all new permit requests. Consider extending this regulation for all property transfers as well.
-  Offer free landowner assistance (technical, permitting, and grants) for septic system maintenance and upgrades. After the original watershed restoration plan, funding through NHDES Section 319 grants funded some septic system maintenance and replacements. This grant has since ended and no other funding has been accessed.
-  Continue to help Meredith landowners with emergency financial assistance for cases of economic hardship. This was necessary in one instance in recent history for a sewer connection.
-  Ensure that prioritized sewer replacement projects in Meredith are completed in a timely manner. The Meredith Water Department has identified numerous places where sewer lines should be replaced. Leaking sewer lines are promptly replaced. Between 10-15% of sewer lines are jetted annually.
-  Encourage town officials to track septic system pumping and upgrades; maintain database based on recent comprehensive septic system survey completed by the Lake Winnepesaukee Alliance.
-  Continue progress toward development and implementation of an ongoing septic system inspection program to identify failed systems in the 250 ft shoreline zone around Lake Waukegan and Lake Winona. Inspections have not been occurring.
-  Encourage and help fund voluntary dye testing for homeowners to evaluate septic system performance. Homeowner willingness was seen as a barrier to implementation.
-  Install community septic systems for cluster developments (campgrounds & small camps with outhouses). None installed.
-  Coordinate group septic system pumping discounts.
-  Develop a long-term funding source for septic system upgrades in the watershed.



Monitoring

-  On Lake Waukegan, extended monitoring season to include February, April, and November sampling, including dissolved oxygen profiles and Secchi disk transparency measurements.

The Meredith Water Department secured a grant through the NHDES Drinking Water and Groundwater Bureau to conduct intensive water quality and cyanobacteria monitoring in 2024
-  which informed a Cyanobacteria Monitoring and Response Plan. The project led to the expansion of the monitoring program to include additional parameters such as nitrogen and iron.
-  WWAC hosted a cyanobacteria workshop in June of 2025 and has established a connection with the University of New Hampshire Center for Freshwater Biology.
-  On Lake Waukegan, sediment core sampling was conducted in June 2023 to assess the risk of internal phosphorus loading.

The Meredith Water Department continues to operate a water quality data sonde and an AlgaeTracker deployed on Lake Waukegan which report real-time water quality data. The water department also maintains and operates a weather station deployed on their building.
-  New VLAP and Weed Watchers volunteers are being recruited and trained for Lake Waukegan.
-  Both Lake Winona and Lake Waukegan are continuing to recruit new Lake Host volunteers.
-  Routine VLAP and tributary sampling continues to occur in both lake watersheds.
-  Support State legislation that increases funds for aquatic invasive plant (e.g. milfoil) eradication.

Further research has not been conducted to assess whether or not the drinking water intake in Lake Waukegan should have an isolation zone, demarcated by buoys, in which motorized activity should not occur.
-  Continue to provide water quality data on the Winnetoesaukee Gateway website. The website has been decommissioned.
-  Consider collecting year-round and/or continuous monitoring data in several of the streams to further characterize loading and flow during different times of the year.
-  Conduct bracket sampling upstream of sampling locations to identify potential sources of increased loading, particularly for subwatersheds with the highest TP loading (e.g. Winona East Inlet, Snake River, and Reservoir Brook).
-  Train volunteers to monitor during storm events at road crossings and culverts near the shorelines. Use information to identify problem areas and recommend solutions.
-  Develop a detailed drainage network map of persistent and intermittent streams and tributaries that can be used to guide water quality monitoring, road maintenance, stormwater management, development, review, and emergency response planning.
-  Add continuous loggers for stage/flow, temperature, dissolved oxygen, conductivity, turbidity, etc. at key sampling locations throughout the watershed.

5.2 ACTION PLAN

5.2.1 Top Priority Action Items

Priority Action Items were selected based on their impact in addressing bacteria, balanced with the need for administration and measurement of progress. Item 1.a., assigning a dedicated group committed to implementing the plan, is essential and without which the other items may not be implemented. Items 3.a., 3.b., 3.c., 4.e., and 6.d., address pollutant sources and concerns and work towards mitigating them. Item 6.a. provides a measurement of progress.

Top Priority Action Items

Item 1a. Obtain funding for and implement SCMs at the Lake Waukegan Public Boat Launch site (3-01).

Items 8c & 8h. Strengthen collaborations between WWC, LWIA, and other local watershed associations.

Item 6b. Implement and enforce health regulations that require all septic systems within 250 feet of Lake Waukegan and/or Lake Winona to be pumped every 3 or 5 years.

Item 5a. Identify conservation buyers and maximize conservation land (especially in the Lake Winona watershed).

Item 4a. Present WRP recommendations to municipal boards.

Item 4d. Increase minimum lot sizes in high buildout potential areas.

Item 2a. Share the Municipal SCMs Guide with other municipalities in the watershed.

5.2.2 Detailed Action Plan

The Action Plan (Table 18) outlines responsible parties, approximate costs⁴, an implementation schedule, and potential funding sources for each recommendation 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) Wastewater Management; (7) Monitoring; and (8) Education and Outreach. The plan is designed to be implemented from 2027-2036 and is flexible enough to allow for new priorities

⁴ Cost estimates for each recommendation will need to be adjusted based on further research and site design considerations.

throughout the ten-year implementation period as additional data are acquired. The implementation schedule is provided in Figure 40. There are 78 total action items, 30 of which are in direct alignment with one or more action items from [Meredith's 2025 Community Plan](#).

Table 18. Action Plan for the Lake Waukegan and Lake Winona watershed.



Action Item 1: Watershed and Shoreline SCMs

#	Sub-Item Description	Priority Level	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
1a	Complete a construction ready 100% design for the Lake Waukegan boat ramp site (site 3-01), obtain the necessary permits, and implement SCMs at the boat ramp. Achieves 2.4% (0.8 kg/yr of 33 kg/yr) of Objective 1 for Lake Waukegan. Aligns with Action 4.6 of the Meredith Community Plan .	High	WWAC, Town of Meredith, Engineering Consultant	\$290K-360K 2027-2029	Grants (LSWPG, 319, Moose Plate, CWSRF), municipality
1b	Establish a tracking mechanism for SCM implementation efforts based on the SCM matrix (see Appendix A), which includes other stormwater management efforts outside of those identified in the WRP. Rely on NHDES or a consultant for pollutant load reduction support. Continue holding regular meetings with the town manager and Department of Public Works to review the SCM matrix and top prioritized sites to ensure that targeted sites are appropriate for the watershed and local interests.	High	WWAC, NHDES, Consultant	Staff time 2027-2036	Municipalities
1c	Complete design and construction of SCMs at the remaining top 10 sites identified in the 2025 watershed re-survey. Achieves 21% (6.8 kg/yr of 33 kg/yr) of Objective 1 for Lake Waukegan (7 sites) and 13% (1 kg/yr of 8 kg/yr) of Objective 1 for Lake Winona (2 sites). See Appendix A. Aligns with Actions 2.13 and 4.6 of the Meredith Community Plan	High	WWAC, LWIA, Municipalities	\$160K-\$295K 2027-2031	Grants (LSWPG, 319, Moose Plate, NFWF 5-Star, ILFP, CWSRF), municipalities, private landowners

#	Sub-Item Description	Priority Level	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
1d	Promote evaluations and certifications through NH Lakes LakeSmart program to educate property owners about lake-friendly practices such as revegetating shoreline buffers with native plants, eliminating or minimizing large grassy areas, and increasing mower blade heights to 4 inches. Cost assumes coordination and materials for up to 10 workshops.	High	WWAC, WWC, LWIA	\$5,000 2026-2035	Grants (319, Moose plate, CWSRF), municipalities, NH Lakes
1e	Complete a shoreline re-survey, which includes surveying all parcels around Lake Winona and the remaining ~80 parcels around Lake Waukewan that were not included in LWA's 2026 survey. Calculate potential pollutant load reductions.	High	LWA, LWIA, WWAC	\$5,000 2027	Grants (LSWPG, Moose Plate, CWSRF), municipalities, donations
1f	Complete design and construction of SCMs at the remaining 67 sites identified during the 2025 watershed re-survey based on the ranking and as opportunities arise. Collaborate across towns and with NHDOT for projects on state roads. Achieves 27% (8.9 kg/yr of 33 kg/yr) of Objective 1 for Lake Waukewan and 21% (1.7 kg/yr of 8 kg/yr) of Objective 1 for Lake Winona. See Appendix A. Aligns with Actions 2.13 and 4.6 of the Meredith Community Plan .	Medium	WWAC, LWIA, municipalities, NHDOT, private landowners	787K-1.77M 2029-2036	Grants (LSWPG, 319, Moose Plate, NFWF 5-Star, ILFP, CWSRF), municipalities, private landowners

#	Sub-Item Description	Priority Level	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
1g	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 LWA's updated shoreline survey. Cost assumes technical assistance and implementation cost sharing provided to the two high-impact shoreline properties, as identified in LWA's shoreline survey for Lake Waukegan. Achieves 7% (2.3 kg/yr of 33 kg/yr) of Objective 1 for Lake Waukegan.	Medium	WWAC, WWC, LWA, municipalities, private landowners	\$20,000 2027-2029	Grants (319, Moose plate, CWSRF), municipalities, private landowners
1h	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 12 medium impact and 51 low impact shoreline properties, as identified in the shoreline survey. Achieves 33% (10.9 kg/yr of 33 kg/yr) of Objective 1 for Lake Waukegan.	Medium	WWAC, WWC, LWA, municipalities, private landowners	\$189,000 2029-2036	Municipalities, private landowners
1i	Provide technical assistance and/or implementation cost sharing to watershed/shoreline property owners to install SCMs such as rain gardens and buffer plantings on additional properties identified during the shoreline re-survey in Action 1e. Data from 2014 indicate there are likely six low impact properties around Lake Winona. Cost assumes landowner implementation costs (budget: \$3,000 each) for the assumed six properties. Achieves 11% (0.9 kg/yr of 8.0 kg/yr) of Objective 1 for Lake Winona.	Medium	LWIA, WWAC, WWC, LWA, municipalities, private landowners	\$18,000 2027-2036	Municipalities, private landowners

#	Sub-Item Description	Priority Level	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
1j	Continue the WWC Storm Water Grant Program, which covers 50% of the cost of stormwater improvement projects up to \$1,000 for WWC members. Cost assumes five grants are awarded yearly for the maximum award amount of \$1,000.	Medium	WWC	\$50,000 2027-2036	Donations, municipalities, Grants (319, Moose plate, CWSRF)
1k	Organize and host an annual spring plant sale. Locally-sourced, native plants can be used for shoreline buffer plantings by landowners. Collaborate with WWC to source native plants and potentially obtain a group discount or plants for raffle.	Low	WWC, LIWA, WWAC	N/A 2029-2036	Donations, private landowners
1l	Organize local youth groups, high school students, or sports teams to help maintain high-profile SCMs such as rain gardens and/or install plantings on shoreline properties.	Low	WWC, LWIA, WWAC	\$1,000 2028-2036	Donations
1m	Repeat the watershed and shoreline surveys in 10 years when updating the WRP. Use the results to target education and technical assistance for high/medium impact sites. Cost assumes hired consultant for survey and summation of shoreline survey results.	Low	WWAC, LWIA, municipalities	\$20,000 2035-2036	Grants (LSWPG, Moose plate, CWSRF), municipalities



Action Item 2: Road and Driveway Management

#	Sub-Item Description	Priority Level	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
2a	Share the Municipal Stormwater Control Measures guide with New Hampton, Center Harbor, Ashland, and Holderness Departments of Public Works.	High	Meredith Public Works Department	Staff time 2027	Municipality
2b	Using the Municipal Stormwater Control Measures guide, review practices for road and drainage maintenance currently used by municipalities and private entities/groups (road agents) and determine areas for improvement in all watershed towns. Cease ditch scraping practices which can accelerate erosion. In Meredith, incorporate the guide into a Complete Streets Policy (aligns with Actions 2.1, 2.13, and 4.6 of the Meredith Community Plan).	High	Municipalities, WWAC	\$3,000 2027	Grants (Moose Plate, NFWF 5-Star, CWSRF), municipalities
2c	Continue providing education and training to contractors and municipal staff on protocols for road maintenance best practices. Assumes one workshop. Consider holding joint workshop with other municipalities or lake associations (or other wider service area) for cost sharing savings.	Medium	Municipalities, WWAC, BCCD, GCCD	\$10,000 2028	Grants (Moose Plate, NFWF 5-Star, CWSRF), municipalities
2d	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 four workshops.	Medium	WWAC, BCCD, GCCD, municipalities, private landowners	\$5,000-\$10,000 2027, 2029, 2031, 2033, 2035	Grants (Moose Plate, NFWF 5-Star, CWSRF), municipalities, private landowners

#	Sub-Item Description	Priority Level	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
2e	Facilitate annual or bi-annual meetings with road agents to discuss road maintenance and challenges and to share information and lessons learned.	Low	Municipalities, WWAC, BCCD, GCCD	N/A 2027-2036	Municipalities
2f	Identify stream crossings that do not meet specifications according to the NH Stream Crossings Guidelines and replace non-conforming stream crossings. Aligns with Actions 2.15 of the Meredith Community Plan .	Low	Municipalities, private landowners	TBD 2031-2036	Municipalities, private landowners
2g	Have PWD staff or representatives from all towns participate in Green SnowPro training to become Green SnowPro certified. Road agents should encourage contractors to be Green SnowPro certified. Continue practicing low salt application practices in the watershed. Aligns with Action item 2.12 of the Meredith Community Plan .	Low	Municipalities (Public Works/Highway)	\$350/person 2027-2036	Municipalities
2h	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.	Low	Municipalities, NH Dept of Transportation	N/A 2030-2033	Municipalities



Action Item 3: Other Municipal Operations

#	Sub-Item Description	Priority Level	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
3a	Continue using zero phosphorus, organic fertilizers on publicly-owned properties in Meredith. Aligns with Action 4.14 of the Meredith Community Plan .	High	Town of Meredith	N/A 2027-2036	Municipalities
3b	Review and optimize MS4 compliance for municipalities (regardless of MS4 designation), including infrastructure mapping, erosion and sediment controls, illicit discharge programs, and good housekeeping practices such as regular catch basin cleaning. Aligns with Action 2.14 of the Meredith Community Plan .	Medium	Municipalities (Public Works/Highway)	TBD 2027-2036	Municipalities
3c	Develop best practice design standards for SCMs, including deep sump catch basins.	Low	Municipalities (Public Works/Highway)	N/A 2029-2032	Municipalities



Action Item 4: Municipal Land Use Planning and Zoning

#	Sub-Item Description	Priority Level	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
4a	Present WRP recommendations to Select Boards and Planning Boards and discuss the connection between municipal land use planning and water quality. Aligns with Actions 4.1, 4.2, and 4.13 of the Meredith Community Plan .	High	WWAC, WWC, LWIA, Conservation Commissions	N/A 2027	Conservation commissions
4b	Meet with municipal staff to review recommendations to improve or develop ordinances addressing setbacks, buffers, lot coverage, low impact development, and open space. Cost assumes consultant assistance. Aligns with Actions 4.1, 4.2, and 4.13 of the Meredith Community Plan .	High	WWAC, WWC, LWIA, municipalities	\$10,000 2027-2029	Grants (319, CWSRF), municipalities
4c	Ensure proper enforcement of shoreland zoning, temporary erosion control measures for construction projects, and septic system inspections.	High	WWAC, municipalities	N/A 2027-2036	Municipalities
4d	Increase minimum lot size requirements in zoning districts with high build-out potential through zoning ordinance amendments or through establishing and overlay district for the Lake Waukegan watershed (already established in New Hampton). These zoning districts may include: Center Harbor's Agricultural Residential District (0.92 acre minimum lot size), Holderness's Rural Residential District (1 acre minimum lot size), Ashland's Rural Residential District (0.92 acre minimum lot size), New Hampton's General Residential District within the Waukegan Watershed Overlay District (2 acre minimum lot size).	Medium	Municipalities	N/A 2029-2033	Municipalities, conservation commissions

#	Sub-Item Description	Priority Level	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
4e	Develop or strengthen watershed overlay districts that direct development away from ecologically-sensitive areas, guide construction and development, and prohibit high risk land uses. Aligns with Action 4.9 in the Meredith Community Plan .	Medium	Municipalities	N/A 2029-2033	Municipalities, conservation commissions
4f	Require erosion control SCMs through the development review process, including construction inspection and site stabilization. Distinguish between temporary and permanent erosion control methods. This has been completed for Meredith but should also be completed for the other watershed towns.	Medium	Municipalities	N/A 2031-2036	Municipalities, conservation commissions
4g	Adopt a wetlands ordinance (New Hampton and Center Harbor) and expand wetlands setbacks/protections (other towns). Aligns with Action 4.7 in the Meredith Community Plan .	Medium	Municipalities	N/A 2028-2033	Municipalities, conservation commissions

4h	Adopt/strengthen zoning ordinance provisions and enforcement mechanisms in watershed towns. Certain recommendations may only be applicable to specific towns:				
	1. Require stormwater SCMs in the Shoreland Zone for permits and property transfers. Must be integrated with Towns' Master Plans.				
	2. Mandate 75-foot setbacks from lakes and ponds for primary structures, buffers between development and waterbodies, and impervious cover restrictions of 20% maximum per lot. Aligns with Action 4.7 in the Meredith Community Plan .				
	3. Consider adopting a mandatory septic system inspection and pump-out every 3 years for properties within 250 feet of a waterbody.				
	4. Require phosphorus/nitrogen loading analysis for any development greater than 1 acre in watershed.	Medium	Municipalities	N/A 2027-2035	Municipalities
	5. Extend the wetlands setback to 100 feet for very poorly drained soils and 50 feet for poorly drained soils.				
	6. Prohibit disturbance on slopes greater than 20% near surface waters; require engineered erosion controls on all slopes greater than 15%. Aligns with Action 4.5 of the Meredith Community Plan .				
	7. Develop a Road Ordinance for all new roads requiring drainage standards and ongoing erosion control.				
	8. Address fertilizer use, pesticide use, and animal waste for water quality protection.				
	9. Clearly define riparian buffer and increase the mandatory buffer width for perennial streams, rivers, lakes, and				

#	Sub-Item Description	Priority Level	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
	ponds, with wider buffers required on steeper slopes. Aligns with Action 4.7 in the Meredith Community Plan. 10. Consider increasing the mandatory open spaces for conservation subdivisions above 50%. Aligns with Action 3.9 of the Meredith Community Plan. 11. Make low impact development strategies mandatory in all developments, including rain gardens, permeable pavements, and green roofs, to reduce runoff and improve water infiltration. Aligns with Actions 4.6 and 4.8 in the Meredith Community Plan.				
4i	Require increasing the required vertical separation distance between septic system effluent disposal areas and the seasonal high water table from 24 inches (the state standard) to 36 inches on properties within 250 feet of Lake Waukegan and Lake Winona.	Low	Municipalities	N/A 2032-2036	Municipalities, conservation commissions
4j	Require that all contractors used by municipalities are NHDES-certified so they have adequate low impact development and SCM use ethics.	Low	Municipalities	N/A 2028-2031	Municipalities

#	Sub-Item Description	Priority Level	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
4k	Increase municipal staff capacity through code enforcers/building inspectors for inspections and enforcement of regulations on public and private lands. Develop a manageable system for enforcement of septic system maintenance, stormwater runoff, shoreland development, erosion and sediment control, and tree and vegetation clearing. Consider working with the town departments of public works to complete regular checks. Ensure compliance with Meredith's existing septic system regulations. Aligns with Action 2.31 of the Meredith Community Plan .	Low	Municipalities	TBD 2027-2036	Municipalities



Action Item 5: Land Conservation

#	Sub-Item Description	Priority Level	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
5a	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. Consider adding a "conservation" line to town budgets. Aligns with Actions 4.16, 4.18, and 4.19 of the Meredith Community Plan .	High	WWAC, municipalities, Conservation Commissions, Lakes Region Conservation Trust or other local land trusts	N/A 2030-2036	Grants (Moose Plate, LCHIP, RCPP, NAWCA, LWCF, ACEP, CSP, EQIP)

#	Sub-Item Description	Priority Level	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
5b	Continue to provide opportunity for residents to donate money or contribute land to land conservation projects. WWAC currently advertises this on their website.	High	WWAC, WWC, LWIA	N/A 2027-2036	WWAC, WWC
5c	Update natural resources inventories for all five watershed towns. Aligns with Action 4.15 of the Meredith Community Plan .	Medium	Municipalities, conservation commissions	\$125,000 2027-2030	Grants (NFWF, NEFRF, CWSRF), municipalities
5d	Create a priority list of watershed areas that need protection based on natural resources inventories or other resources. Refer to Section 4.2.3 to understand current conservation lands and valuable habitats and wildlife in the watershed that can be used to help identify potential areas to target for conservation. Land within Ashland's rural residential zoning district and New Hampton's general residential zoning district may be targeted for conservation based on build-out potential. Aligns with Action 4.17 of the Meredith Community Plan .	Medium	Municipalities, Conservation Commissions, Lakes Region Land Trust or other local land trusts	\$4,000-\$8,000 2027-2030	Grants (NFWF, NEFRF, NAWCA, CWSRF), municipalities

#	Sub-Item Description	Priority Level	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
5e	Enhance community education regarding private land conservation easements. Host workshops educating landowners on the benefits. Also enhance advertisement of available public lands so folks are aware of what is available to them. Query about land accessibility at workshops to understand how land accessibility can be improved. Aligns with Actions 4.12 and 4.18 of the Meredith Community Plan .	Medium	WWAC, WWC, LWIA, Conservation Commissions	N/A 2027-2032	Grants (Moose Plate, LCHIP, RCPP, NAWCA, LWCF, ACEP, CSP, EQIP, NFWF NEFRF), municipalities, private landowners
5f	Prioritize conserving land around "prime wetlands" as identified in town code. Aligns with Action 4.17 of the Meredith Community Plan .	Medium	Municipalities, Lakes Region Land Trust, Conservation Commissions	TBD 2030-2036	Municipalities
5g	Create a watch list containing potential parcels for conservation. Prioritize the protection of water quality when conserving land. These parcels may include those with high build-out potential.	Medium	WWAC, LWIA, Conservation Commissions	N/A 2027-2030	Municipalities, WWAC
5h	Recruit volunteers for monitoring and maintaining conservation lands and stewardship. Aligns with Actions 4.21 and 4.23 of the Meredith Community Plan .	Low	Municipalities, Conservation Commissions	N/A 2027-2036	Municipalities, WWAC
5i	Lead an annual guided hike through a publicly accessible conservation trail to demonstrate the benefit of conserving land.	Low	WWAC, WWC, LWIA	N/A 2027-2036	WWAC, WWC, LWIA



Action Item 6: Septic System Management

#	Sub-Item Description	Priority Level	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
6a	Continue to enforce the " <i>Regulations pertaining to certain subsurface wastewater disposal systems in the Lake Waukegan watershed</i> " that requires inspections and maintenance of septic systems for all new permit requests. Consider extending this regulation for all property transfers as well.	High	Town of Meredith	Staff time 2027-2036	Municipality
6b	Implement and enforce health regulations that require all septic systems within 250 feet of Lake Waukegan and/or Lake Winona to be pumped every 3 or 5 years. The regulation(s) may also apply to other waterbodies in the respective towns, such as Lake Winnepesaukee. Pump-outs (~\$250 per system) are the responsibility of the owner.	High	Towns of Meredith, New Hampton, Center Harbor	N/A 2030-2036	Municipalities
6c	Encourage town officials to track septic system pumping and upgrades; maintain database based on recent comprehensive septic system survey completed by FBE. Add short term rental information to the database in tandem with the Town of Meredith's short term rental tracking. Aligns with Actions 3.14 and 4.4 of the Meredith Community Plan	High	WWAC, municipalities	N/A 2027-2036	Municipalities
6d	Distribute educational materials to property owners about septic system function and maintenance and complying with local ordinances.	High	Municipalities, WWAC, WWC, LWIA	\$3,000 2027, 2030, 2033, 2036	Grants (319, CWSRF), municipalities

#	Sub-Item Description	Priority Level	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
6e	Work with watershed representatives and road agents to facilitate scheduled pump-outs and inspections. Develop a list of preferred contractors and coordinate potential group rates.	Medium	WWAC	N/A 2027-2036	WWAC
6f	Compile survey and GPS information of septic systems in shoreland area to facilitate code enforcement of septic system ordinances. Consider expanding watershed-wide. 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. Aligns with Action 4.4 of the Meredith Community Plan	Medium	WWAC, LWIA, municipalities	\$25K-50K 2032	Grants (CWSRF), municipalities
6g	Assess sewer capacity, sewer infrastructure conditions ,and conduct a septic system risk assessment to identify areas which may be more susceptible to septic system malfunction due to high groundwaters, soil filtering capacity, risk of flooding, age of infrastructure, which may guide future development. Aligns with Actions 2.24 and 4.4 in the Meredith Community Plan .	Medium	Municipalities, Town of Meredith Energy Committee	\$50,000 2032-2033	Municipalities
6h	Develop a long-term funding source for septic system upgrades. Investigate the feasibility of a septic system utility.	Low	Municipalities, BCCD, GCCD, LWA	\$60,000 2032-2036	Municipalities, Grants (CWSRF)



Action Item 7: Monitoring

#	Sub-Item Description	Priority Level	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
7a	Continue the current VLAP monitoring and Lake Host programs to track water quality and invasive species. Aligns with Action 4.3 of the Meredith Community Plan .	High	WWAC, WWC, LWIA	TBD 2027-2036	Grants (NHDES AIPC), WWAC
7b	Consider expanding routine monitoring if resources are available. See Section 6.4: Monitoring Plan. Aligns with Action 4.3 of the Meredith Community Plan .	Medium	WWAC, LWIA	TBD 2028-2036	WWAC, volunteers
7c	Expand on water quality data reporting to make information more accessible and known (see Item 8r).	Medium	WWAC, LWIA	TBD 2027-2036	WWAC, donations



Action Item 8: Education and Outreach

#	Sub-Item Description	Priority Level	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
8a	Create a new section to the Meredith website that would provide educational information regarding the protection of waterbodies in the Town and Waukegan watershed; include link to plan. Replicate these efforts in other towns. Aligns with Actions 2.28 and 2.29 of the Meredith Community Plan .	High	Town of Meredith, municipalities	N/A 2027-2036	Municipality
8b	Post a link to the WRP on the WWC and LWIA websites.	High	WWC, LWIA	N/A 2027	WWC, LWIA

#	Sub-Item Description	Priority Level	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
8c	Strengthen the collaboration between WWAC/WWC and LWIA to promote watershed-wide initiatives that cross town and sub-watershed boundaries. Aligns with Actions 4.2 and 4.11 of the Meredith Community Plan .	High	WWAC, WWC, LWIA	N/A 2027-2036	LWI, WWC
8d	Continue to keep the WWC website updated with new resources, notifications of upcoming events, ways to get involved, etc. Ensure the website is easy to navigate and engaging. Consider posting upcoming events by organizations other than WWAC so residents have ample opportunity for education.	High	WWC	TBD 2027-2036	Grants, donations
8e	Continue current outreach events, including: 1. Neighborhood showcases and site walks when new SCM projects are installed (private and public). 2. Workshops for property-level stormwater management, fertilizer use, septic system practices, cyanobacteria, shoreline buffers, conservation easements, and invasive species management (at least two per year). Add a workshop for road associations on camp road maintenance. Aligns with Action 4.14 of the Meredith Community Plan. 3. Quarterly updates to the Meredith Select Board	High	WWAC, WWC, LWIA conservation commissions	TBD 2027-2036	Grants, donations, municipalities
8f	Continue to publicize events, water quality updates, and WRP implementation progress. WWC website, emails, and person-to-person communication were identified as the best mode of communication to residents.	High	WWC, LWIA	TBD 2027-2036	Grants, donations

#	Sub-Item Description	Priority Level	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
8g	Continue posting educational signage in highly visible, public locations throughout the watershed, including boat ramps.	High	WWAC, LWIA	\$5,000 2027-2036	Grants, donations
8h	Continue strengthening partnerships between WWC, LWA, the Winnisquam Watershed Network, and other lake associations in the region (including but not limited to Newfound Lake, Lake Kanasatka, Lake Wicwas, and Squam Lakes). Potential new collaborators include White Oak Pond in Holderness, which is adjacent to the Lake Winona watershed. Leverage collective power to advocate to municipal boards and the State of New Hampshire for lake-minded policies. Aligns with Actions 4.2 and 4.11 of the Meredith Community Plan .	High	WWC, LWIA	N/A 2027-2036	Donations, lake associations
8i	Host another regional workshop that brings together multiple lake associations similar to the 6/17/2026 event hosted by WWAC/WWC. Aligns with Actions 4.2 and 4.11 of the Meredith Community Plan .	High	WWAC, WWC, LWIA	\$3,000 2031	Municipalities, donations
8j	Educate private property owners on questions to ask hired landscaping companies to ensure they are complying with shoreland protection regulations.	High	WWC, LWIA	N/A 2027-2036	WWC
8k	Educate contractors and municipal staff about erosion and sediment control practices required on plans. Work with municipalities to ensure that there are sufficient resources to enforce permitting conditions.	High	Municipalities, WWAC, BCCD, GCCD	\$6,000 2027-2036	Grants (319, CWSRF), municipalities

#	Sub-Item Description	Priority Level	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
8l	Provide a training for local contractors regarding the use of low impact development and SCM installation for all permit work.	Medium	WWAC, LWA	\$2,000 2028, 2032, 2036	Grants, donations, municipalities
8m	Locate willing volunteers to demonstrate what an ideal shoreline buffer looks like and how it functions.	Medium	WWAC, WWC, LWIA	N/A 2027-2036	Donations
8n	Develop and send emails to residents in the spring showing before/after photos of implemented SCMs.	Medium	WWC, LWIA	N/A 2028-2036	Donations
8o	Develop and send/post on-line a self-assessment quiz to help homeowners determine whether or not they have an erosion problem.	Medium	WWAC, Municipalities	N/A 2028-2029	Donations, municipalities
8p	Work with WWC who has an established conservation fund to continue raising money from individual donors to help fund action items.	Medium	WWAC, WWC	N/A 2027-2036	Donations
8q	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. This has been completed for LWIA.	Medium	Municipalities, WWAC, WWC, LWIA	\$20,000-\$60,000 2030-2031	Grants (319, CWSRF), municipalities

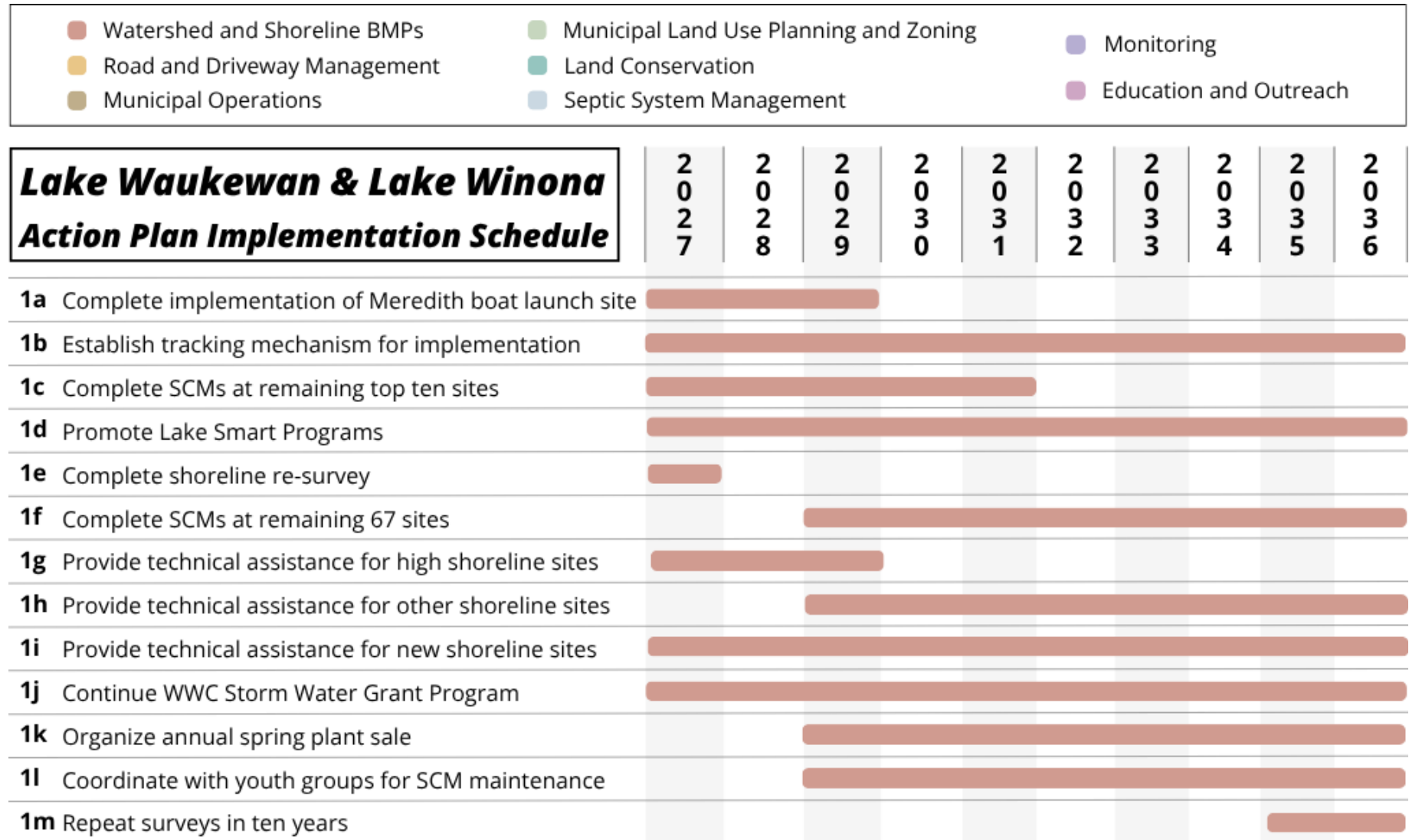
#	Sub-Item Description	Priority Level	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
8r	Report water quality data to the public once available from VLAP and in a summary report at the end of each sampling season. Disseminate through the WWC and LWIA newsletter and on the website. Ensure that the information is clear and accessible to all audiences (NHDES recommends an eighth grade reading level for accessibility).	Medium	WWC, LWIA, VLAP	N/A 2027-2036	WWC
8s	Provide a list of trusted contractors that residents can use for projects that require stormwater management and for camp road and driveway upgrades. Prioritize DES-certified contractors. Work with the watershed representatives and road agents to disseminate lists and keep them up to date.	Medium	WWC, LWIA	N/A 2028-2036	WWC
8t	Add a workshop topic that focuses on the regulations / ordinances that relate to watershed health (e.g., shoreland ordinance, tree-cutting rules, permitting requirements, etc.). Include hand-outs that provide clear guidance/FAQ on regulations / ordinances and permitting requirements that is also made available on the WWC websites. Guidance on local regulations is already available on the LWIA website.	Low	WWC, LWIA	\$1,000 2032	Grants, donations
8u	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.	Low	WWC, WWAC, LWIA, NH Lakes	TBD 2027-2036	Grants, donations

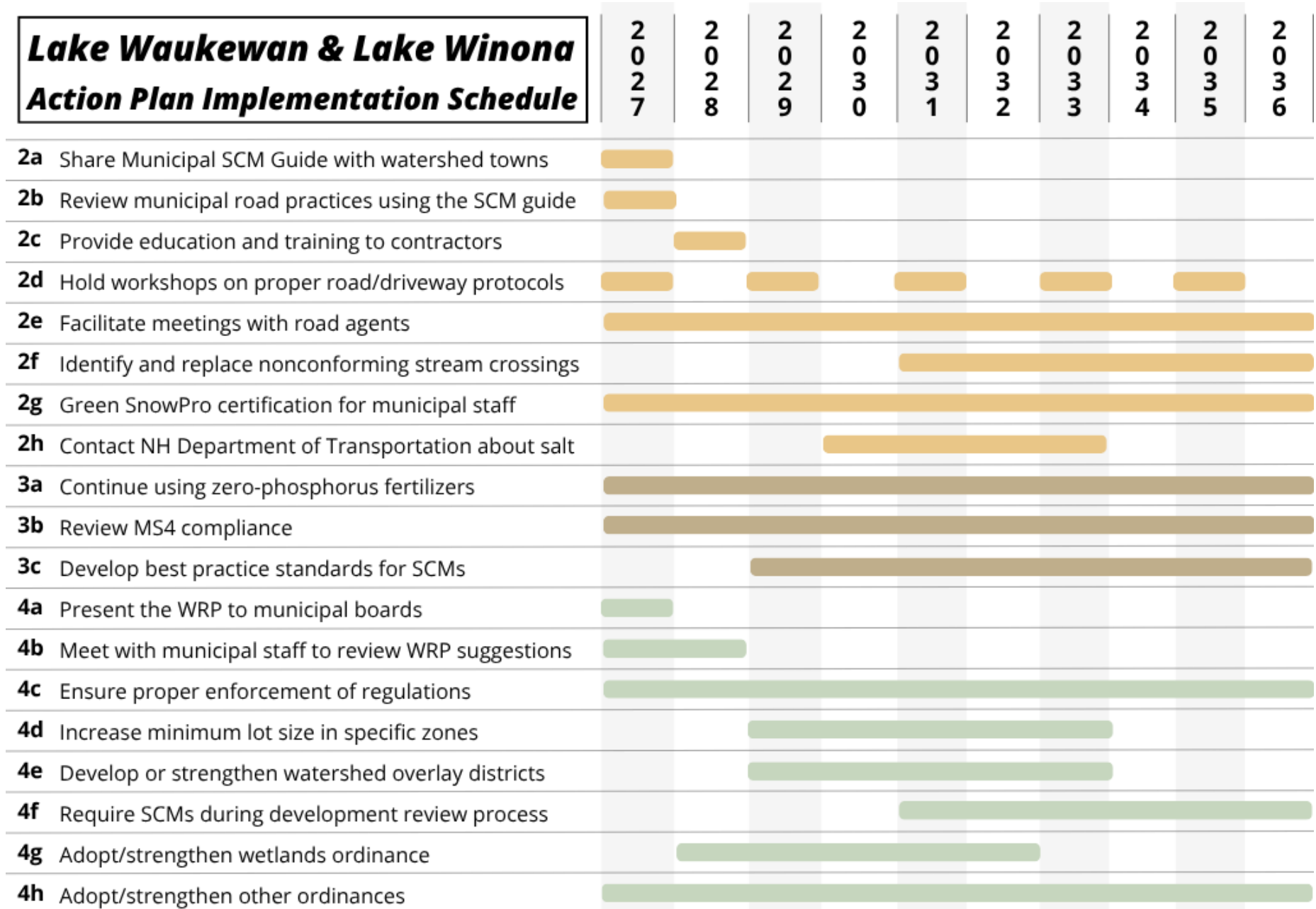
#	Sub-Item Description	Priority Level	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
8v	Develop outreach plans for watershed representatives and road agents to ensure they are engaging with all residents in their area.	Low	WWAC, WWC, LWIA	\$10,000 2032-2036	Grants, donations
8w	Encourage private property and road owners to hire Green SnowPro certified commercial salt applicators.	Low	WWAC, WWC, LWIA, municipalities	N/A 2027-2036	Grants, municipalities

5.2.3 Action Plan Implementation Schedule

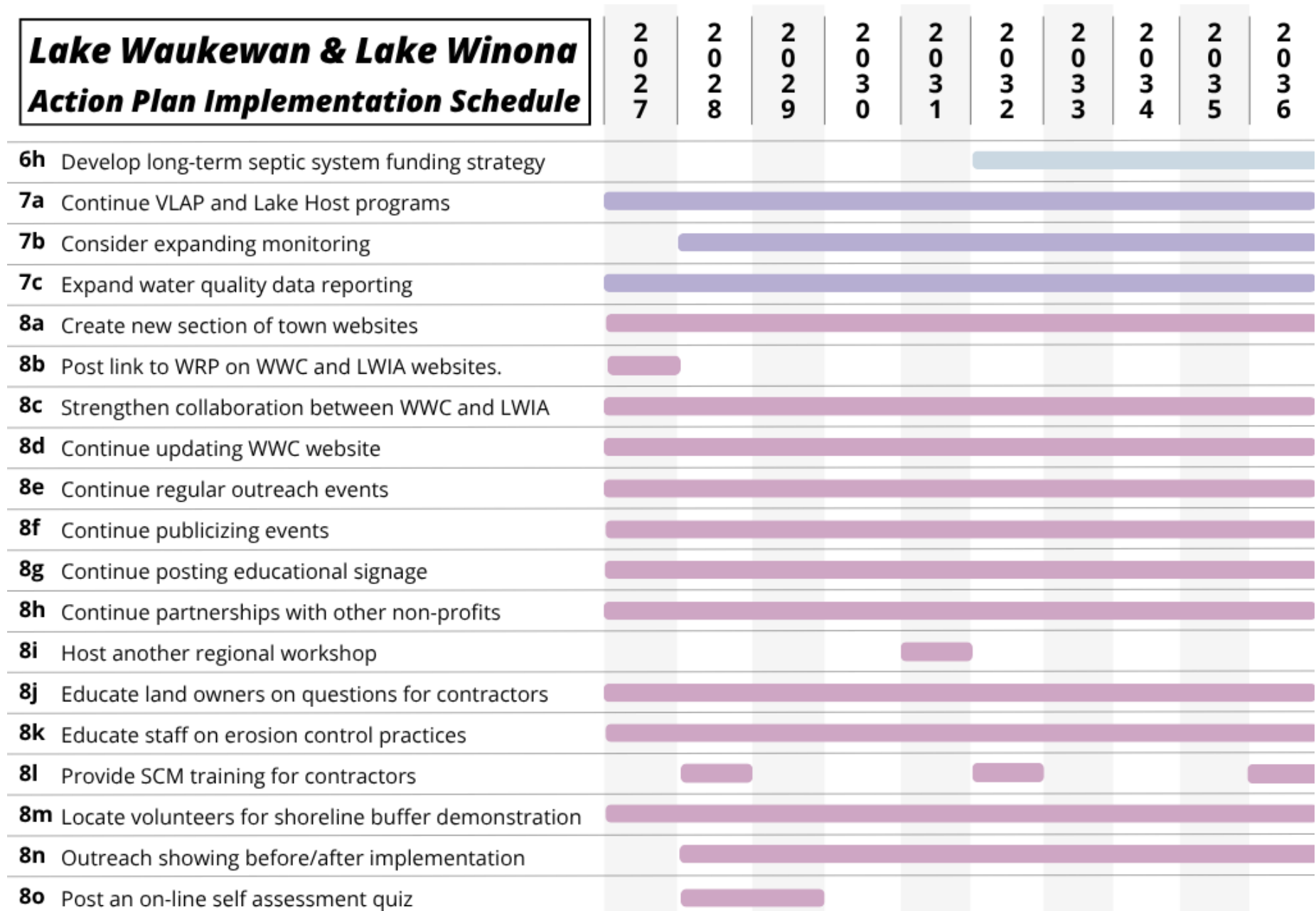
The following is a graphical timeline of the Lake Waukegan and Lake Winona Action Plan implementation schedule.

Figure 40. Lake Waukegan and Winona Lake Action Plan implementation timeline.





Lake Waukewan & Lake Winona Action Plan Implementation Schedule	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
4i Change design requirements for septic systems										
4j Require NHDES-certified contractors										
4k Increase municipal capacity to ensure compliance										
5a Identify conservation buyers or potential easements										
5b Provide donation opportunities										
5c Update natural resources inventories										
5d Create priority list of areas for conservation										
5e Enhance community education about easements										
5f Prioritize conserving prime wetlands										
5g Create watch list of priority parcels for conservation										
5h Recruit volunteers for land stewardship										
5i Lead an annual guided hike through conserved land										
6a Enforce existing septic regulation in Meredith										
6b Implement septic pumping/inspection regulations										
6c Encourage town tracking of septic systems										
6d Distribute septic system educational materials										
6e Facilitate scheduled pump-outs and inspections										
6f Expand data collection efforts for septic systems										
6g Assess sewer capacity and septic vulnerability										



Lake Waukewan & Lake Winona Action Plan Implementation Schedule	2 0 2 7	2 0 2 8	2 0 2 9	2 0 3 0	2 0 3 1	2 0 3 2	2 0 3 3	2 0 3 4	2 0 3 5	2 0 3 6
8p Raise money from individual donors for conservation										
8q Create “watershed homeowner” packet										
8r Report water quality data to the public										
8s Provide list of trusted contractors										
8t Add a regulation/ordinance focused workshop										
8u Target seasonal residents for outreach in public areas										
8v Develop outreach plans for local representatives										
8w Promote using Green SnowPro certified professionals										

5.3 POLLUTANT LOAD REDUCTIONS

To meet the Objective 1 water quality goal for Lake Waukegan, set a target phosphorus load reduction of 33 kg/yr to achieve an in-lake total phosphorus concentration of 5.4 ppb, which meets state water quality standards for oligotrophic waterbodies and is anticipated to substantially reduce the likelihood of cyanobacteria blooms in Lake Waukegan. To meet the Objective 1 water quality goal for Lake Winona, set a target phosphorus load reduction of 8.0 kg/yr to achieve an in-lake total phosphorus concentration of 7.2 ppb, which meets state water quality standards for oligotrophic waterbodies and is anticipated to substantially reduce the likelihood of cyanobacteria blooms in Lake Winona. 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 77 watershed survey sites could prevent up to **16.5 kg/yr** of phosphorus load from entering Lake Waukegan and **2.7 kg/yr** from entering Lake Winona.
- 2** Upgrading the 124 shorefront septic systems older than 25 years is estimated to reduce the phosphorus load by **7.1 kg/yr** (71 systems) for Lake Waukegan and by **5.3 kg/yr** (53 systems) for Lake Winona.
- 3** Treating shoreline survey sites identified by LWA could likely reduce the phosphorus load to Lake Waukegan by **2.3 kg/yr** for the two high impact sites (disturbance score 11+), **3.5 kg/yr** for the 12 medium impact sites (disturbance score between 9-10), and **7.4 kg/yr** for the 51 low impact sites (disturbance score between 7-8). Treating shoreline survey sites could likely reduce the phosphorus load to Lake Winona by **0.9 kg/yr** based on the six low impact sites (disturbance score between 7-8) identified from the original 2014 shoreline survey. Completing the remaining parcels along the Lake Waukegan shoreline and re-surveying the Lake Winona shoreline may reveal additional load reduction opportunities.

Total potential load reduction for Lake Waukegan = 36.8 kg/yr

(meets 112% of reductions needed to achieve Objective 1 for Lake Waukegan; Table 20)

Total potential load reduction for Lake Winona = 8.9 kg/yr

(meets 111% of reductions needed to achieve Objective 1 for Lake Winona; Table 19)

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 Lake Waukegan and Lake Winona 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)



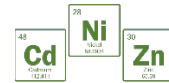
Petroleum
products



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 success. 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.

Monitoring buoy on Lake Waukegan © FBE



Table 19. Breakdown of phosphorus load sources and modeled water quality for current and target conditions that meet the water quality goal for Lake Winona (Objective 1) paired with all quantified load reduction opportunities. Reduction percentages are based out of the current condition value for each parameter. kg/yr = kilograms per year. ppb = parts per billion.

Lake	Parameter	Unit	Current Condition	Target Condition	Reduction (unit, % change)
Lake Winona	Total phosphorus load (all sources) ⁴	kg/yr	116.9	108.9	-8.0 (7%)
	(A) Background phosphorus load ¹	kg/yr	42.2	42.2	0.0 (0%)
	(B) Disturbed (human) phosphorus load ²	kg/yr	74.7	66.7	-8.0 (11%)
	(C) Developed land use phosphorus load ³	kg/yr	56.1	52.5	-3.6 (6%)
	(D) Septic system phosphorus load	kg/yr	12.9	7.6	-5.3 (41%)
	(E) Internal phosphorus load	kg/yr	5.7	5.7	0.0 (0%)
	In-lake total phosphorus*	ppb	7.8	7.2	-0.6 (8%)
	In-lake chlorophyll- <i>a</i> *	ppb	4.7	4.4	-0.3 (6%)
	In-lake Secchi disk transparency*	meters	4.4	4.7	0.3 (7%)
	In-lake bloom probability*	days	19	14	-5 (26%)

¹ Approximated using the pre-development total phosphorus load. Includes the Lake Winona background load.

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

³ Calculated via difference between current and pre-development total phosphorus load, subtracting out the septic system and internal loads.

⁴ Total phosphorus load (all sources) = $A + B$

* Water quality parameters were sourced from the model and adjusted to reflect observed summertime conditions.

Table 20. Breakdown of phosphorus load sources and modeled water quality for current and target conditions that meet the water quality goal for Lake Waukegan (Objective 1) paired with all quantified load reduction opportunities. Reduction percentages are based out of the current condition value for each parameter. kg/yr = kilograms per year. ppb = parts per billion.

Lake	Parameter	Unit	Current Condition	Target Condition	Reduction (unit, % change)
Lake Waukegan	Total phosphorus load (all sources) ⁵	kg/yr	384.6	348.0	-36.6 (10%)
	(A) Background phosphorus load ¹	kg/yr	118.2	118.2	0.0 (0%)
	(B) Direct disturbed (human) phosphorus load ²	kg/yr	266.4	233.4	-36.8 (14%)
	(C) Lake Winona disturbed (human) phosphorus load ³	kg/yr	33.5	29.9	-3.6 (11%)
	(D) Developed land use phosphorus load ⁴	kg/yr	182.5	152.9	-29.7 (16%)
	(E) Septic system phosphorus load	kg/yr	29.2	22.1	-7.1 (24%)
	(F) Internal phosphorus load	kg/yr	21.2	21.2	0.0 (0%)
	In-lake total phosphorus*	ppb	6.1	5.4	-0.6 (10%)
	In-lake chlorophyll- <i>a</i> *	ppb	2.1	1.8	-0.3 (14%)
	In-lake Secchi disk transparency*	meters	5.1	5.6	0.5 (10%)
	In-lake bloom probability*	days	0	0	0 (0%)

¹ Approximated using the pre-development total phosphorus load. Includes the Lake Winona background load.

² Sum of developed land use load, shorefront septic system load, and internal load ($B = D + E + F$)

³ Calculated via difference between the Lake Winona portion of the Lake Waukegan current and pre-development total phosphorus loads.

⁴ Calculated via difference between current and pre-development total phosphorus load, subtracting out the septic system and internal loads.

⁵ Total phosphorus load (all sources) = $A + B + C$

* Water quality parameters were sourced from the model and adjusted to reflect observed summertime 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 WWAC and supported by a diverse group of partners including local non-profits, municipal boards, conservation commissions, state and federal agencies, 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

WWAC	Continue to lead plan oversight, fund water quality monitoring, outreach, and fundraising for stewardship and restoration projects.
WWC & LWIA	Continue to conduct water quality monitoring through the VLAP program and lead education and outreach efforts.
Municipalities	Continue to address nonpoint source pollution, maintain roads using best practices, and consider adopting ordinances that protect water quality. The Town of Meredith will continue to provide administrative and grant support for SCM implementation and education/outreach efforts.
Conservation Commissions	Continue to collaborate with municipal staff to help implement recommended actions.
NHDES	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 for Lake Waukegan and Lake Winona in the next ten years. **Successful implementation is estimated to cost over two million dollars over the next ten or more years** (Table 21). 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 21. Estimated total phosphorus load reduction and total and annual costs for implementation of the Action Plan. Load reductions represent the sum of actions for both Lake Winona and Lake Waukegan. 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	33.4	\$1.55M – \$2.73M	\$155K – 273K
2. Road Management	<i>TBD</i>	\$19,000 - \$24,000	\$1,900 - \$2,400
3. Municipal Operations	<i>TBD</i>	<i>TBD</i>	<i>TBD</i>
4. Municipal Land Use Planning & Zoning	(52.4)*	\$10,000	\$10,000
5. Land Conservation	<i>Included in land use planning and zoning</i>	\$129,000 - \$133,000	\$12,900 - \$13,300
6. Septic System Management	12.4	\$138,000 - \$163,000	\$13,800 - \$16,300
7. Monitoring	<i>TBD</i>	<i>TBD</i>	<i>TBD</i>
8. Education & Outreach	<i>TBD</i>	\$49,000 - \$89,000	\$4,900-\$8,900
Total	45.7	\$1.895M - \$3.139M	\$189,500-\$313,900

*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 WWAC 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. WWAC has already obtained municipal funding from the other watershed towns to support monitoring efforts. WWAC and the Town of Meredith have been successful in the past with grant applications in the past to support monitoring, including a \$200,000 grant from the NHDES Drinking Water and Groundwater Bureau to develop a Cyanobacteria Monitoring and Response Plan for Lake Waukegan. The Town of Meredith also established its own Cyanobacteria Mitigation Fund to be administered through WWAC to protect Lake Waukegan. WWAC conducts fundraisers and uses annual dues to provide financial assistance up to \$1,000 to fund stormwater improvements on shoreline properties. After the original WRP was published in 2016, the Town of Meredith utilized Section 319 Watershed Assistance Program funding to improve septic systems along the Lake Waukegan shoreline.

WWAC, the Town of Meredith, WWC, and LWIA may take a similar approach for funding acquisition to implement the WRP. Funding for septic system improvements, roads, and shoreland zone buffers would likely come from private landowners. Listed below are state and federal funding sources that could assist the WWAC, watershed towns, WWC, and LWIA with future water quality and watershed work for Lake Waukegan and Lake Winona.

Funding Options



Water Quality and Wastewater Infrastructure

- **EPA Clean Water Act Section 319 Grants (NHDES Watershed Assistance Grants)**
\$50,000–\$150,000 for two-year projects to reduce nonpoint source pollution and restore impaired waters. Restoration priorities are identified in the NH Nonpoint Source Management Program Plan (NHDES, 2024d). These grants are only available for the implementation of WMPs.
- **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.
- **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.

- **Local Source Water Protection Grant (LSWPG)**
Provides small grants (maximum \$25,000 to \$30,000 depending on project components) to fund drinking water supply protection and planning. Because Lake Waukegan is a public drinking water supply, certain projects protecting its water quality are eligible.
- **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.
- **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.



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.



Agriculture, Forestry, and Land Stewardship

- **US Department of Agriculture Conservation Stewardship Program (CSP)**
Supports conservation activities on working agricultural and forest lands.
- **US 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 to be conducted by WWC and VLAP volunteers as feasible.

- Continue current routine monitoring at all long-term lake and stream monitoring locations.
- Collect additional dissolved oxygen and temperature profiles in Lake Winona. We recommend that profiles be collected 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 VLAP.

If additional funding is available, we also recommend the following to better characterize the contribution of phosphorus from internal loading:

- Stream flow monitoring at select tributary sites can help characterize pollutant loading from streams under different weather conditions. We recommend flow monitoring at tributaries that are regularly sampled for total phosphorus, such as a low-gradient site close to the inlet to Lake Waukegan on the Snake River, and potentially EE Brook, Sayward Brook, or Mayo Farm Brook. Lake Winona sites such as the inlet from Hawkins Pond, the North Inlet, or Heights Brook Inlet are also viable candidate sites.

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 22). Milestones are set for short-term (2028), mid-term (2030), and long-term (2035) intervals, based on actions identified in the Action Plan (Section 5). These milestones support periodic plan updates, ensure ongoing relevance, and help the WWAC 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 22. Environmental, programmatic, and social indicators for the Lake Waukegan and Lake Winona WRP Update. Milestones are cumulative, starting at year 1, 2027. ppb = parts per billion.

Environmental Indicators

Milestone	2029	2031	2036
Achieve an average summer deep spot epilimnion total phosphorus concentration of 5.4 ppb across the two Lake Waukegan Deep Spots [WAUMERMD and WAUMERWD].	<6.0 ppb	<5.7 ppb	<5.4 ppb
Achieve an average summer deep spot epilimnion total phosphorus concentration of 7.2 ppb at the deep spot site at Lake Winona [WINNWHHD].	<7.7 ppb	<7.5 ppb	<7.2 ppb
Achieve an average summer deep spot epilimnion chlorophyll- <i>a</i> concentration of less than 1.5 ppb across the two Lake Waukegan Deep Spots [WAUMERMD and WAUMERWD].	<2.0 ppb	<1.9 ppb	<1.8 ppb
Achieve an average summer deep spot epilimnion chlorophyll- <i>a</i> concentration of less than 1.4 ppb at the deep spot station at Lake Winona [WINNWHHD].	<4.6 ppb	<4.5 ppb	<4.4 ppb
Prevent the occurrence of cyanobacteria or algal blooms in Lake Waukegan (milestones based on modeled results and observed blooms over the past ten years).	0 days per year	0 days per year	0 days per year
Eliminate the occurrence of cyanobacteria or algal blooms in Lake Winona (milestones based on modeled results).	15 days per year	10 days per year	0 days per year
Achieve an average summer water clarity of 6.0 meters or deeper at the deep spot station in Lake Waukegan [WAUMERMD and WAUMERWD] (based on modeled results).	5.6 meters+	5.8 meters+	6.0 meters+
Achieve an average summer water clarity of 6.3 meters or deeper at the deep spot station at Lake Winona [WINNWHHD] (based on modeled results).	5.2 meters+	5.4 meters+	5.6 meters+
Prevent and/or control the introduction and/or proliferation of invasive aquatic plants all waterbodies.	Absence of invasives	Absence of invasives	Absence of invasives



Programmatic Indicators

Milestone	2029	2031	2036
Amount of funding secured from municipal/private work, fundraisers, donations, and grants.	\$500,000	\$1,000,000	\$2,000,000

Number of nonpoint source sites remediated for Lake Waukegan.	15	30	60
Number of nonpoint source sites remediated for Lake Winona.	4	8	17
Percentage of shorefront properties with LakeSmart certification.	25%	50%	75%
Number of watershed/shoreline properties receiving technical assistance for implementation cost sharing on Lake Waukegan.	18	35	70
Number of watershed/shoreline properties receiving technical assistance for implementation cost sharing on Lake Winona.	2	4	6
Number of workshops and trainings for stormwater improvements to residential properties (e.g., NH Lakes).	3	6	10
Number of updated or new ordinances that target water quality protection.	3	6	9
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 or enforced through Town of Meredith regulations).	35	70	140
Number of septic system upgrades.	7	14	50
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.	3	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	2	3
Number of meetings and/or presentations to municipal staff and/or boards related to the WMP (excluding quarterly updates to Meredith Select Board).	3	6	12



Social Indicators

Milestone	2029	2031	2036
Number of new association members (across both WWC and LWIA).	5	10	25
Number of volunteers participating in educational campaigns.	75	150	250
Number of people participating in informational meetings, workshops, trainings, SCM demonstrations, or group septic system pumping.	250	350	500
Number of watershed residents installing conservation practices on their property and/or participating in LakeSmart.	25	500	100
Number of municipal Public Works staff receiving Green SnowPro training and receiving certification.	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%	25%	50%
Number of weekly visitors to the WWC and LWIA websites.	25	50	100

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.

[NHDES Fact Sheets on Watersheds, Low Impact Development, Snow and Ice, and Salt Reduction.](#) New Hampshire Department of Environmental Services.

[NHDES Road Salt Reduction.](#) New Hampshire Department of Environmental Services.

NRCS [Field Office Technical Guide \(FOTG\)](#) for New Hampshire to provide information regarding agricultural BMPs.

[Protecting water resources and managing stormwater.](#) University of New Hampshire, Cooperative Extension and Stormwater Center. March 2010.

NHDES Fact Sheets

[Cyanobacteria in New Hampshire Waters.](#) WD-WMB-10, 2023.

[Erosion Control for Construction within the Protected Shoreland.](#) SP-1, 2020.

[Lake Eutrophication.](#) WD-BB-3, 2019.

[Lawn Care within the Protected Shoreland](#). SP-2, 2020.

[New Hampshire Fish Consumption Guidelines](#). ARD-EHP-25, 2021.

[New Hampshire Volunteer Lake Assessment Program \(VLAP\)](#). WB-BB-26, 2019.

[Phosphorus: Too much of a good thing](#). WD-BB-20, 2019.

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APPENDIX A: SCM MATRIX

Following a Steering Committee meeting on 12/10/2025, FBE, with assistance from HW, re-prioritized sites in the SCM matrix based on environmental, social, and economic factors that were not considered in the original ranking. Qualitative and quantitative ranking criteria were assigned scores between 1-3 for each factor; the sum of all factors served as the final score for each site. For sites attaining the same final score, sites were prioritized using the average cost per kilogram of phosphorus reduced, which reflects the most efficient use of funds in terms of phosphorus reduction. The update ranking is provided in Table A-1. The ranking criteria are as follows:

Environmental Factors:

- **Total Phosphorus Reduction.** Sites where reductions of greater than 1.5 lbs of phosphorus per year (0.68 kg-P/yr) are possible were considered “High Impact” and received a score of 3. Sites with reductions between 1.5 lbs/yr and 1.0 lbs/yr (0.45 kg-P/yr) were considered “Moderate Impact” and received a score of 2. Site with reductions below 1.0 lbs/yr were considered “Low Impact” and received a score of 1.
- **Transport to the waterbody.** Sites where stormwater and/or sediment was observed to be leading directly into Lake Waukegan, Lake Winona, another lake/pond, a tributary, or stormwater infrastructure that discharges directly to surface waters (ex. catch basins) were considered to have a “direct” impact on water quality and received a score of 2. Sites where erosion or other stormwater issues were present but there was minimal evidence of direct transport to the waterbody were considered to have a “limited” impact on water quality and received a score of 1.

Social Factors:

- **Feasibility.** Feasibility to implement the remedial actions recommended for the site are considered in the scoring system. Sites fully located within town-owned land or roads were considered “high” feasibility. Sites that would require collaboration between the town and private landowners or sites that are on state-owned land/roads were considered “medium” feasibility. Sites on private land were considered “low” feasibility.
- **Community Input.** The Steering Committee identified sites of local importance during the 12/10/2025 meeting, which included the Lake Waukegan Boat Launch and Vittner Beach as two high impact areas. During the watershed survey, a resident of Wall Street identified specific issues related to drainage and flooding. Each site specifically identified by a community member was given a score of 1.

Economic Factors:

- Average cost per kilogram of phosphorus reduced. The average cost per kilogram of phosphorus reduced represents the most effective use of funds solely based on phosphorus reduction. In this way, sites are ranked not based on their overall cost, but on how much funding is needed to reduce phosphorus loading by one kilogram at that site. Sites where the average cost per kilogram of phosphorus is less than \$100,000 received a score of 3 for the most efficient use of funds. Sites where the average cost per kilogram of phosphorus is between \$100,000 and \$300,000 received a score of 2. Sites where the average cost per kilogram of phosphorus is greater than \$300,000 were assigned a score of 1.

Table A-1. Site ID, priority rank, location description, latitude, longitude, and estimated pollutant load reductions following Stormwater Control Measure (SCM) implementation for the 77 nonpoint source sites identified in the Lake Waukegan and Lake Winona 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. kg-P = kilograms of phosphorus. Details and coordinates for recommended SCMs by site are available in a separate Microsoft Excel® document. *Note that load reduction and cost estimates for Site 3-01 are updated based on HW's calculations during the 10% conceptual design phase, which changes the average cost per kilogram of phosphorus. The original ranking was kept because the level of detail in the design is not consistent with the methods used to generate cost estimates for the rest of the sites; costs for other sites may be higher or lower after additional design is conducted.

Site ID	Location	Town	Transport	Feasibility	TP (kg/yr)	TN (kg/yr)	TSS (metric tons/yr)	Avg. Cost Est.	Avg. Cost per kg-P	Score	Rank
3-01	Lake Waukegan Boat Launch	Meredith	DIRECT	HIGH	0.8	6.9	0.2	\$325,000	\$406,250*	12	1
2-05	Opposite Side of 36 Forest Hill Road	Meredith	DIRECT	HIGH	1.4	3.7	5.5	\$17,500	\$12,289	11	2
3-08	Winona Shores Road & Indian Trail Intersection #1	Meredith	LIMITED	HIGH	1.3	3.5	5.1	\$12,500	\$9,375	10	3
2-02	Robin Way	Meredith	LIMITED	HIGH	1.8	4.5	6.8	\$45,000	\$25,313	10	4
2-15	Lambert Road	Ashland	DIRECT	HIGH	0.5	1.3	1.9	\$15,000	\$30,068	10	5
3-07	Pollard Shores Road	Meredith	LIMITED	HIGH	0.6	1.4	2.1	\$17,500	\$31,372	9	6
2-19	Intersection of Piper Hill Road & Hawkins Pond Road	Center Harbor	DIRECT	HIGH	0.4	1.1	1.5	\$22,500	\$51,680	9	7

Site ID	Location	Town	Transport	Feasibility	TP (kg/yr)	TN (kg/yr)	TSS (metric tons/yr)	Avg. Cost Est.	Avg. Cost per kg-P	Score	Rank
4-09	Med Urgent Care at Traffic Circle	Meredith	DIRECT	LOW	1.1	5.9	0.6	\$60,000	\$53,133	9	8
1-08B	Corner of Railroad Tracks and Waukegan Street	Meredith	DIRECT	HIGH	0.1	0.4	0.5	\$7,500	\$55,125	9	9
2-24	Mayo Shore Campground Stream Crossing	Center Harbor	DIRECT	MEDIUM	0.5	2.7	0.2	\$30,000	\$60,136	9	10
3-04	Railroad Tracks South of Waukegan Beach	Meredith	DIRECT	HIGH	0.0	0.2	0.0	\$3,000	\$66,150	9	11
1-23	Bonney Shore Road	Meredith	DIRECT	HIGH	0.1	0.3	0.3	\$10,000	\$76,563	9	12
4-07	Ocean State Job Lot	Meredith	DIRECT	LOW	2.2	12.2	0.8	\$200,000	\$89,634	9	13
1-24A	Upstream Side of Stream Crossing on Waukegan Street	Meredith	DIRECT	HIGH	0.1	0.2	0.2	\$10,000	\$91,875	9	14
1-09C	Waukegan Street, West of Site 1-09B	Meredith	LIMITED	HIGH	0.1	0.5	0.1	\$1,500	\$12,721	8	15
3-10	Vittner Beach	New Hampton	DIRECT	LOW	0.1	0.5	0.0	\$3,000	\$30,068	8	16
4-03	Birch Hill Road	Meredith	LIMITED	HIGH	0.3	0.8	1.1	\$17,500	\$59,365	8	17
2-12	Winona Lake Outlet Canoe Launch	Center Harbor	DIRECT	MEDIUM	0.2	0.5	0.6	\$12,500	\$59,918	8	18
3-09	Winona Shores Road & Indian Trail Intersection #2	Meredith	LIMITED	HIGH	0.3	0.7	1.1	\$17,500	\$62,238	8	19
3-14	Wood Ridge Circle	Center Harbor	LIMITED	HIGH	0.3	0.9	1.3	\$22,500	\$67,962	8	20
4-04	Piper Lane	Meredith	LIMITED	HIGH	0.1	0.3	0.4	\$7,500	\$68,906	8	21
1-06	Waukegan Street Near Railroad	Meredith	LIMITED	HIGH	0.0	0.0	0.0	\$1,500	\$75,000	8	22
2-03B	28 Forest Hill Road	Meredith	LIMITED	MEDIUM	0.6	1.6	2.4	\$47,500	\$76,451	8	23

Site ID	Location	Town	Transport	Feasibility	TP (kg/yr)	TN (kg/yr)	TSS (metric tons/yr)	Avg. Cost Est.	Avg. Cost per kg-P	Score	Rank
3-12	Waukegan Road Near Waukegan Golf Club	Center Harbor	DIRECT	MEDIUM	0.4	1.0	1.5	\$30,000	\$77,824	8	24
1-12	Wall Street and Waukegan Street Intersection	Meredith	DIRECT	MEDIUM	0.0	0.1	0.0	\$3,000	\$82,688	8	25
2-16B	Piper Hill Road at Hawkins Pond Parking Lot	Center Harbor	LIMITED	HIGH	0.2	0.5	0.7	\$15,000	\$82,688	8	26
2-16A	Hawkins Pond Parking Lot	Center Harbor	DIRECT	MEDIUM	0.1	0.4	0.5	\$12,500	\$86,133	8	27
3-28	Piper Hill Road by MacDonald Excavation	Center Harbor	LIMITED	HIGH	0.1	0.3	0.5	\$12,500	\$98,438	8	28
3-06	Road Ditch at 110 Waukegan Street	Meredith	LIMITED	HIGH	0.1	0.3	0.5	\$12,500	\$98,438	8	29
1-07	Beach South End	Meredith	DIRECT	HIGH	0.1	0.2	0.4	\$10,000	\$105,000	8	30
3-05	Driveway of 98 Waukegan Street	Meredith	DIRECT	HIGH	0.1	0.2	0.3	\$7,500	\$110,250	8	31
1-19	Reservoir Road	Meredith	DIRECT	HIGH	0.3	0.7	1.1	\$35,000	\$122,500	8	32
3-03	Sidewalk Above Waukegan Beach	Meredith	DIRECT	HIGH	0.1	0.2	0.0	\$7,500	\$137,813	8	33
1-14 & 1-15	Wall Street #1	Meredith	DIRECT	MEDIUM	0.1	0.4	0.0	\$12,500	\$162,132	8	34
1-24B	Downstream Side of Stream Crossing on Waukegan Street	Meredith	DIRECT	HIGH	0.0	0.1	0.1	\$7,500	\$165,375	8	35
1-09A	Stream Crossing West of Beach Area	Meredith	DIRECT	HIGH	0.1	0.4	0.0	\$12,500	\$177,823	8	36
2-04	36 Forest Hill Road	Meredith	DIRECT	HIGH	0.1	0.2	0.3	\$12,500	\$196,875	8	37

Site ID	Location	Town	Transport	Feasibility	TP (kg/yr)	TN (kg/yr)	TSS (metric tons/yr)	Avg. Cost Est.	Avg. Cost per kg-P	Score	Rank
4-15	Massachusetts Avenue Catch Basin #2	Meredith	DIRECT	HIGH	0.1	0.0	0.1	\$30,000	\$236,250	8	38
3-02	Waukegan Street Kayak Launch	Meredith	DIRECT	HIGH	0.0	0.1	0.0	\$7,500	\$236,250	8	39
4-16	Lower Ladd Hill and Massachusetts Avenue Intersection	Meredith	DIRECT	HIGH	0.2	0.8	0.6	\$60,000	\$259,412	8	40
4-01	Fortier Street	Meredith	DIRECT	HIGH	0.2	1.2	0.1	\$60,000	\$281,489	8	41
2-01	Winona Shores Road	Meredith	DIRECT	LOW	0.1	0.3	0.3	\$3,000	\$20,672	7	42
4-08	Footlight Circle	Meredith	DIRECT	LOW	0.1	0.7	0.0	\$3,000	\$41,344	7	43
3-13	Wood Ridge Road Near Waukegan Golf Club	Center Harbor	LIMITED	MEDIUM	0.1	0.3	0.4	\$5,000	\$44,100	7	44
4-10	Parade Road Near Tracy Way	Meredith	LIMITED	MEDIUM	0.1	0.1	0.0	\$3,000	\$55,125	7	45
3-16	Winona Road Parking Area #1	New Hampton	LIMITED	MEDIUM	0.2	0.6	0.4	\$17,500	\$70,159	7	46
3-25	South of Winona Road & Hawkins Pond Road Intersection	Center Harbor	LIMITED	MEDIUM	0.3	0.7	1.1	\$22,500	\$82,688	7	47
3-29	Bonney Shores Road & Ledgewood Drive Intersection	Meredith	LIMITED	MEDIUM	0.2	0.5	0.7	\$17,500	\$91,875	7	48
1-02AB	Water Street Stream Crossing	Meredith	LIMITED	HIGH	0.1	0.2	0.3	\$7,500	\$110,250	7	49
3-27	Piper Hill Road by Hawkins Pond Wetland	Center Harbor	LIMITED	HIGH	0.2	0.6	0.9	\$30,000	\$120,273	7	50

Site ID	Location	Town	Transport	Feasibility	TP (kg/yr)	TN (kg/yr)	TSS (metric tons/yr)	Avg. Cost Est.	Avg. Cost per kg-P	Score	Rank
1-11	Waukegan Street Stream Crossing	Meredith	DIRECT	MEDIUM	0.1	0.2	0.1	\$12,500	\$125,284	7	51
1-02C	Unknown Stream	Meredith	DIRECT	MEDIUM	0.1	0.3	0.0	\$7,500	\$127,212	7	52
1-22	Unpaved Section of Red Gate Road	Center Harbor	DIRECT	HIGH	0.1	0.4	0.6	\$20,000	\$137,813	7	53
2-21	Winona Drive Hawkins Pond Stream Crossing	Meredith	LIMITED	MEDIUM	0.2	0.6	0.6	\$25,000	\$137,813	7	54
1-10B	House next to Carder Lane on Waukegan Street	Meredith	DIRECT	MEDIUM	0.1	0.8	0.0	\$22,500	\$165,375	7	55
3-15	Railroad Crossing on Winona Road	New Hampton	DIRECT	MEDIUM	0.1	0.3	0.3	\$25,000	\$212,019	7	56
1-05	Red Gate Lane	Meredith	LIMITED	HIGH	0.2	0.4	0.7	\$40,000	\$232,105	7	57
2-13	Winona Road Bordering Winona Lake	Center Harbor	DIRECT	MEDIUM	0.1	0.4	0.6	\$35,000	\$241,172	7	58
2-20	Hawkins Pond Outlet Stream Crossing	Meredith	DIRECT	HIGH	0.0	0.2	0.0	\$12,500	\$393,750	7	59
1-01	Water Street #1	Center Harbor	DIRECT	HIGH	0.0	0.1	0.0	\$12,500	\$393,750	7	60
3-26	Fire Truck Pull Off at Hawkins Pond Dam	Center Harbor	DIRECT	HIGH	0.0	0.1	0.0	\$7,500	\$413,438	7	61
2-18	Bear Pond Stream Crossing of Piper Road	Center Harbor	DIRECT	HIGH	0.0	0.1	0.0	\$17,500	\$643,125	7	62
1-21	Ditches on Waukegan Street at Bruce's Landscaping	Meredith	LIMITED	MEDIUM	0.1	0.4	0.5	\$15,000	\$106,694	6	63
3-17	Winona Road Parking Area #2	New Hampton	LIMITED	MEDIUM	0.0	0.1	0.0	\$3,000	\$132,300	6	64

Site ID	Location	Town	Transport	Feasibility	TP (kg/yr)	TN (kg/yr)	TSS (metric tons/yr)	Avg. Cost Est.	Avg. Cost per kg-P	Score	Rank
3-24	Winona Road & Hawkins Pond Road Intersection	Center Harbor	LIMITED	MEDIUM	0.1	0.3	0.4	\$17,500	\$154,350	6	65
3-30	Bonney Shores Road & Beth Lane Intersection	Meredith	LIMITED	MEDIUM	0.1	0.2	0.3	\$15,000	\$194,559	6	66
1-03A	Red Gate Lane Culvert	Meredith	LIMITED	MEDIUM	0.1	0.2	0.3	\$15,000	\$194,559	6	67
2-11	Bay View Beach	New Hampton	DIRECT	LOW	0.0	0.0	0.0	\$3,000	\$220,500	6	68
4-12	Lower Ladd Hill Road Near Daniel Webster Highway	Meredith	LIMITED	HIGH	0.0	0.1	0.1	\$12,500	\$393,750	6	69
1-04	Red Gate Lane Ditch Near End of Road	Meredith	LIMITED	HIGH	0.0	0.0	0.0	\$3,000	\$661,500	6	70
4-14	Massachusetts Avenue Catch Basin #1	New Hampton	DIRECT	MEDIUM	0.0	0.0	0.0	\$1,000	<i>none</i>	6	71
2-10	Railroad off Winona Shores Road	Meredith	DIRECT	MEDIUM	0.0	0.0	0.0	\$0	<i>none</i>	6	72
3-11	Road by Vittner Beach	New Hampton	LIMITED	LOW	0.4	0.9	1.4	\$37,500	\$104,668	5	73
2-09	Seminole Ave Near Railroad	New Hampton	DIRECT	LOW	0.2	0.5	0.7	\$60,000	\$322,683	5	74
3-23	Parking Pull Off on Winona Road	Center Harbor	LIMITED	MEDIUM	0.0	0.0	0.0	\$7,500	\$413,438	5	75
3-21	Winona Road Culvert	Center Harbor	LIMITED	MEDIUM	0.0	0.1	0.0	\$27,500	\$2,021,250	5	76
4-13	West View Drive	Meredith	LIMITED	MEDIUM	0.0	0.0	0.0	\$12,500	\$2,756,250	5	77
TOTAL					19.2	68.1	50.1	\$1,831,000	\$95,364		

APPENDIX B: 10% CONCEPTUAL ENGINEERING DESIGN

Lake Waukewan Boat Launch Stormwater Management Conceptual Design

Meredith, New Hampshire

September 2026

PREPARED FOR

Town of Meredith, NH

PREPARED BY



Horsley Witten Group, Inc.
113 R2 Water Street
Exeter, NH 03833

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INTRODUCTION

The Town of Meredith contracted with FB Environmental Associates (FBE) to update the Lake Waukewan and Lake Winona Watershed Restoration Plan, in partnership with the Waukewan Watershed Advisory Committee (WWAC) and the Windy Waters Conservancy (WWC). As part of the watershed restoration plan update, FBE subcontracted to Horsley Witten Group (HW) to develop a conceptual design for nonpoint source mitigation measures at one watershed site. The Town, WWAC, and WWC selected the Lake Waukewan Boat Launch as the priority site for HW to advance to a conceptual design level.

Lake Waukewan (NHLAK700020108-02-01) is a tributary to Meredith Bay in Lake Winnepesaukee and serves as the primary drinking water supply for the Town of Meredith. Lake Waukewan generally has excellent water quality that is representative of oligotrophic, or high-quality, conditions. However, the lake is listed by NHDES as impaired for aquatic life integrity due to low dissolved oxygen and impaired for primary contact recreation due to elevated cyanobacteria hepatotoxic microcystins. Water quality trends have shown phosphorus levels increasing over time in both the epilimnion (upper water layer) and hypolimnion (lower water layer).

As part of a watershed survey for the Lake Waukewan watershed management plan, FBE had identified the Lake Waukewan Boat Launch (Site 3-01) as one of 77 sites contributing nonpoint source pollution to Lake Waukewan. Water quality sampling at a near-shore sampling site at the Lake Waukewan Boat Launch has found higher levels of chloride, specific conductivity, and total phosphorus. High concentrations at that sampling site suggest that direct runoff from the roads and outfalls near the boat launch may have a disproportionate impact on these contaminant levels throughout the lake.

As documented in the Lake Waukewan Watershed Survey Results Memorandum, dated January 14, 2026, FBE recommended redesigning the boat ramp, diverting runoff from the street into the park, constructing a rain garden in the park to treat the runoff, and revegetating the shoreline buffer. FBE estimated the improvements would reduce average annual total phosphorus load by 0.8 kg/yr (1.7 lb/yr).

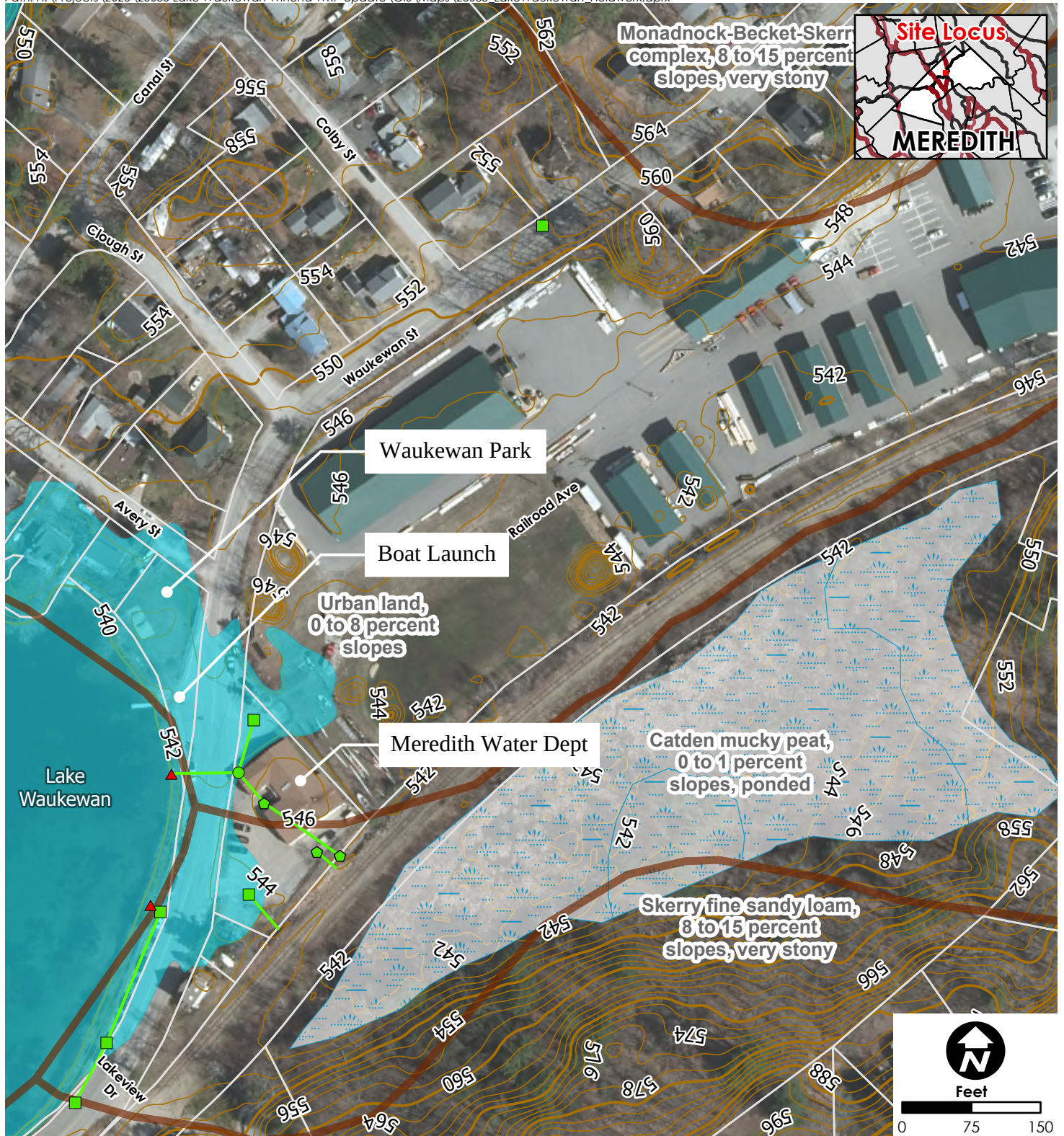
To advance FBE's planning-level recommendations to conceptual design level, HW staff Lori Kennedy, PE, and Mike Easler, RLA, visited the Lake Waukewan Boat Launch on May 21, 2026. Lori and Mike were joined on site by WWAC members and Town staff from Public Works, Planning, and Water and Sewer departments. During the site visit, HW gathered information on site uses, existing infrastructure, and drainage issues, and collected measurements and photos. The group discussed initial ideas for potential site improvements.



Stakeholders meet with HW at Waukewan Park, May 2026.

This report presents a conceptual (10% level) design for stormwater management at the site, along with planning-level estimates of costs and nutrient load reduction. The goal of the proposed improvements is to reduce phosphorus loading to Lake Waukewan. The design also aims to maintain or enhance existing site uses, create public amenities, and educate the public about water quality.

Path: H:\Projects\25085 Lake Waukegan Winona WRP Update\GIS\Maps\25085 LakeWaukegan_Fieldwork.aprx



Date: 9/8/2026
Data Sources: NH Statewide GIS Clearinghouse (NHGRANIT), FEMA, ESRI

This map is for informational purposes and may not be suitable for legal, engineering, or surveying purposes.

EXISTING CONDITIONS

The following paragraphs describe existing conditions at the Lake Waukewan Boat Launch and surrounding areas, including Waukewan Street, Waukewan Park, and the Meredith Water Department property. Our understanding of existing conditions is based on stakeholder input, a review of publicly available GIS data, and HW's site visit observations in May 2026.

Location

The Lake Waukewan Boat Launch is located along Waukewan St in Meredith, NH, abutting Waukewan Park at 49 Waukewan St and opposite the Meredith Water Department property at 50 Waukewan St. The study area includes the drainage areas to the boat launch and two nearby stormwater outfalls, extending roughly from 37 Waukewan St south to 62 Waukewan St and including the Water Department property and adjacent railroad.

Ownership

The boat launch, Waukewan Park, Water Department property, and Waukewan St are all owned by the Town of Meredith. The railroad right-of-way is owned by the State of New Hampshire, Department of Transportation Bureau of Rail and Transit.

Site Uses

Boat launch

- On busy days, such as for fishing tournaments, the boat launch is used by up to 20 boats. Vehicles with boat trailers stage along Waukewan Rd. Trailer parking is available along Waukewan St or at the Town parking lot at Rt 3 and Rt 25.
- The concrete boat ramp is 12 ft wide and is in poor condition. Stakeholders hope to replace the boat ramp surface while keeping it the same width. There are no regulatory limits on boat size or type on the lake.
- There is a dock just to the south of the boat launch. There also used to be a dock further south, near a set of concrete steps, where crew boats could dry launch into the lake.
- Stakeholders would like a separate launch area for kayaks and other cartop boats within sight of the Lake Hosts area.

Waukewan Park

- The park is small and has few amenities and limited parking. It is therefore not highly utilized. The Town does not host events at the park.
- Amenities in the park include a lawn, shade trees, a small flower garden along the front fence, and two picnic tables. The Greater Meredith Program (GMP) and Community Garden Club of Meredith maintain the flower garden.
- Lake Hosts, who inspect boats before they launch, set up under a tree in the park near the top of the boat ramp. Stakeholders would like a formalized area in the park for Lake Host staging and public education.
- A rain garden was created by NH Lakes along the northwest side of the park approximately 15 years ago. In recent years it has not been maintained as a rain garden and is now maintained as part of the lawn.

- The water intake pipe for the Meredith water treatment facility exists near the northwest corner of the park out into the lake.

Waukewan Street

- Waukewan St has a sidewalk along the west side of the roadway, with the exception of the frontage along Waukewan Park and the boat launch where there is no sidewalk. Stakeholders would like to see the sidewalk extend across the park frontage to connect the existing sidewalks.
- There are 17 parking spaces along the west side of Waukewan St south of the boat launch, as well as two parking spaces on the east side on front of the Water Department property.

Water Department

- The building on the water department property contains the Meredith Water Treatment Plant, which treats water pumped from Lake Waukewan.
- The property has a paved parking lot (in front) and a gravel driveway and parking area to the south.
- To the north is a paved driveway to an area that the Town leases from the lumber yard to use for stockpiling. HW observed sediment around a catch basin in the north driveway. The sediment is likely from a combination of erosion and tracking by vehicles parking off the side of the road, from winter road sand, and from erosion of stockpiled soil behind the Water Department building.

Utilities

Drainage infrastructure within the study area consists of catch basins and drainage pipes. The drainage infrastructure, as observed by HW during the May 2026 site visit, is illustrated in **Figure 1**. The exact routing of drainage from the Water Department property is uncertain. When cleaning out the ditch between the Water Department building and the railroad track, DPW uncovered a culvert inlet. It appears that the culvert originally drained high groundwater from the ditch through the drainage pipes under the Water Department parking lot to an outfall just south of the boat launch. The corrugated metal pipe (CMP), however, may be so corroded that it is no longer conveying flows from the ditch to the outfall. HW recommends a video inspection or dye testing of the drainage system to confirm the routing and condition of drainage pipes.

A water intake pipe crosses Waukewan Park to the Water Treatment Plant at an unknown location. Close to the treatment plant, the pipe has approximately 8 ft of cover, but the cover gets shallower toward the lake. The pipe may limit potential subsurface infiltration opportunities within the park.

The old water treatment pump station was abandoned in place under the park. This would also be a conflict for potential subsurface infiltration opportunities in the park. Test pits may be needed to locate the water intake pipe and abandoned pump station under the park lawn.

Maintenance

Meredith DPW maintains the boat launch, road, and water department property. The DPW contracts out street sweeping and catch basin cleaning. DPW also has a vacuum truck that they can use to clean catch basins, and is comfortable with maintaining all types of stormwater control measures.

Wind pushes snow and ice across Lake Waukewan toward Waukewan St, often creating drifting and ice piling. Waukewan St within the study area is designated as a low salt area, and mechanical removal and sand treatment have maintenance implications for proposed improvements.

Topography

The boat launch sits at the low point of the drainage area. Based on 2-ft contours from NH Granit and site observations, topography is gently sloping from 564 ft to 540 ft. The slope along Waukewan St is 1-2%.

Soils

Soils in the north portion of the drainage area are classified by Natural Resource Conservation Service (NRCS) as Urban Land, indicating heavily altered and disturbed soils. Within the area to the south along the railroad tracks, soils are classified as Calden mucky peat, ponded, very poorly drained, hydrologic soil group (HSG) A/D, indicating poor infiltration capacity and high groundwater.

Wetland Resources

Lake Waukewan has an area of approximately 953 acres and a surface elevation “reference line” of 540 ft (based on the NHDES consolidated list). The study area lies within the Lake Waukewan 250-ft Shoreland Protection Sone. A freshwater forested/shrub wetland is mapped on the south side of the railroad tracks, opposite the Water Department property. Based on FEMA’s preliminary flood hazard zone map, the base flood (1% annual chance, or 100-year flood) elevation for Lake Waukewan is 544.6 ft. The boat launch, adjacent Waukewan St, and a portion of the Water Department property lie within the flood zone.



Photo 1: Boat ramp and dock, facing west.



Photo 2: Boat ramp and dock, facing east.

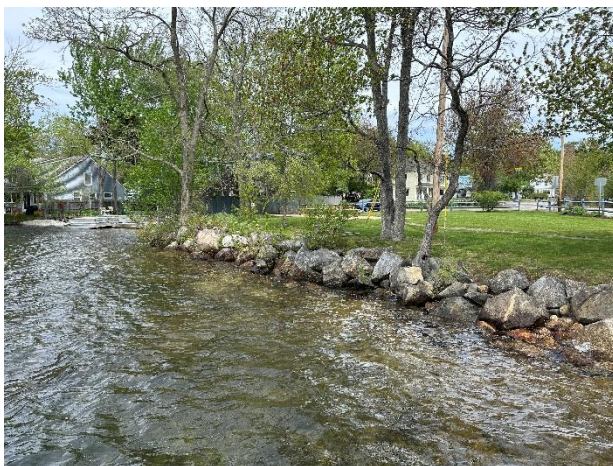


Photo 3: Shoreline along Waukewan Park, just north of the boat ramp.



Photo 4: Shoreline south of the boat ramp, facing north.



Photo 5: Waukwan St at boat ramp and kiosk, facing north.



Photo 6: Waukewan St in front of the park, facing north.



Photo 7: Park entrance at top of boat ramp, facing northwest.



Photo 8: Picnic tables in park on concrete pad left from demolished water department building.



Photo 9: Sparsely vegetated buffer along shoreline at park.



Photo 10: Depressed area on northwest side of park, previously the location of a rain garden.



Photo 11: Corrugated metal outfall pipe near concrete steps south of the boat ramp.



Photo 12: Corrugated metal outfall pipe near concrete steps south of the boat ramp.



Photo 13: On-street parking along Waukegan St south of the boat ramp, facing north.



Photo 14: On-street parking along Waukegan St south of the boat ramp, facing south.



Photo 15: Meredith Water Department water treatment facility.



Photo 16: Ditch along railroad track to the south of Water Department building and drive.

PROPOSED IMPROVEMENTS

Our conceptual design focuses on treating stormwater runoff before it discharges into the lake at the boat ramp or via the 24-inch corrugated metal outfall pipe near the concrete steps. The proposed improvements, described below and illustrated in **Figure 2**, are separated into six stormwater control measures (SCMs) to allow for the Town to pursue funding for SCMs individually or in combination. Additional recommendations are provided below for the Water Department property but are not included in **Figure 2** nor in the pollutant load reductions or cost estimates.

Rain Garden at Waukewan Park

NH Lakes created a rain garden approximately 15 years ago along the northwest side of Waukewan Park to treat stormwater runoff from Avery Street. We recommend redeveloping the rain garden by creating a shallow swale to a depression along the northwest side of the park, improving basin soil conditions, and planting with native species. The rain garden will allow runoff from Avery St to pond and slowly filter through plants and soil into groundwater.

Stormwater Tree Trench at Waukewan Park

HW had initially considered diverting runoff from Waukewan St into subsurface infiltration chambers under the park; however, the water intake pipe, abandoned pump station, and high groundwater levels will likely preclude chambers under a large portion of the park. Instead, we recommend constructing an infiltrating stormwater tree trench along Waukewan Street. Runoff from Waukewan St will flow into a crush-stone reservoir under a row of newly planted trees. The runoff will nourish the trees while recharging groundwater. If runoff fills up the stone reservoir in the tree trench, it will bypass the tree trench and continue to the proposed infiltration basin at the Water Department north drive (described below). This SCM includes many components for conveying and creating space for the stormwater tree trench:



Example stormwater tree trench

- Grade in a grass conveyance swale along the east side of Waukewan St, where the road is pitched to the inside (east) of the curve.
- Install a deep-sump, hooded catch basin with domed grate opposite Avery St to collect runoff from the grass swale. Convey runoff via a drainage pipe across Waukewan St to Waukewan Park.
- Construct a stormwater tree trench, consisting of planting soil, crushed stone, distribution pipes, and trees, along the front edge of the park.
- Realign the edge of road along the front of the park to create space for the stormwater tree trench.
- Install a sidewalk with granite curb along the road, to match sidewalks to the north and south. Extend the stone reservoir of the tree trench under the sidewalk.

Infiltration Basin at Water Department North Drive

Just north of the Water Department property, a catch basin collects runoff from a paved access drive (to the stockpile area) and the east edge of Waukegan St. We recommend grading in a grass swale along the east side of Waukegan St to better capture and convey runoff, including runoff that bypasses the proposed catch basin opposite Avery St. At the curve north of the access drive, grade in a grassed infiltration basin to pond, infiltrate, and settle runoff before it flows into the catch basin. We recommend installing an asphalt berm along the edge to better delineate the edge of road and to discourage parking in the grass swale or basin. A curb cut along the drive will direct sediment-laden runoff from the stockpile area into a concrete-paver sediment forebay, to better capture and remove sediment and allow for easy maintenance of the grass swale.

Trench Drain and Bioretention Basin at Boat Ramp

The existing boat ramp entrance, including staging areas along Waukegan St, is wider than necessary and uncomfortable and even unsafe to pedestrians. Stakeholders also noted that the concrete area to the south of the ramp where the kiosk is currently located is not well suited to Lake Host activities, and the Lake Host volunteers instead set up in the park to the north of the boat ramp. As part of the stormwater improvements at the boat ramp, we recommend reconfiguring the boat ramp entrance, relocating the kiosk to the park, and removing excess concrete and asphalt pavement on either side of the boat ramp. These improvements will reduce impervious cover, improve pedestrian access and safety, enhance Lake Host and public education activities, and create space for stormwater treatment.

For stormwater treatment, we recommend installing a trench drain across the boat ramp entrance above a proposed elevated crosswalk that will double as a shallow berm. The trench drain will direct runoff through a water quality unit (to be determined later in the design process) and into a newly constructed bioretention basin. The bioretention basin will be located within an area of concrete removal south of the boat ramp. Given the limited space available for a bioretention basin, an alternative could be to revegetate the shoreline and install a level spreader/terracing to allow runoff to filter through vegetation and soil before reaching the lake.



Example bioretention basins / rain gardens

Infiltration Trench along Waukegan St

Runoff from a small section of Waukegan St to the south of the boat ramp currently flows to and down the boat ramp into the lake. While some of that runoff could be captured by the trench drain and bioretention basin described above, those practices have limited treatment capacity given spatial constraints. We recommend constructing an infiltration trench below the parking lane along the west side of Waukegan St. Runoff would be captured by two new deep-sump, hooded catch basins, which would provide pretreatment before distributing runoff into the trench as shown on **Figure 2**. The size of the trench could be increased to treat a larger volume of runoff, depending on the location of sewer and water mains and on whether suitable

soil and groundwater conditions are found during future site investigations. This improvement could be replicated further down Waukegan St and even at other locations around the lake.

Vegetated Shoreline Buffer Restoration

The shoreline north and south of the boat ramp is armored with large rocks and sparsely vegetated. Within Waukegan Park, there is sufficient space to expand the vegetated buffer into the park up to approximately 15 feet or more. Along Waukegan St, the shoreline could be better protected with the addition of shrubs and trees between the sidewalk and water's edge.



Example shoreline buffer restoration.

Water Department Investigations and Stormwater Treatment

While the Water Department property is outside the scope for this design, we offer a few recommendations for future investigations and design work to prevent stormwater pollutants and potentially contaminated groundwater from reaching the lake via the 24-inch CMP outfall.

- 1) Conduct a video CCTV inspection and dye testing of the Water Department drainage system to confirm routing and pipe conditions.
- 2) Cap/fill the pipe inlet at the railroad drainage ditch to isolate the groundwater and prevent it from discharging to the lake. Build a berm along the Water Department south drive to prevent flooding from the ditch onto the drive.
- 3) Redirect runoff from the Water Department parking lot and access drives to a separate drainage pipe network instead of discharging it to the railroad ditch. Install a vortex unit or similar treatment system under the Water Department parking lot for pollutant removal prior to discharge to the lake.

PERMITTING CONSIDERATIONS

The project site lies within the NH Shoreland Protection Zone (extending 250 feet from the reference elevation). For shoreland protection permitting, this project would qualify for a Shoreland Permit-by-Notification as a voluntary retrofit proposed for the sole purpose of stormwater management and erosion control. While the project site lies near a wetland, the proposed improvements would not disturb the wetland and therefore would not be subject to wetland permitting. The project also falls within the preliminary 1% chance flood hazard zone, which does not currently carry regulatory requirements but should be considered during future design work.

OPERATION AND MAINTENANCE

Operation and maintenance (O&M) for the proposed stormwater improvements is expected to take 20 hours annually. Typical O&M includes routine inspections, preventative maintenance, and corrective actions, such as the following:

- 1) Clean out trash, debris, and accumulated sediment from forebay and the bioretention areas.
- 2) Clean sediment and debris from deep sump catch basins.

- 3) Maintain vegetation (weeding, replanting, etc.) and water plants during establishment period.
- 4) Check for erosion; stabilize areas of erosion, if found.
- 5) Check for standing water (lack of drainage) in the rain garden, bioretention basin, and infiltration trenches. Investigate and correct clogging if they do not drain within 48 hours following a rain event.

NEXT STEPS

- Complete site investigations, including soil evaluation and topographic survey.
- Consider maintenance needs for the proposed stormwater control measures. Engage with DPW, WWAC, WWC, and the Garden Club to explore shared maintenance responsibilities (e.g., plant care for the rain garden). Refine the design, as needed, to match maintenance capabilities.
- Prepare permit-ready (75% level) design plans.
- Complete shoreland permitting through NHDES.
- Develop final design and construction documents.

DESIGN SUMMARY

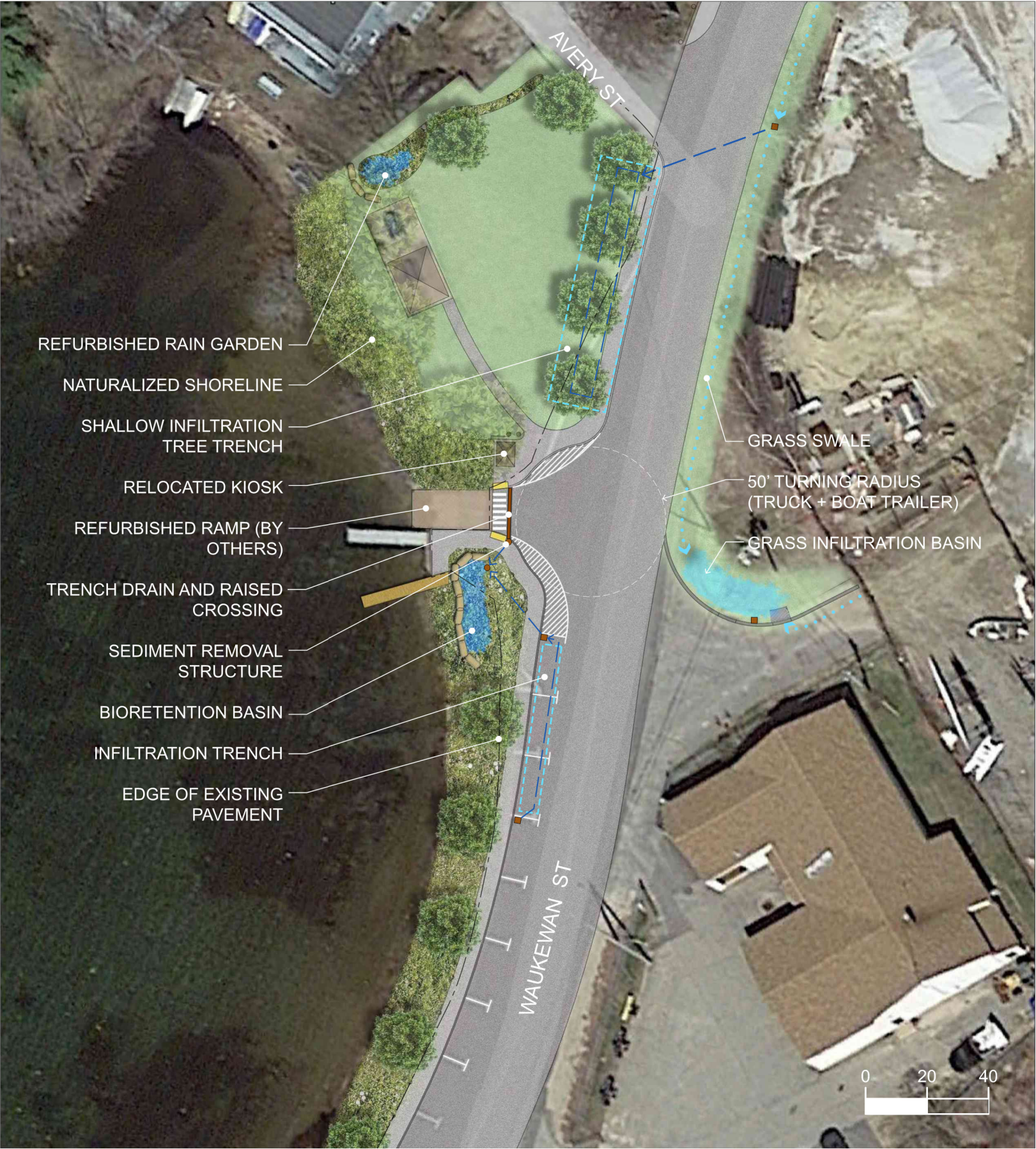
Table 1 presents a summary of recommended improvements and associated pollutant load reductions and construction cost estimates. Due to space limitations, poorly draining soils, and high groundwater, as well as the desire to maintain and enhance existing uses, the overall nutrient removal of the proposed improvements is somewhat limited but will still have a beneficial impact to the lake ecosystem.

Table 1. Conceptual Design Summary

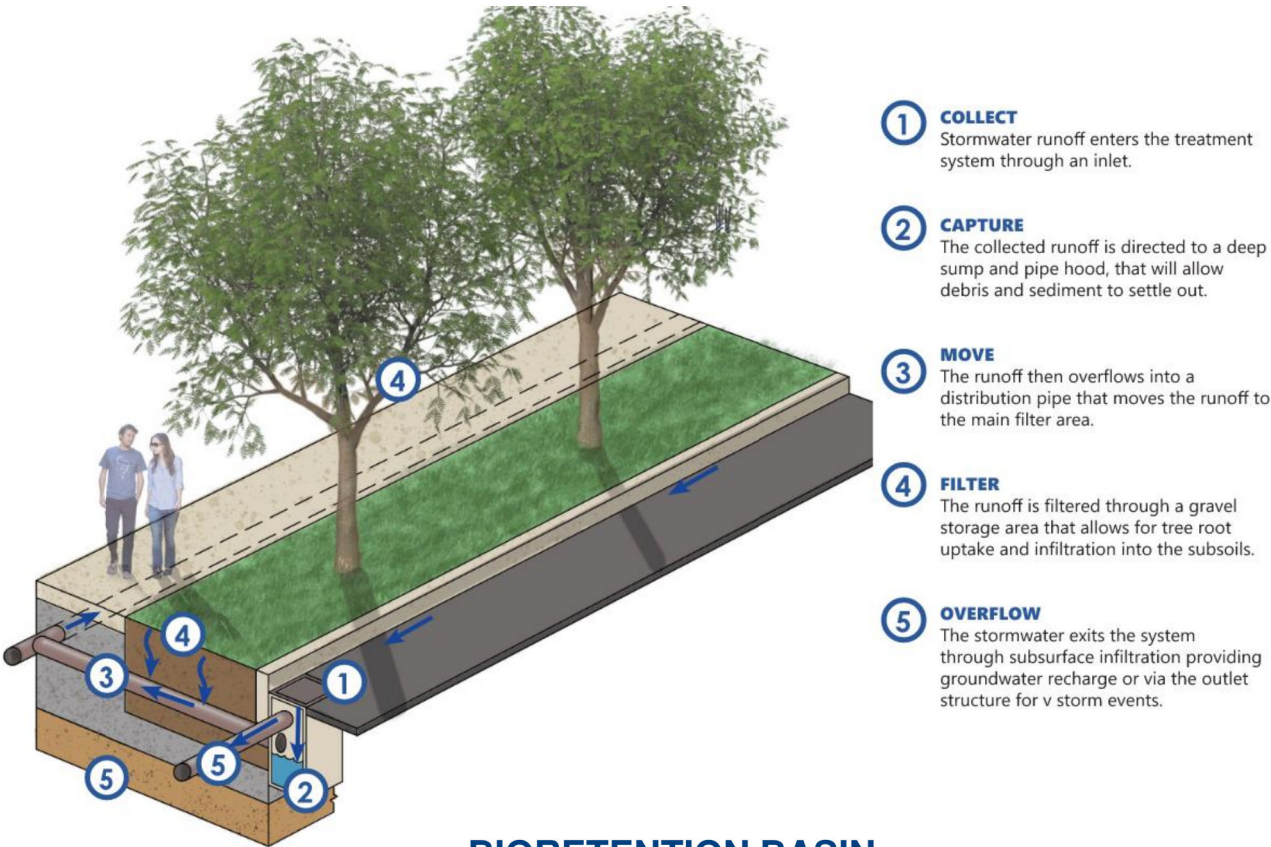
SCM Name	Proposed Improvements	Drainage Area Description ¹	Drainage Area (acres)	Treated Depth of Runoff from Impervious Area (inch)	Average Annual TP Load Reduction (lb/yr) ²	Average Annual TN Load Reduction (lb/yr) ²	Average Annual TSS Load Reduction (lb/yr) ²	Estimated Construction Cost ³
Waukegan Park Rain Garden	Grass swale and rain garden on northwest side of the park.	Residential area along Avery St.	0.63	0.1	0.2	2.4	89.9	\$11,000
Waukegan Park Stormwater Tree Trench	Grass conveyance swale on east side of Waukegan St. Deep-sump, hooded catch basin. Drainage pipe from new catch basin to park. Infiltrating stormwater tree trench along park frontage, extending under new sidewalk in front of park.	Waukegan St north to the existing CB near Colby St. Includes properties and side streets to the west that slope toward Waukegan St.	2.30	0.5	1.1	10.3	328.6	\$124,000 ⁴
Waukegan St infiltration basin at Water Department north drive	Grass conveyance swale on east side of Waukegan St. Grassed infiltration basin at Water Department north drive. Asphalt berm around curve. Curb cut to sediment forebay. Adjust existing catch basin with domed grate.	East side of Waukegan St, paved access drive north to the proposed CB.	0.17	0.9	0.1	0.9	29.8	\$11,000
Boat ramp trench drain and bioretention basin	Relocate kiosk to the park. Remove existing concrete. Reconfigure boat ramp and Waukegan St intersection. Elevated crosswalk. Trench drain to water quality structure. Bioretention basin with retaining wall.	Waukegan St from park south to new CB proposed for infiltration trench.	0.13	0.3	0.1	0.4	45.7	\$44,000

SCM Name	Proposed Improvements	Drainage Area Description ¹	Drainage Area (acres)	Treated Depth of Runoff from Impervious Area (inch)	Average Annual TP Load Reduction (lb/yr) ²	Average Annual TN Load Reduction (lb/yr) ²	Average Annual TSS Load Reduction (lb/yr) ²	Estimated Construction Cost ³
Waukewan St infiltration trench south of boat ramp	Two new catch basins routed to a subsurface infiltration trench filled with crushed stone under parking lane. Overflow to the boat ramp bioretention basin.	Waukewan St south of the boat ramp from proposed CB south to existing CB.	0.10	0.5	0.1	1.3	40.8	\$35,000
Shoreline Revegetation	Expand and revegetate the shoreline along Waukewan Park. Add shrubs (likely with live stakes) to shoreline along Waukewan St south of boat ramp.	NA, this practice is primarily for stabilizing the shoreline to prevent erosion.	0.00	0	0.0	0.0	0.0	\$34,000
Total Pollutant Load Reduction (lb/yr)					1.7	15.3	534.8	
Construction Costs							\$230,000 - \$280,000	
Design & Permitting Costs							\$60,000 - \$80,000	
Total Implementation Costs							\$290,000 - \$360,000	
Notes: 1. For all proposed SCMs, soils are mapped by NRCS as Urban Land; design calculations assume HSG C. 2. Pollutant load reductions were estimated using pollutant load export rates and BMP performance curves from the NH MS4 Permit Appendix F. 3. Planning-level construction costs were estimated using NHDOT and MassDOT unit prices, EPA Region 1 (2016) <i>Methodology for Developing Cost Estimates for Opti-Tool</i> , and best professional judgement. Costs include 30% contingency and are expressed in 2026 dollars. 4. Construction cost estimate for Waukewan Park Stormwater Tree Trench includes sidewalk and granite curb. Abbreviations: Stormwater Control Measure (SCM), Catch Basin (CB), Total Phosphorus (TP), Total Nitrogen (TN), Total Suspended Solids (TSS), Pound (lb), Year (yr)								

Figure 2. Conceptual Design Sketch and Typical Sections



STORMWATER TREE TRENCH



BIORETENTION BASIN

