Sunrise Lake Watershed Management Plan

December 31, 2021

Town of Middleton, NH
in coordination with
Strafford Regional Planning Commission
and the
New Hampshire Department of Environmental Services

This project was funded by a Water Quality Planning Grant from the NH Department of Environmental Services with Clean Water Act with Section 604(b) funds from the U.S. Environmental Protection Agency

Cover Photo: New Hampshire Shores Boat Ramp
Photo Credit: Don Kretchmer

Foreword

Despite what many think, I am not a New Hampshire native. I was born and raised in Tiverton, Rhode Island – a small town located on the eastern shores of Narragansett Bay, adjacent to the Sakonnet River. Upon being accepted by the University of New Hampshire in 2002, I moved north and have spent the last 20 years as a New Hampshire resident.

Growing up, I was incredibly lucky. Most folks in my family either owned a boat or worked on one. My father had a 17’ Boston Whaler; one uncle had a 25’ Parker Sport Cabin; another uncle had a 35’ Duffy and Duffy Downeast sport fishing boat; and another worked on a 94’ offshore lobster boat named the Diamond Girl. To say I spent a lot of time on the water is an understatement – I practically lived on the water and fishing was a huge part of my childhood. Whether we were trolling for stripers along Prudence Island, keeping an eye out for large flocks of diving birds (a strong indicator that large schools of pogies or bluefish were present), or heading out into the Sound to chase bonitos – I have a lot of fond memories of being out in New England’s largest tidal estuary. These experiences have forged a profound appreciation and deep understanding of the necessity to protect our water resources.

When I moved to New Hampshire, I unfortunately lost my access to a boat and was vanquished to a 12’ fiberglass canoe. As a result, I had to surrender my ability to go fishing in saltwater and was forced to learn how to fish in freshwater. Relying on mostly word of mouth from friends who grew up here, I slowly began to explore many of the rivers, lakes, and ponds the region had to offer. The Lamprey and Isinglass rivers for trout; the Bellamy Reservoir, Pawtuckaway Lake, Mendums Pond, and Swains Lake for bass – were some of my early favorites. With time, freshwater became my preferred choice of fishing. It was quiet, calm, and beautiful. My former preconceived notions of murky waters filled with leaches, water-born parasites, and prehistoric-looking snapping turtles ready to remove one of your toes slowly faded, and with it, a new romance emerged.

Given everything I just described, it is easy to understand that when I was given the opportunity to work in collaboration on a project to help address existing water quality problems on Sunrise Lake, I took it. Over the course of my twelve years with the planning commission, I have worked on numerous environmental projects, but never a watershed-based management plan and nothing of this magnitude in Middleton. This was a new and exciting learning experience that I will never forget.

As a planner, I truly believe that these types of efforts can and will make a difference in addressing an existing challenge. I am proud of the work we accomplished and hope this plan can be used to ensure Sunrise Lake remains healthy and resilient and raises awareness on matters affecting the lake.

- Kyle Pimental, Principal Regional Planner, Strafford Regional Planning Commission

Acknowledgements

This project was funded by a Water Quality Planning Grant from the NH Department of Environmental Services with Clean Water Act with Section 604(b) funds from the U.S. Environmental Protection Agency.

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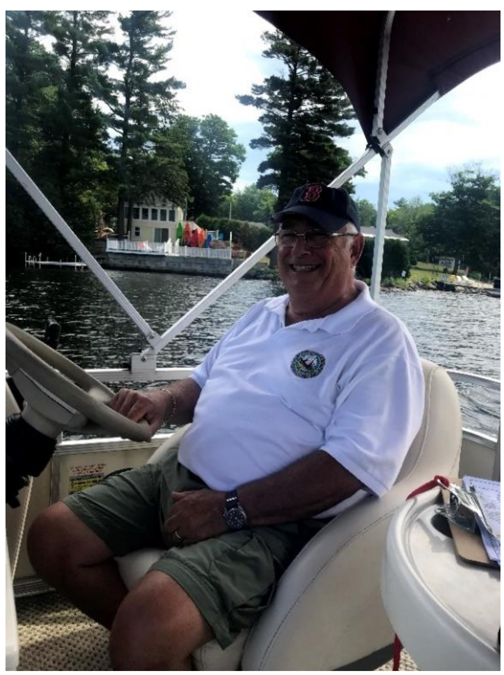
On behalf of the entire project team, I would like to express my deepest appreciation to John Mullen for his local leadership and the countless hours he spent with us answering all our questions.



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Acronyms

Acronym	Definition
ALI	Aquatic Life Integrity
AUID	Assessment Unit Identification
BMPs	Best Management Practices
Chl-a	Chlorophyll-a
CWA	Clean Water Act
DKWRC	DK Water Resource Consulting
FC	Fish consumption
ha	Hectare
kg	Kilogram
LLRM	Lake Loading Response Model
m	Meter
NHDES	New Hampshire Department of Environmental Services
NHFG	New Hampshire Fish and Game Department
HS	Hampshire Shores
NLCD	National Land Cover Database
NPS	Nonpoint Source
NWI	National Wetland Inventory
PCR	Primary Contact Recreation
ppb	Parts per billion
QAPP	Quality Assurance Project Plan
SLE	Sunrise Lake Estates
SLLA	Sunrise Lake Lands Association
SLVD	Sunrise Lake Village District
SRPC	Strafford Regional Planning Commission
SDT	Secchi Disk transparency
SOAK	Soak Up the Rain
TP	Total phosphorus
UNHSC	University of New Hampshire Stormwater Center
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VLAP	Volunteer Lake Assessment Program
WMP	Watershed Management Plan

Incorporating EPAs Nine Elements

The Sunrise Watershed Management Plan includes the nine-element (a-i) criteria[1] to restore waters impaired by nonpoint source pollution. These guidelines, set forth by the U.S. Environmental Protection Agency (EPA), highlight important steps in protecting water quality for waterbodies impacted by human activities, including specific recommendations for guiding future development, and strategies for the reducing the cumulative impacts of NPS pollution on lake water quality.

A. **Identify causes and sources of pollution**: An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this watershed-based plan (and to achieve any other watershed goals identified in the watershed-based plan), as discussed in item (b) immediately below. Sources that need to be controlled should be identified at the significant subcategory level with estimates of the extent to which they are present in the watershed (e.g., X linear miles of eroded stream bank needing remediation).

B. **Estimate pollutant loading into the watershed and the expected load reductions**: An estimate of the load reductions expected for the management measures described under paragraph (c) below (recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time). Estimates should be provided at the same level as in item (a) above (e.g., eroded stream banks).

C. **Describe management measures that will achieve load reductions and targeted critical areas**: A description of the NPS management measures that will need to be implemented to achieve the load reductions estimated under paragraph (b) above (as well as to achieve other watershed goals identified in this watershed-based plan), and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan.

D. **Estimate amounts of technical and financial assistance and the relevant authorities needed to implement the plan**: An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan. As sources of funding, communities should consider the use of their Section 319 programs, State Revolving Funds, USDA's Environmental Quality Incentives Program and Conservation Reserve Program, and other relevant federal, state, local and private funds that may be available to assist in implementing this plan.

E. **Develop an information/education component**: An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented.

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[1] https://www.epa.gov/nps/handbook-developing-watershed-plans-restore-and-protect-our-waters

F. **Develop a project schedule**: A schedule for implementing the NPS management measures identified in this plan that is reasonably expeditious.

G. **Describe the interim, measurable milestones**: A description of interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented.

H. **Identify indicators to measure progress**: A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether this watershed-based plan needs to be revised or, if a NPS TMDL has been established, whether the NPS TMDL needs to be revised.

I. **Develop a monitoring component**: A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h) immediately above.

Table 1: EPA's Nine Elements of Watershed Planning

Element	Plan Section	Element Description
a	5.0	Identify causes and sources of pollution
b	6.0	Estimate pollution load reductions needed for restoration
c	7.0	Identify actions needed to reduce pollution
d	7.0	Estimate costs and authority to implement restoration actions
e	7.0	Implement outreach and education to support restoration
f	8.0	Restoration schedule
g	8.0	Milestones – interim measures to show implementation progress
h	9.0	Success indicators and evaluation – criteria to show restoration success
i	10.0	Monitoring plan

1.0 Introduction

The Sunrise Lake Watershed Management Plan describes water quality conditions, watershed characteristics, and sources of phosphorus loading to Sunrise Lake; plus, identifies actions to improve the lake's water quality. The plan establishes water quality goals, outlines nutrient management approaches, and describes management actions for meeting water quality improvement goals.

The plan summarizes previous studies, water quality data, watershed survey information, and phosphorus loading modeling output. The plan incorporates this information into actions and recommendations for reducing pollutant loading to the lake. The goals of the Sunrise Lake Watershed Management Plan are:

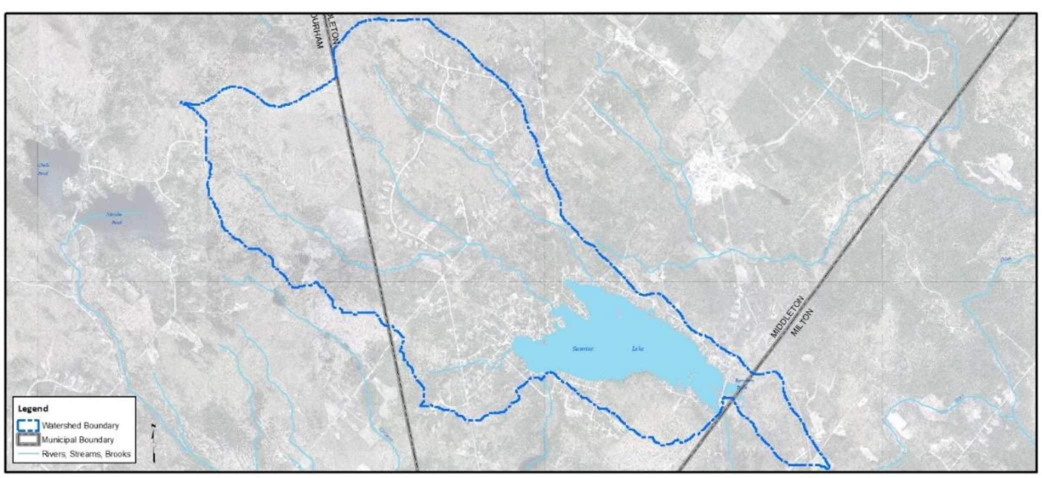
- Identify and quantify sources of phosphorus loading to the lake
- Establish a water quality goal for the lake
- Identify management actions to reduce phosphorus loading

The adaptive management approach described in the plan enables project partners to conduct restoration activities in a responsive manner; however, the plan recognizes that improvements in water quality cannot be achieved with a single restoration action or within an immediate timeframe. Implementation of this pro-active approach ensures that as management activities are conducted, water quality response is monitored, and success is documented.

1.1 Background and Purpose

Located in central New Hampshire, just southeast of Lake Winnipesaukee in the town of Middleton, Sunrise Lake is a relatively shallow, man-made waterbody. The lake is about a mile long by a half mile wide, within a watershed area of roughly 2,100 acres or 850 Hectares (ha) and is a mix of silty, sandy, and rocky bottom types that offers excellent opportunities for boating, fishing, and swimming for residents and visitors to the Sunrise Lake Town Beach. There are also seven association-owned community beaches and several small private beaches along the shores of the lake.

Figure 1. Watershed Area Map



In the late 1970s Sunrise Lake was classified as oligotrophic or nutrient poor. The lake has experienced declines in water quality in recent years and is currently classified as mesotrophic or moderately enriched with nutrients. New Hampshire's Watershed Report Cards from the 2018 305(b) and the 303(d) Assessment Summary Reports give Sunrise Lake a poor grade (not supporting, marginal) for Chlorophyll-*a* (Chl-a) and phosphorus for Aquatic Life Integrity and cyanobacteria hepatotoxic microcystins for Primary Contact Recreation. Sunrise Lake Town Beach received a severe grade (not supporting, severe) for Escherichia coli for Primary Contact Recreation. Because some forms of cyanobacteria are toxic to people as well as animals, the blooms have resulted in advisories to protect the public (NHDES, 2018). Nutrient input, such as phosphorus, to lakes and ponds can fuel algal blooms. The lake is also listed for Primary Contact Recreation (swimming) due to cyanobacteria blooms.

Reducing cyanobacteria blooms and Chl-a concentrations in Sunrise Lake will require reducing the amount of phosphorus entering the lake from septic systems, stormwater runoff, erosion, and other sources. It is widely understood among lake managers that phosphorus is usually the most important nutrient determining the growth of algae and aquatic plants. Because phosphorus is typically less abundant than nitrogen, it is considered the "limiting nutrient" for biological productivity. Therefore, increased phosphorus levels tend to be strongly correlated with decreased water clarity, increased algae, and other indicators of declining water quality.

This watershed planning project explores connections between identified impairments in the lake and other signs of stress in the lake and its tributaries. The outcome of this project is the development of a watershed-based restoration plan that defines a realistic goal for lake restoration – including reducing pollutant loads and removing Sunrise Lake from the NHDES 303(d) for Primary Contact Recreation Use and Aquatic Life Integrity.

1.2 Goal Statement

The Sunrise Lake Watershed Management Plan describes the water quality conditions, watershed characteristics, and sources of phosphorus to the lake. Additionally, this WMP provides short and long-term goals for improving the water quality of Sunrise Lake over the next 10 years (2021-2031). The long-term goal is to improve the water quality and prevent the future occurrence of toxic cyanobacteria blooms. **Success would mean reducing the amount of phosphorus entering the lake by 20 percent**. This goal can be achieved by implementing the following strategies:

- Structural Strategies
- Non-Structural Strategies
- Septic System Strategies
- Regulatory Strategies

These objectives are discussed in greater detail in the action plan.

1.3 Plan Development Process

This plan was developed through the collaborative efforts of numerous project management team meetings and conference calls between Strafford Regional Planning Commission (SRPC), Geosyntec Consultants (Geosyntec), DK Water Resource Consulting LLC (DKWRC), the UNH Stormwater Center (UNHSC), and the New Hampshire Department of Environmental Services (NHDES), hereunto referred to as the project management team.

1.3.1 Public Engagement

The project management team offered several opportunities for public engagement, including:

- A kickoff meeting, which held on January 19, 2021, provided attendees with a brief project overview and work done to date including goals for improving the lake's water quality, what the NHDES Water Quality Planning Grant encapsulates, the request for qualification process SRPC conducted, and introduction of the selected consultant team (Geosyntec Team). The Geosyntec Team presented a summary of literature/data review results, planned additional evaluations, and potential solutions. After which, a discussion ensued on possible avenues to communicate with residents, possible areas of concern around the lake for runoff and contamination, and details of a septic system assessment.

- The NHDES Soak Up the Rain (SOAK) educational program presented to sixteen interested residents on June 5, 2021, at the Sunrise Lake Lands Association's beach on Lakeshore Drive. Staff from NHDES provided attendees with an overview of the watershed management process and how they could get involved with a simple do-it-yourself stormwater project. The workshop included information about how to identify runoff problems, why it's important to manage stormwater runoff to protect water quality, and discussed strategies for managing runoff such as raingardens, infiltration trenches, and more.

- A final presentation, which comprised of a two-hour virtual workshop hosted by the project management team to provide project overview, summary of finding, management actions and recommendation, and next steps, was held on January 5, 2022. Municipal boards and commissions, as well as staff were invited to participate. This included members of the Board of Selectmen, Planning Board, Conservation Commission, the Road Agent, and Code Enforcement Officer/Health Officer. In addition, an invitation was extended to all the homeowner association presidents and property owners along the lake.

1.3.2 Septic System Survey

A septic survey was developed and distributed to all properties (over 210 properties) located within 250 feet of Sunrise Lake. Promotion methods included posting the survey on Middleton's website, sending individualized letters to homeowners, Facebook reminders to members of several lake homeowner's associations, and direct door-to-door outreach. This led to a final response rate of 27.4% (57 total responses).

Results of the septic survey indicate:

- Most respondents rated perception of lake water quality neutral or above
- Most septic systems were reported to be > 15 years old
- > 70% of respondents pump system at least every 5 years
- > 80% of respondents either do not have a lawn or don't use fertilizer
- There appears to be misconceptions surrounding ways to keep the lake clean and what is contributing to appearance or odor; however, respondents are interested

1.3.3 Ongoing Watershed Efforts

Various entities, including several of the lake homeowners' associations, local citizens, regional/state agencies, among others, have participated in watershed efforts, including:

- **NHDES Volunteer Lake Assessment Program (VLAP)**: Sunrise Lake has participated in the VLAP since 1997. Other Sunrise Lake water quality monitoring stations have been sampled periodically. Data for VLAP parameters include total phosphorus (TP), chlorophyll-a (Chl-a), pH, dissolved oxygen, and temperature. VLAP data is accessible through the NHDES Environmental Monitoring Database. More information can be found in Section 4.0.

- **Milfoil Mitigation**: Over the course of the last five years, the lake has experienced issues with invasive plants including variable milfoil. However, aggressive mitigation efforts have brought that under control. The milfoil infestation began in earnest in 2012 where the Town removed 950 gallons of the invasive plant through hand removal and diver-assisted suction harvesting. In 2016 only 330 gallons was harvested. In 2017 Middleton continued the Milfoil Management Control Plant, which included eight DASH (diver assisted suction harvest) treatments beginning in August and concluding in October. The harvest removed 1,080 gallons of variable milfoil. This was prior to the 2019 application of ProcellaCOR, a milfoil herbicide, which has drastically reduced milfoil in the lake. More information can be found in Section 2.4.

- **Additional Outreach through the Sunrise Lake Chronicle**: The Sunrise Lake Chronicle is a quarterly newsletter created by local resident John Mullen that provides updates and happenings around the lake. To date, there have been two issues – one in the spring and one in the summer of 2021. At the time of this plan development, a winter edition 2021/2022 is nearly ready for publication. The Chronicle is distributed to lakefront property owners and made available to the public through social media and posting to the Town's website. Hard copies are also available at the Town Hall. This may include information on cyanobacteria blooms, milfoil mitigation, the Chinese Mystery Snails, lake volunteer opportunities, and nesting loons.

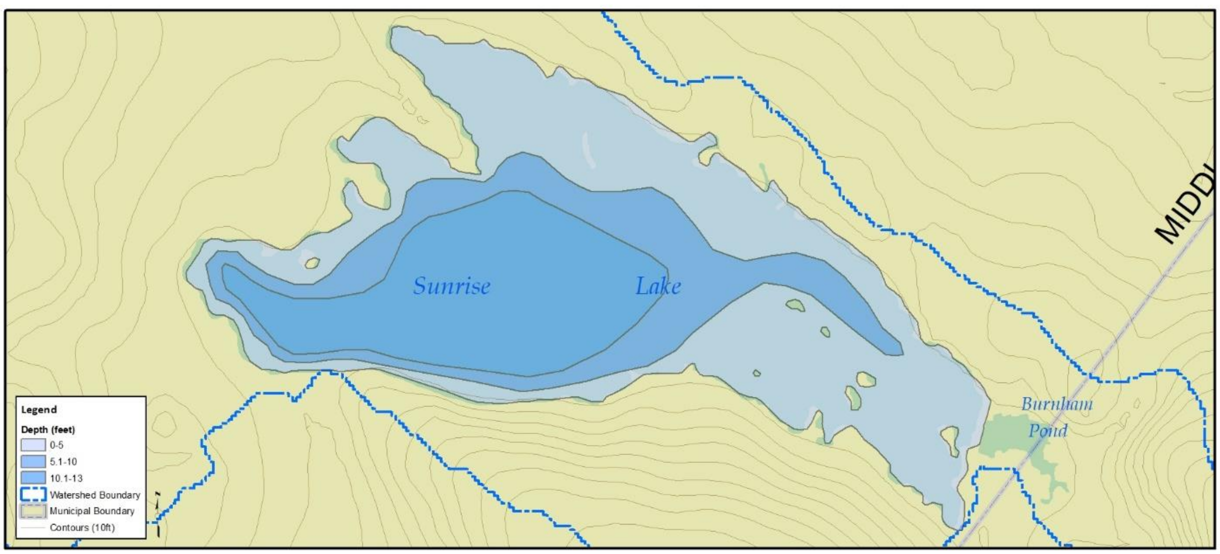
2.0 Characteristics of Sunrise Lake

Sunrise Lake is in the Cocheco River Basin within the town of Middleton New Hampshire. The dammed, 100- ha (247 acre) lake has a maximum depth of 4.1 meter (m) (13.5 feet (ft)) and a mean depth of 1.9 m (6.2 ft) (Figure 2). The lake volume is 1,966,000 cubic meters with a flushing rate of approximately 3.2 times per year. The watershed is 8.3 times the lake area making Sunrise Lake moderately susceptible to excessive nutrient loading from activities in the watershed. The larger the watershed area relative to lake area, the more likely that watershed runoff is the driver of in-lake water quality. The smaller the ratio of watershed area to lake area, the more likely that in-lake processes drive water quality. Selected characteristics of Sunrise Lake relevant to the Lake Loading Response Model (LLRM) effort are presented in Table 2.

Table 2: Characteristics of Sunrise Lake, Middleton, NH

Parameter	Value
Lake Area (ha)	100
Lake Volume (m^3)	1,966,000
Watershed Area (ha)	826
Watershed/Lake Area	8.3
Mean Depth (m)	1.9
Max Depth (m)	4.1
Flushing Rate (yr^{-1})	3.2
Hypolimnetic Anoxia	No

Figure 2. Bathymetric Map of Sunrise Lake



2.1 Sunrise Lake Dam

Originally built in 1877, the Sunrise Lake Dam, now owned and operated by the Sunrise Lake Village District (SLVD), created the 247-acre lake. Established in 1980, the SLVD was the first village district created in

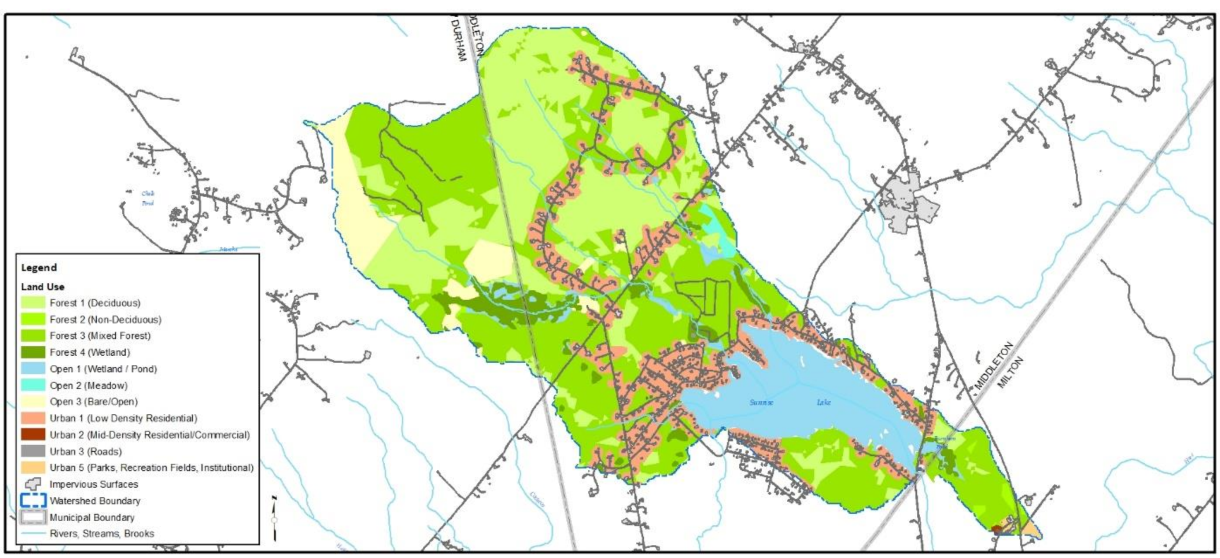
New Hampshire under RSA 52, which allowed the formation of village districts for the purpose of impounding water and were tasked with the dam reconstruction. A dam repair was conducted to complete major renovations to the earth berm in late 2008 and concluded in 2009. The lake was fully drained in late 2008 and began re-filling in July 2009, which accounts for why there is no VLAP data for 2009; fish were restocked via approval of Fish and Game.

2.2 Land Use

Middleton is geographically small with limited development. Most of the developed land is of residential nature, with only a scattering of commercial and public uses. The residential uses are predominantly single-family detached homes, many of which surround Sunrise Lake. The pattern of development is dispersed requiring driving to get around, except perhaps for the relatively few people living near the Town Center (Middleton Corners) or around Sunrise Lake.

Approximately 62 percent of the Sunrise Lake watershed is forest. Sixteen percent is residential development (mostly single-family homes), and 11 percent is open water. Wetlands make up 4 percent of the watershed, and the remaining 7 percent comprises disturbed land, road rights of way, auxiliary transportation, and brush or transitional land (see Figure 3). Most of the 350 acres of residential development is along the lake shore. There are several densely developed neighborhoods around the lake, including Sunrise Lake Estates (SLE), Hampshire Shores (HS), and Sunrise Lake Lands Association (SLLA); upgraded homes; and camps. According to a NHDES 2008 report, the 138 houses on the lake shore are a mix of seasonal and year-round dwellings. There are also 452 back lots that have access rights to the lake. Wastewater for residential homes in the watershed is treated by individual septic systems. As more land in the watershed is converted from forest to residential use, the rate at which nonpoint source (NPS) pollutants reach the lake and likely cause water quality impairments will accelerate.

Figure 3. Land Use Map of Sunrise Lake



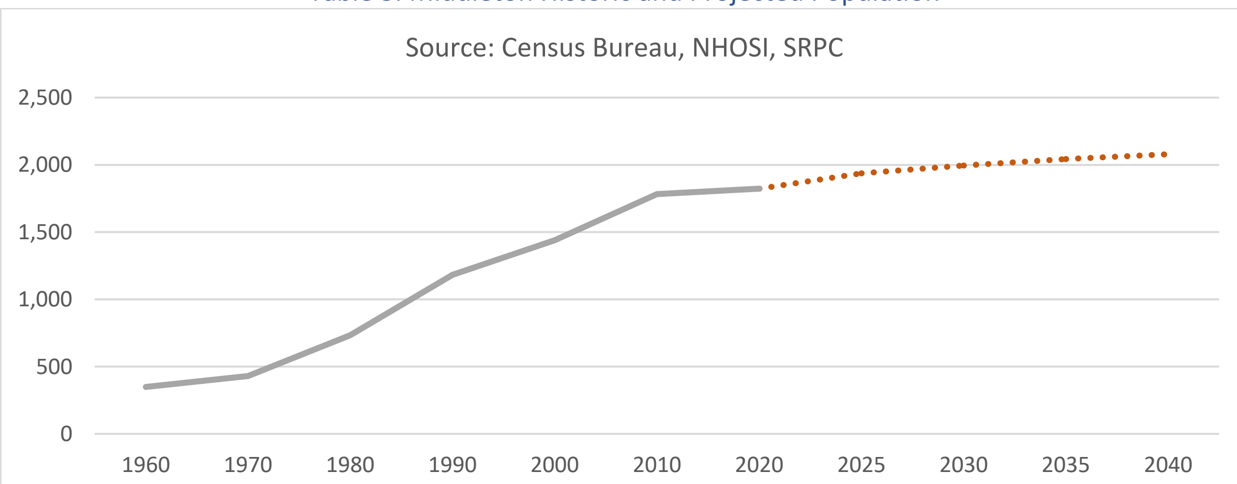
2.3 Population and Growth Trends

According to data from the U.S. Census Bureau, Middleton has an estimated population of 1,823 – making it the least populated municipality in Strafford County, and the second least populated municipality in the Strafford Planning Region, trailing only Brookfield (Carroll County). Despite its relatively low overall population, the Town has witnessed substantial population growth over the past fifty years, which is projected to continue, albeit not at the same rate.

2.3.1 Historic Population Trends

Historically, Middleton underwent significant population growth beginning in the 1970s and continued through 2010. Over the past decade, population growth rate has slowed; however, Middleton's population has experienced roughly a 21 percent increase in total population since 2000 (383 people). This change is considerably higher than that of Strafford County, one of the fastest growing areas of the state, which saw a 14 percent increase in population over the same 20-year time.

Table 3. Middleton Historic and Projected Population



2.3.2 Projected Population Change

National population projections by the Census Bureau suggest that the United States will reach a population of approximately 380 million by 2040 (an 18% overall population growth). Although the Strafford Planning Region is not expected to grow on pace with the national rate, it is expected to grow by close to 10%, a somewhat higher rate than projected for the state of New Hampshire (7.2%). Population projections completed by the New Hampshire Office of Strategic Initiatives and the state's Regional Planning Commissions, suggest that Middleton can expect an overall growth in population of 12.3 percent (approximately 3.1% per decade) in the 20-year period between 2020 and 2040.

2.4 Surficial Geology and Soils

A watershed's surficial geology plays an important role in the erosive potential of soils and soil infiltration capacity which is an important factor in subsurface phosphorus transport and attenuation potential. The surficial geology in the Sunrise Lake watershed consists mainly of alluvial material deposited 12,000 years ago at the end of the Great Ice Age. This material is characterized by unconsolidated materials, typically stony material, fine loams, and sand with moderate to high infiltration capacity. Soils of the Sunrise Lake watershed consist of rocky, sandy, and fine loams dominated by soil types such as Gloucester, Hollis, and Leicester (USDA, 1977). These soils are mostly well drained. Slopes in the watershed vary from zero percent to 25 percent with many slopes around eight percent. Steep slopes dominate the western portion of the watershed including 1,300-foot Birch Ridge which forms a watershed divide where several tributaries to the lake originate.

2.5 Watershed Habitat

The New Hampshire Wildlife Action Plan (NHFGD, 2015) indicates that the watershed contains lands considered to include habitat that is supportive of diverse species (NHFGD, 2020). A small corridor of highly ranked habitat connects to the lake's southeastern shore where the headwaters of Dame's Brook form. Mammals, reptiles, birds, insects, and fish benefit from the watershed's rich natural habitats including forested lands, wetlands, and open water.

Forest types in the watershed include hemlock-hardwood-pine forest in the south, and Appalachian oak-pine in the northern and western sections. Tree species for these forest types include white pine, Eastern hemlock, maples, and oaks. The lake's shoreline contains a diversity of native shrubs typical for New Hampshire lakes including button bush, high bush blueberry, and sweet pepperbush. Aquatic plants include scattered populations of vegetation such as sedges, water lilies, pickerel weed, and several types of rushes (NHDES, 1990).

Endangered species in the watershed include the Common Loon and spotted turtle. Anecdotal reports from lakeshore residents indicate that Common Loons have nested and raised young on the lake for many years. The lake is classified as a warmwater fishery (NHFGD, ret. 2021). Observed fish species in the lake include largemouth bass, smallmouth bass, brown bullhead, yellow perch, chain pickerel, and sunfish.

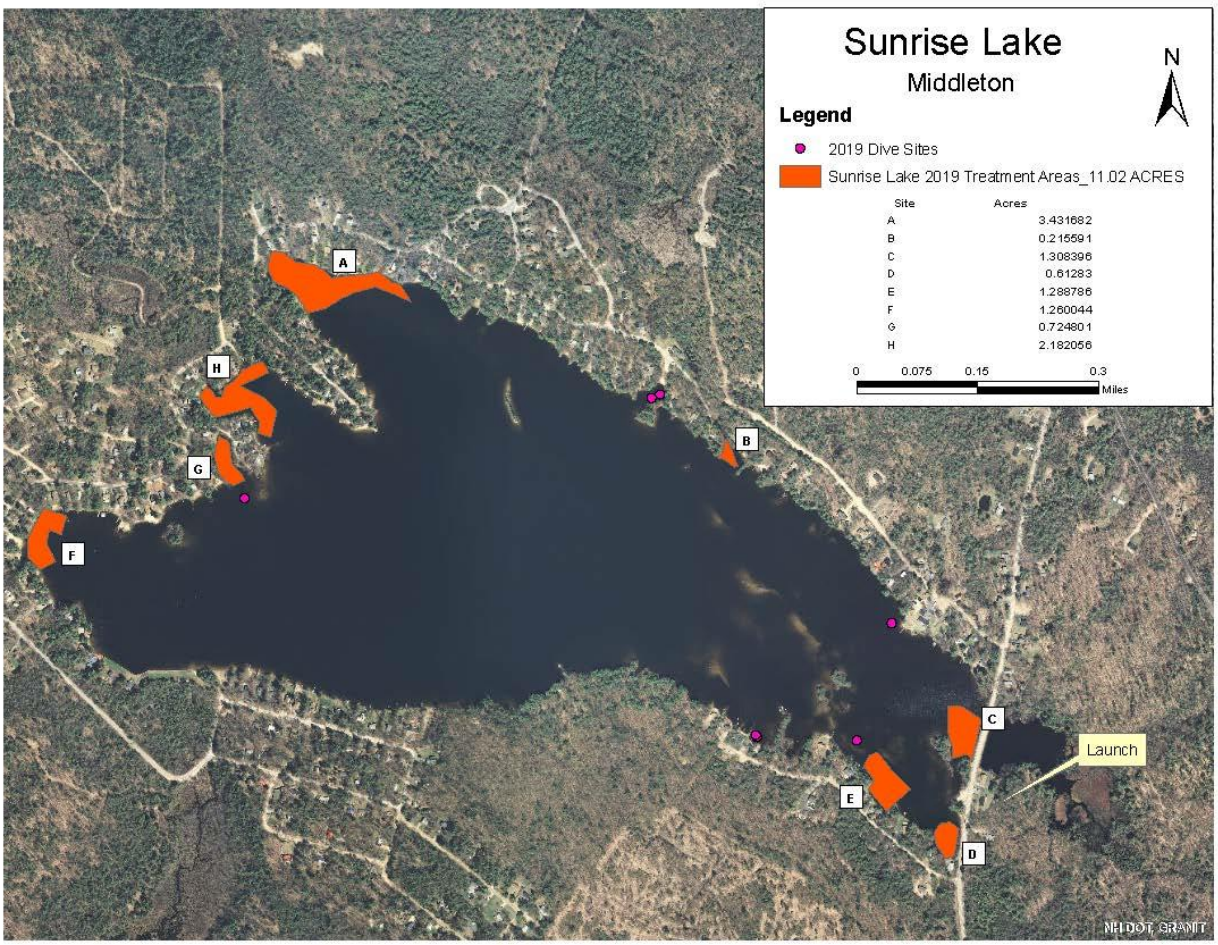
2.6 Invasive Aquatic Vegetation

Over the course of the last five years, the lake has experienced issues with the invasive plant, variable milfoil, and aggressive mitigation has brought that under control. The milfoil infestation began in earnest in 2012 where the Town removed 950 gallons of the invasive plant through hand removal and diver-assisted suction harvesting. In 2016 only 330 gallons was harvested. The cost for the treatment amounted to a total $6,100 less $1,830 in state grants equaling a net cost to the town of $4575. The town's portion came from the Milfoil Capital Reserve. An additional donation of $250 was made by the Hampshire Shores Association. Also, $500 was donated by Bruce Hart of Pinkham Road. In 2017 Middleton continued the Milfoil Management Control Plant, which included eight DASH (diver assisted suction harvest) treatments beginning in August and concluding in October. The harvest removed 1,080 gallons of variable milfoil. This was prior to the 2019 application of ProcellaCOR, a milfoil herbicide, which has drastically reduced milfoil in the lake. See Figure 4 for a map of the treatment areas.

In May 2020, NHDES conducted a follow up site visit to the lake and reported no infestation. However, with the input from lake residents and a reexamination of the waters, small amounts of variable milfoil were reported at Sunrise Lake Land Association Beach, Warrens Cove and Pinkham Cove. Thanks to the generosity of the taxpayers of Middleton, the Hampshire Shores Association, and a resident on the Town's Milfoil Capital Reserve Fund, there has been sufficient funds to cover the cost for a team of Diver Assisted Suction Harvesting (DASH) and/or individual divers to mitigate the variable milfoil in the 2020 identified areas.

In June 2021, the lake was surveyed for the presence of variable milfoil. Only a small amount was identified in Pinkham Cove. Divers pulled and removed six gallons, which is real progress.

Figure 4. Sunrise Lake 2019 ProcellaCOR Treatment Areas



2.7 Algae and Cyanobacteria

Algae range in size from microscopic to larger algal masses that often appear to be plants when floating on or near the surface. There are both attached forms (filamentous and periphyton) and free-floating forms (phytoplankton). Cyanobacteria can be either free floating or attached. Evidence of impairment has been documented in the NHDES 305(b) and 303(d) Water Quality Reports for 2016 and in the annual reports of the Sunrise Lake Volunteer Lake Assessment Program (VLAP). In August 2018, NHDES issued a cyanobacteria warning for Sunrise Lake and advised lake users to avoid contact with the water in areas experiencing elevated levels of cyanobacteria (blue-green algae).

Cyanobacteria, which have characteristics of both plants and bacteria, have been around for a long time – in fact 3.5 billion years. This group of organisms represented by hundreds of species are found in nearly every waterbody in the world. Under certain conditions within a water body cyanobacteria will rapidly multiply to form what is characterized as a bloom. Factors such as temperature, water chemistry and weather all contribute to a bloom. In addition, stormwater runoff, excess phosphorus loading from natural and manmade sources such as septic systems and agricultural products can also cause a bloom. Cyanobacteria can be very toxic to animals and humans and should be avoided.

New Hampshire has always been aware and watchful of these organisms but in the past few years, the State has increased its capacity to identify, respond to, and manage harmful algal blooms. The State now has a special unit that does only cyanobacteria testing and has put together a team to specifically address these organisms. This new program is called the CyanoHAB Response Protocol for Public Waters. It has a dedicated web page that fully explains what cyanobacteria is and what is being to address it. Sunrise Lake began testing specially for cyanobacteria in its water testing program in 2017. Blooms were reported in Sunrise Lake in 2016 and 2018 and the areas of the blooms were posted. In both instances, the blooms dissipated shortly.

3.0 Assessment of Water Quality

This section provides an overview of New Hampshire's water quality standards and criteria that apply to Sunrise Lake, the methodologies used by NHDES to assess water quality, and a summary of water quality conditions for parameters of concern. The State's assessment process and water quality parameters of concern for Sunrise Lake – total phosphorus (TP), chlorophyll-a, and cyanobacteria – provide a foundation for the watershed management plan's water quality goal and for the success indicators which serve as targets for measuring water quality improvement as management actions are implemented.

3.1 Applicable Water Quality Standards and Criteria

To set the context for the water quality goals and success indicators presented in this watershed management plan, a review of the State's water quality standards is presented below. This information has been applied to the water quality goal setting process for the lake.

The NHDES is required to follow federal regulations under the US EPA's Clean Water Act (CWA) with some flexibility as to how those regulations are enacted. The Federal CWA, the NH RSA 485-A Water Pollution and Waste Control Statute, and the NH Surface Water Quality Regulations (Env-Wq 1700) form the regulatory basis for governing water quality protection in New Hampshire. These regulations also serve as the basis for New Hampshire's regulatory and permitting programs related to surface waters. Under the CWA, states are required to establish water quality standards and submit biennial water quality status reports to Congress via the US EPA. These reports provide an inventory of all waters assessed by the state and indicate which waterbodies exceed or meet the state's water quality standards. These reports are commonly referred to as the "Section 305 (b) Report" and the "Section 303(d) Surface Water Quality List" respectively.

New Hampshire's water quality standards are composed of three parts: designated uses, water quality criteria, and antidegradation. The standards provide a baseline measure of the quality that surface waters must meet to support designated uses. The standards are the "yardstick" for identifying water quality problems and for determining effectiveness of pollution control and prevention programs. The CWA requires states to determine designated uses for all surface waters within the state's jurisdiction. Designated uses are the desirable activities and services that surface waters should be able to support, including Aquatic Life Integrity, Fish Consumption, Shellfish Consumption, Drinking Water Supply, Primary Contact Recreation (swimming), Secondary Contact Recreation (boating and fishing), and Wildlife (Table 4). Surface waters typically have multiple designated uses. States utilize water quality criteria to assess whether waterbodies are meet the water quality standards and designated uses.

The water quality criteria are designed to protect the designated uses of New Hampshire surface waters. If the existing water quality meets or is better than the water quality criteria, the waterbody supports its designated use(s). If the waterbody does not meet water quality criteria, then it is considered impaired for its designated use(s). Water quality criteria for each classification and designated use in New Hampshire can be found in RSA 485 A:8, IV and in the state's surface water quality regulations (NHDES, 2018b). The third and final component is antidegradation, which are provisions designed to preserve and protect the existing beneficial uses and to minimize degradation of the State's surface waters (Env-Wq 1700).

Table 4: Designated Uses

Designated Use	NHDES Definition	Applicable Surface Water
Aquatic Life Use	Waters that provide suitable chemical and physical conditions for supporting a balanced, integrated, and adaptive community of aquatic organisms	All surface waters
Fish Consumption	Waters that support fish free of contamination at levels that pose a human health risk to consumers.	All surface waters
Shellfish Consumption	Waters that support a population of shellfish free from toxicants and pathogens that could pose a human health risk to consumers.	All tidal surface waters
Drinking Water Supply After Treatment	Waters that with adequate treatment will be suitable for human intake and meet state/federal drinking water regulations.	All surface waters
Primary Contact Recreation	Waters suitable for recreational uses that require or are likely to result in full body contact and/or incidental ingestion of water.	All surface waters
Secondary Contact Recreation	Waters that support recreational uses that involve minor contact with the water.	All surface waters
Wildlife	Waters that provide suitable physical and chemical conditions in the water and the riparian corridor to support wildlife as well as aquatic life.	All surface waters

[Source: Adapted from the 2018 New Hampshire Consolidated Assessment and Listing Methodology]

An impaired waterbody is defined as a waterbody that does not meet the water quality criteria for its designated use. The criteria might be numeric and specify concentration, duration, and recurrence intervals for various parameters, or they might be narrative and describe required conditions such as the absence of scum, sludge, odors, or toxic substances. If the waterbody is impaired, the state will place it on the section 303(d) list (NHDES, 2019b).

According to the 2020 303(d) list of impaired or threatened waters, Sunrise Lake is listed as impaired for Aquatic Life Integrity (formerly known as Aquatic Life Use) due to low pH levels, non-native aquatic plans (milfoil), Chl-*a*, and TP. The lake is also impaired for Fish Consumption due to elevated mercury and for Primary Contact Recreation due to recurring cyanobacteria blooms (Figure 5). Additionally, the Sunrise Lake Town Beach is on the state's 303(d) list for E. coli. Because the goal of this watershed management plan is to control nutrient loading to reduce the frequency of cyanobacteria blooms, this watershed plan will focus on impairments related to TP (the nutrient that feeds cyanobacteria), chlorophyll-*a* (the response indicator for nutrient loading), and cyanobacteria. While other impairments are of concern, they are not the focus of this watershed management plan.

Figure 5. Sunrise Lake Water Quality Assessment Summary

Assessment Unit ID: NHLAK600030601-05-01
Assessment Unit Name: Sunrise Lake
Town(s) Primary Town is Listed First: Middleton

Size: 246.3080 ACRES
Assessment Unit Category: 5-M
Beach: N

Draft 2020, 305(b)/303(d) - All Reviewed Parameters by Assessment Unit

Designated Use Description	Desig. Use Category	Parameter Name	Parameter Threatened (Y/N)	Last Sample	Last Exceed	Parameter Category	TMDL Priority
Aquatic Life Integrity	5-M	ALKALINITY, CARBONATE AS CACO3	N	2007	2007	3-ND	
		CHLORIDE	N	2019	N/A	3-PAS	
		CHLOROPHYLL-A	N	2019	NLV	5-M	LOW
		DISSOLVED OXYGEN SATURATION	N	2019	2001	3-PAS	
		Non-Native Aquatic Plants	N			4C-M	
		OXYGEN, DISSOLVED	N	2019	2001	3-PAS	
		PH	N	2019	2016	4A-M	
		PHOSPHORUS (TOTAL)	N	2019	NLV	5-M	LOW
		TURBIDITY	N	2019	N/A	3-PAS	
Fish Consumption	4A-M	MERCURY - FISH CONSUMPTION ADVISORY	N			4A-M	
Potential Drinking Water Supply	2-G	2,4-D	N	2008	N/A	3-ND	
		ESCHERICHIA COLI	N	2019	2019	3-PNS	
		SULFATES	N	1991	N/A	3-ND	
Primary Contact Recreation	5-M	CHLOROPHYLL-A	N	2019	N/A	2-G	
		Cyanobacteria hepatotoxic microcystins		2019	2018	5-M	LOW
		ESCHERICHIA COLI	N	2019	N/A	2-G	

Good	Marginal	Likely Good	No Current Data	Likely Bad	Poor	Severe
Meets water quality standards/thresholds by a relatively large margin.	Meets water quality standards/thresholds but only marginally.	Limited data available. The data that is available suggests that the parameter is Potentially Attaining Standards (PAS)	Insufficient information to make an assessment decision.	Limited data available The data that is available suggests that the parameter is Potentially Not Supporting (PNS) water quality standards.	Not meeting water quality standards/thresholds. The impairment is marginal.	Not meeting water quality standards/thresholds The impairment is more severe and causes poor water quality.

The focus of this watershed planning project is to reduce the frequency of cyanobacteria blooms such that the lake supports the Primary Contact Recreation (PCR) designated use. To reduce the frequency of cyanobacteria blooms, the watershed management approaches outlined in this plan will address parameters that accelerate cyanobacteria blooms in the lake, such as TP, or are indicators of conditions that could affect blooms such as chlorophyll-*a*.

3.2 Role of Trophic Status in Water Quality Assessment

From 1974 to 2010, and from 2013 to 2019, NHDES conducted trophic surveys on waterbodies across the state to determine trophic status. Trophic status is a classification system that categorizes the degree of eutrophication of a waterbody as either oligotrophic, mesotrophic, or eutrophic depending upon their varying levels of productivity, clarity, macrophyte densities, hypolimnetic oxygen concentrations, and other diagnostic parameters and indicators. Generally, oligotrophic waterbodies are less productive or have less nutrients, and are known for having clear water, few macrophytes, high dissolved oxygen levels, and low levels of TP and Chl-*a*. Eutrophic lakes are highly productive and have more nutrients, turbid water, low dissolved oxygen levels, and many macrophytes. Mesotrophic lakes are in-between or in transition between oligotrophic and eutrophic conditions. NHDES assesses waterbody trophic status by evaluating water transparency, chlorophyll-*a* levels, macrophyte density, and dissolved oxygen concentration.

Sunrise Lake has been assessed twice times under NHDES's trophic survey program, in 1977 and 1990. It was determined to be oligotrophic in 1977, but transitioned to mesotrophic in the 1990 survey due to the presence of additional rooted plants and algae, and slightly less water clarity.

Water quality assessments in New Hampshire are based on the highest trophic status reported for a lake; therefore, when NHDES conducts assessments, Sunrise Lake is considered an oligotrophic waterbody. For the parameters of concern for this project, TP and chlorophyll-*a*, in-lake water quality concentrations and water quality goals should be consistent with the state's thresholds for oligotrophic waterbodies (Table 5).

Table 5: Nutrient Criteria by Trophic Class in New Hampshire

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

3.3 Designated Use of Concern: Primary Contact Recreation (PCR)

The definition of the PCR use is "Waters suitable for recreational uses that require or are likely to result in full body contact and/or incidental ingestion of water." This use applies to all surface waters in the state. The narrative criteria for PCR can be found in Env-Wq 1703.03, 'General Water Quality Criteria' and reads, "All surface waters shall be free from substances in kind or quantity that: a) settle to form harmful benthic deposits; b) float as foam, debris, scum or other visible substances; c) produce odor, color, taste or turbidity that is not naturally occurring and would render the surface water unsuitable for its designated uses; d) result in the dominance of nuisance species; e) interfere with recreation activities."

Cyanobacteria scums interfere with aesthetic enjoyment, swimming, and may pose a health hazard to humans and animals. Sunrise Lake was listed as impaired for PCR due to cyanobacteria blooms in 2018 and has remained impaired in subsequent 303(d) listings. A summary of NHDES-issued cyanobacteria warnings is provided below.

Table 6: Cyanobacteria Warnings Issued for Sunrise Lake

Date Issued	Dominant Taxa	Total Cell Conc (cells/ml)	Days
5/27/2016	Anabaena	2,5000,000	6
8/8/2018	Oscillatoria/Planktothrix	>70,000	14

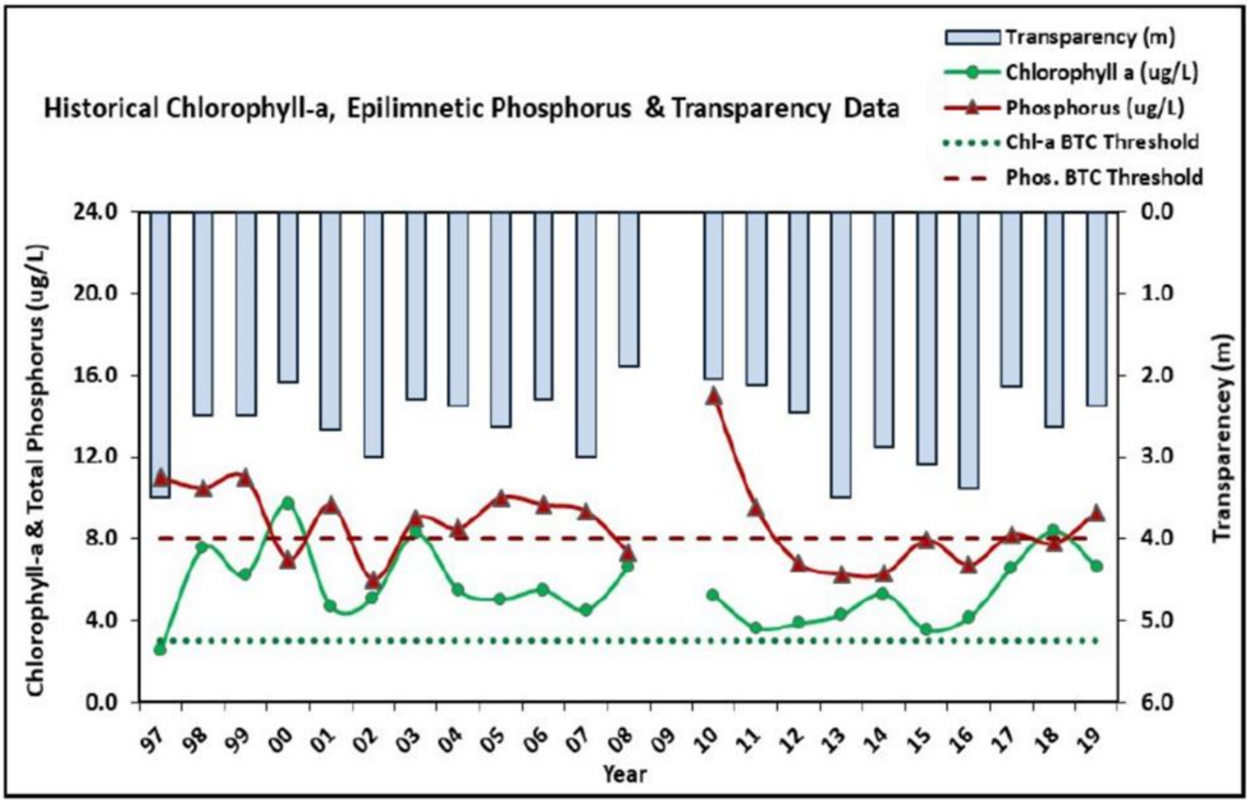
3.3.1 Water Quality Standards and Criteria Summary for Sunrise Lake

In summary, the 2020 305(b)/303(d) Surface Water Quality Report found that designated uses Aquatic Life Integrity, Fish Consumption, and Primary Contact Recreation were of concern; however, the focus of this watershed plan is on water quality parameters and activities that will reduce the frequency and intensity of cyanobacteria blooms including TP and Chl-*a*, a response indicator for nutrient loading.

4.0 Water Quality Summary (Element A)

Water quality data have been collected regularly in Sunrise Lake 1977 primarily as a part of the NHDES Trophic Surveys and Volunteer Lake Assessment Program (VLAP) (NHDES 2019). In the 1977 NHDES trophic survey, Sunrise Lake was classified as oligotrophic. The 1990 survey classifies Sunrise Lake as mesotrophic. Current VLAP reports support current classification as mesotrophic. Data relevant to this plan are summarized in Figure 6.

Figure 6. Water Quality Data from the NH Volunteer Lake Assessment Program (VLAP).



According to VLAP data, the water quality has remained pretty much the same over the past several years. The major change has been the documentation of cyanobacteria since the start of cyanobacteria testing in 2016. Since that time, the lake has only had two (2) cyanobacteria blooms reported and posted. There have been no closures due to e-coli.

In August 2019, a meeting was held at the Old Town Hall asking for help in monitoring the lake and its condition throughout the year. The meeting was well attended, and ten people signed up to offer their help. Unfortunately, that volunteerism was put on hold because of the COVID-19 pandemic and no data was collected during the 2020 season.

In July 2021, the VLAP assessment of the water of Sunrise Lake was conducted. Conducting the testing and providing equipment for NHDES was internist Megan Wimsatt. Accompanying the team was a local young man working on his boy scout Conservation badge. About two hours was spent on the lake taking various samples of the lakes water. Samples were collected and taken back to the NHDES lab for processing. As of August 2021, results have been posted to the Conservation Commission page. These reports are important to show the trends in our water quality.

Due to the shallow depth of Sunrise Lake, thermal stratification does not occur in the summer nor is there documented oxygen depletion (anoxia) near the lake bottom. Anoxic conditions in proximity to lake sediments can lead to release of TP (primarily iron-bound) from the sediments to the water column. This is generally referred to as internal loading and does not appear to be an issue in Sunrise Lake at present.

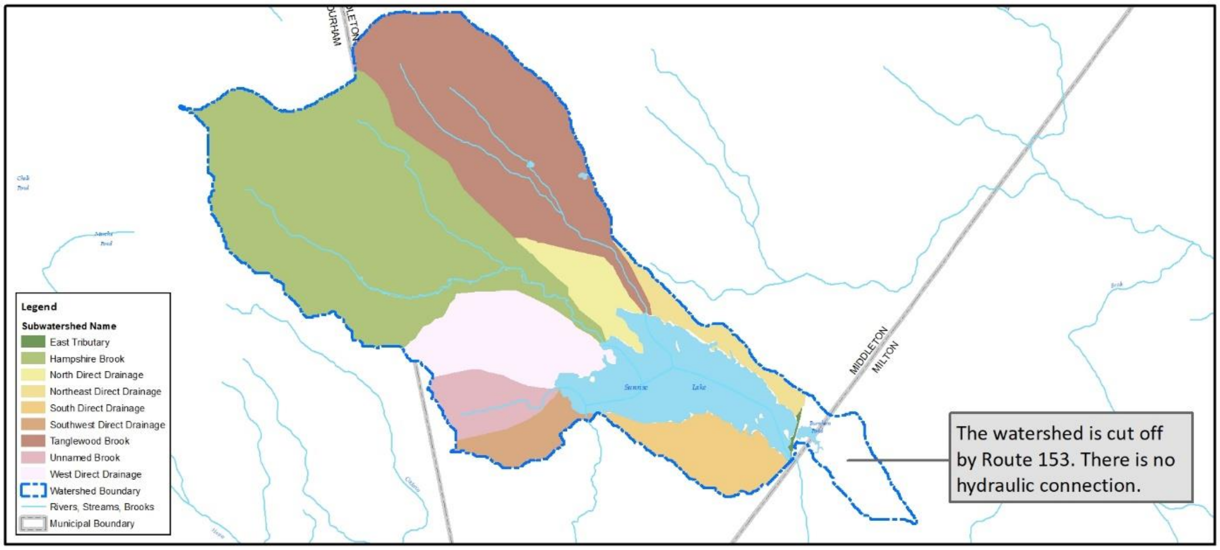
The means of water quality parameters for the past 10 years are summarized in Table 7. This period is considered representative of current conditions and is used as a target for calibration of the water quality model. TP concentrations are just above the threshold for oligotrophic lakes in NH (0.008 mg/l). Similarly, both Chl-a and Secchi transparency do not meet the oligotrophic criteria and support a mesotrophic classification.

Table 7: Sunrise Lake Water Quality Summary 2010-2019 Mean Values

	Epilimnetic TP *mg/l (N)*	Chlorophyll-*a* µg/l (N)	Secchi Transparency *m (N)*
Oligotrophic criteria	<0.008	<3.3	>4
Sunrise Deep Spot Epilimnion	0.009(19)	4.9 (13)	2.9 (19)
Bartlett Cove	0.008(3)		
Pinkham Cover	0.009(6)		
Tanglewood Brook	0.015(8)		
Hampshire Brook	0.010(2)		
N = Number of samples			

Water quality samples have also been collected from the primary tributaries to Sunrise Lake and several coves within the lake's sub-watersheds (Figure 7). Total Phosphorus concentrations are moderate to low in the tributaries and similar to in-lake concentrations in the outlet. However, the samples were all collected during the summer season when flows are expected to be low and vegetation and wetlands throughout the watershed would be expected to absorb TP. It is likely that substantial loading to the lake occurs during periods of vegetative die-back in the fall and runoff from snowmelt and spring rains. Additional seasonal data collection would help to fully understand the sources and timing of TP loading to Sunrise Lake.

Figure 7. Sub-watersheds of Sunrise Lake



4.1 LLRM Model of Sunrise Lake and Watershed Conditions

Current water and TP loading to Sunrise Lake was assessed using the Lake Loading Response Model (LLRM) methodology (AECOM 2009), which is a land cover export/lake response model developed for use in New England and modified for New Hampshire lakes by incorporating New Hampshire land cover TP export coefficients when available. The updated model was calibrated to current conditions using data from 2010 through 2019. The direct and indirect sources of water and pollutant loading to Sunrise Lake in this analysis include:

- Atmospheric deposition (direct precipitation to the lake)
- Surface water base flow (dry weather tributary flows, including any groundwater seepage into streams from groundwater)
- Stormwater runoff (runoff draining to tributaries or directly to the lake)
- Waterfowl (direct input from resident and migrating birds)
- Direct groundwater seepage including septic system inputs from nearby residences

4.1.3 Hydrologic Inputs and Water Loading

Calculating TP loads to Sunrise Lake requires estimation of the sources of water to the lake. The three primary sources of water are: 1) atmospheric direct precipitation; 2) runoff, which includes all overland flow to the tributaries and direct drainage to the lake; and 3) baseflow, which includes all precipitation that infiltrates and is then subsequently released to surface water in the tributaries or directly to the lake (i.e., groundwater). Baseflow is roughly analogous to dry weather flows in streams and direct groundwater discharge to the lake. The annual water budget for the updated model is broken down into its components in Table 8.

- Precipitation - Mean annual precipitation was assumed to be representative of a typical hydrologic period for the watershed. For the Sunrise Lake watershed, 1.25 m (≈49 in) of annual precipitation was used.

- Runoff - For each land cover category, annual runoff was calculated by multiplying mean annual precipitation by basin area and a land cover specific runoff fraction. The runoff fraction represents the portion of rainfall converted to overland flow.

- Baseflow - The baseflow calculation was calculated in a manner similar to runoff. However, a baseflow fraction was used in place of a runoff fraction for each land cover. The baseflow fraction represents the portion of rainfall converted to baseflow. Baseflow is infiltrated into the ground and returned to the lake via groundwater flow and discharge to tributary streams and direct discharge to the lake.

The hydrologic budget was calibrated to a representative standard water yield for New England (Sopper and Lull 1970; Higgins and Colonell 1971).

Table 8: Sunrise Lake Annual Water Budget Under Current Conditions as Estimated Using LLRM

Water Budget	Sunrise Lake (*m^3/yr*)
Atmospheric	624,750
Septic Systems	27,741
Watershed Runoff and Baseflow	5,638,697
Total	6,291,187

4.2 Nutrient Inputs

4.2.1 Land Cover Export

The Sunrise Lake sub-watershed boundaries were determined using a geographic information system (GIS). Land covers within the watershed were determined using the most recent available GIS data (New Hampshire GRANIT 2019, accessed June 2020), Google Earth imagery and ground-truthing (when appropriate).

The TP load for the watershed was calculated using export coefficients for each land cover type. These coefficients were based on recent modeling efforts in NH. Watershed loading was adjusted based upon proximity to the lake, soil type, presence of wetlands, and attenuation provided by Best Management Practices (BMPs) for water or nutrient export reductions. The watershed load (baseflow and runoff) was combined with direct loads (atmospheric, internal, septic system, and waterfowl) to calculate TP loading. The generated load to the lake was then entered into a series of empirical models that provided predictions of in-lake TP concentration, Chl-a concentration, algal bloom frequency and water clarity. Current watershed land cover and export coefficients are summarized in Table 9. It is recognized that some land cover categories are not explicitly represented in the data.

Table 9: Land Cover Categories and Export Coefficients for 2021 Sunrise Lake Model

Land Cover	Total (ha)	Percentage of land cover	TP Export Coefficient (kg/ha/yr)	Source for Export Coefficient
Urban 1 (Low Density Residential)	141.1	17.1	0.34	USEPA, 2017
Urban 3 (Roads)	11.5	0.11	0.82	USEPA, 2017
Forest 1 (Deciduous)	252.0	30.5	0.03	Tarpey, 2013
Forest 2 (Non-Deciduous)	0.9	0.1	0.03	Tarpey, 2013
Forest 3 (Mixed Forest)	321.2	38.9	0.03	Tarpey, 2013
Forest 4 (Wetland)	32.9	4.0	0.03	Tarpey, 2013
Open 1 (Wetland / Lake)	14.8	1.8	0.01	Schloss et al., 2000
Open 2 (Meadow)	4.0	0.5	0.29	USEPA, 2017
Open 3 (Bare/Open)	48.1	5.8	0.80	Omernik, 1976
Other 1: Gravel Roads	0.0	0.0	0.83	Hutchinson Environmental Sciences Ltd., 2014
Total	826.3	100.0		
Note: Gravel roads are not included explicitly due to the coarse resolution of the spatial data; however, their contribution is included in the overlying land category (e.g., Low Density Residential or Institutional) export coefficient.				

The percentage of land cover by type for the entire watershed is illustrated in Figure 8. The percentage of watershed TP export by land cover type is illustrated in Figure 9. Watershed export does not include direct loads such as septic systems in proximity of the lake, waterfowl, internal load, or direct atmospheric deposition which are loaded directly to Sunrise Lake. Although a small percentage of the land area has developed land cover (e.g., houses, roads, bare open land (recently logged), a large percentage of the TP load to Sunrise Lake comes from those land cover types. For Sunrise Lake, most of the open/bare land cover is recently logged areas in the upper reaches of the Hampshire Brook sub-watershed.

Figure 8. Percentage of land cover by type for the Sunrise Lake watershed

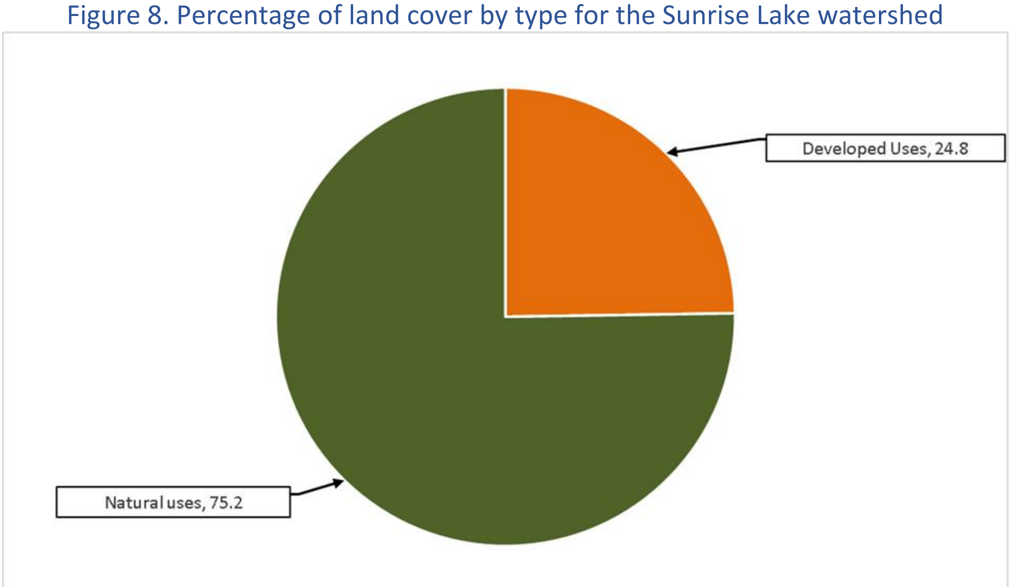
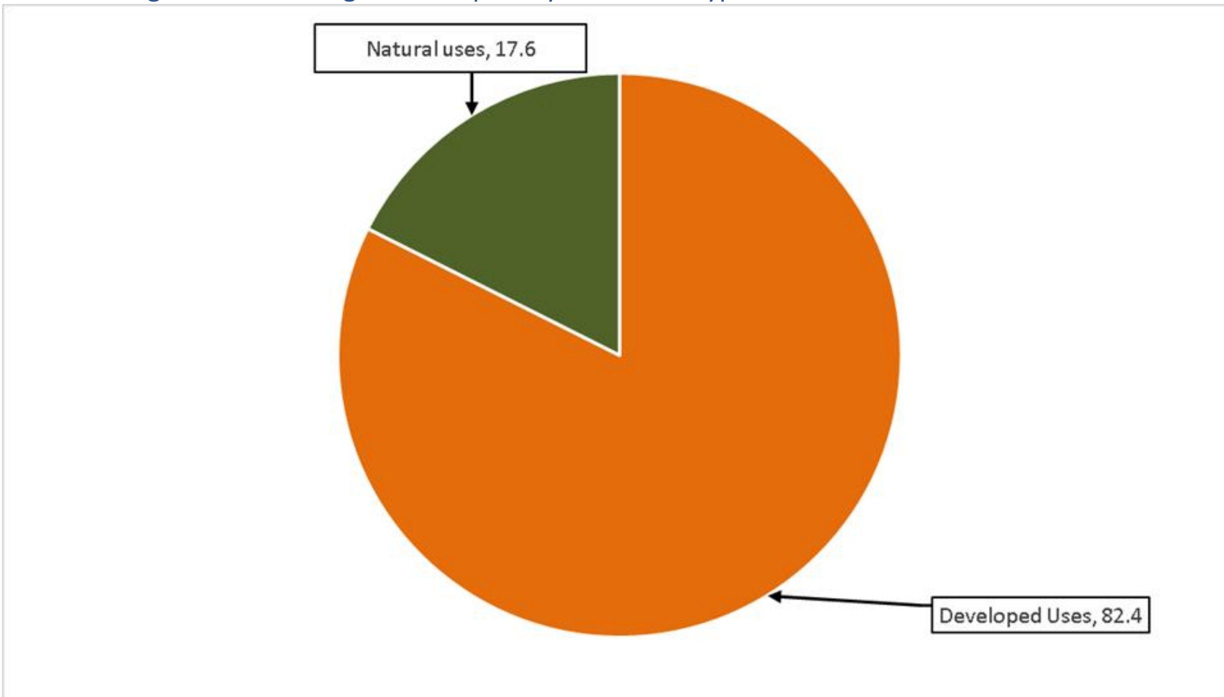


Figure 9. Percentage of TP export by land cover type for the Sunrise Lake watershed



4.2.2 Atmospheric Deposition

Nutrient inputs from atmospheric deposition were estimated based on TP coefficients for direct precipitation. The atmospheric load of 0.11 kg/ha/y includes both the mass of TP in rainfall and the mass in dryfall (Schloss and Craycraft 2013). The sum of these masses is carried by rainfall. The coefficient was then multiplied by the lake area (ha) to obtain an annual estimated atmospheric deposition TP load.

4.2.3 Waterfowl

Total phosphorus load from waterfowl was estimated using a TP export coefficient and an estimate of annual mean waterfowl population of 0.3 birds per ha. The TP export coefficient used for waterfowl were 0.2 kg/waterfowl/y. Waterfowl loadings of nutrients are small relative to watershed loads but may be locally important to nearshore areas in the lake. Actual waterfowl counts would help improve this estimate. Waterfowl loading may be a component of the nutrient budget that can be beneficially addressed.

4.2.4 Septic Systems

Total phosphorus export loading from residential septic systems was estimated within the 250 ft shoreline zone. These systems were split into new (<15 years), middle aged (15-25 years) and old (>25 years) based on the 2021 septic survey. Likewise, use was split into 3 categories, year-round, 3-5 month seasonal and 1-2 month seasonal. It was assumed that there were the same proportion usage and age in the overall septic system population as in the survey respondent population. New systems were assumed to trap 90% of the TP that entered them, middle aged 85% while older systems were assumed to trap 80%.

4.2.5 Internal Loading

Internal loading generally refers to the release of TP from sediments in the lake, typically under low oxygen conditions but also from resuspension of sediments. Neither anoxia or elevated TP concentrations near the sediments have been observed in Sunrise Lake so this component is assumed to be negligible and is not part of the nutrient budget for Sunrise Lake at this time.

4.3 Phosphorus Loading Assessment Summary

Overall, the watershed of Sunrise Lake is dominated by forest and low-density residential land. The developed areas of the watershed tend to yield a larger portion of the nutrient load to the lake than their land area might suggest because of their relatively high nutrient export coefficients when compared to forest (Figures 8 and 9). TP loads were estimated based on runoff and groundwater land cover export coefficients. Because much of the loading occurs in areas of the watershed close to the lake or tributary streams, attenuation of TP loads was determined to be relatively low. Land based TP load by sub-watershed is illustrated in Figure 10. However, the TP contribution on an aerial (per unit area) basis provides additional information on which sub-watersheds have the most concentrated sources (Figure 11). So, while the Hampshire sub-watershed is the largest source of TP overall, the direct drainage areas contribute substantially more TP per unit area to Sunrise Lake.

Table 10: Land Area Drained and TP Load by Sub-watershed for Sunrise Lake.

	Land Area (ha)	Load (kg/yr)
East Tributary	0.9	0.1
Hampshire Brook	355.5	45.6
North Direct Drainage	32.4	4.2
Northeast Direct Drainage	25.6	6.1
South Direct Drainage	50.8	5.4
Southwest Direct Drainage	27.4	4.4
Tanglewood Brook	216.2	16.7
Unnamed Brook	35.9	4.5
West Direct Drainage	81.8	14.9
Total	826.6	101.9

Figure 10. Current Watershed-based TP Loading by Sub-watershed for Sunrise Lake

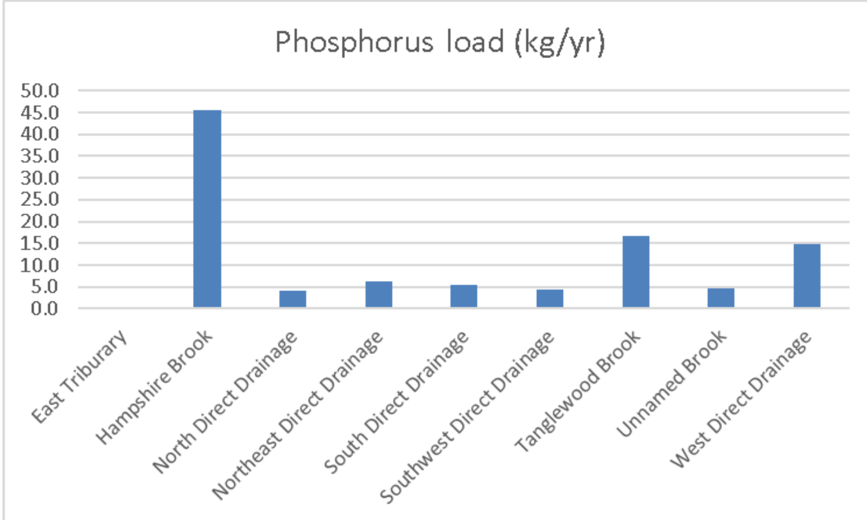
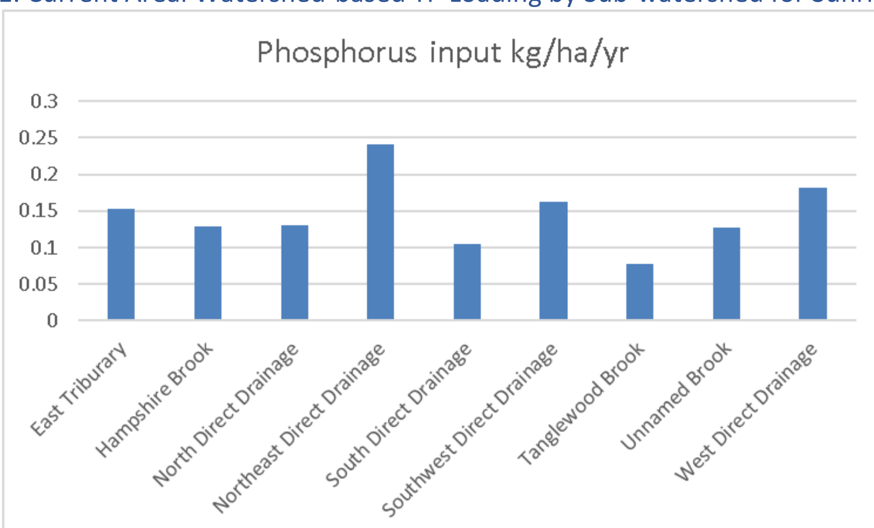


Figure 11. Current Areal Watershed-based TP Loading by Sub-watershed for Sunrise Lake



The estimated existing TP sources to Sunrise Lake under current conditions by source are presented in Figure 11.

Loading from the watershed was overwhelmingly the largest source of TP to the lake followed by septic systems. Both watershed and septic inputs should be reduced to meet the goals outlined elsewhere in this plan. These potential reductions are discussed further in the management section of the plan.

Table 11: Sunrise Lake Modeled Phosphorus Loading Summary Under Current Conditions

Watershed and Direct Loads to Lake	TP (kg/yr)
Atmospheric	11.0
Internal	0.0
Waterfowl	4.0
Septic System	33.9
Watershed Load	101.9
Total Load to Lake	150.8

Predicted loads from the watershed as well as direct sources used to predict in-lake concentrations of TP, Chl-a, SDT, and algal bloom probability. The in-lake predictions were then compared to in-lake and tributary concentrations. A successful calibration shows a close agreement between predicted in-lake TP and observed mean/median TP. However, perfect agreement between modeled concentrations and monitoring data were not expected as monitoring data are generally limited to the ice-free season which may or may not have been representative of long- term average conditions in the lake.

While the analysis presented above provides a reasonable accounting of sources of TP loading to Sunrise Lake, there are several limitations to the analysis:

- Precipitation varies among years and hence hydrologic loading will vary. This may greatly influence TP loads in any given year, given the importance of runoff to loading.

- Spatial analysis has innate limitations related to the resolution and timeliness of the underlying data. In places, local knowledge was used to ensure the land cover distribution in the LLRM model was reasonably accurate, but data layers were not 100% verified on the ground. In addition, land covers were aggregated into classes which were then assigned export coefficients; variability in export within classes was not evaluated or expressed.

- Total phosphorus export coefficients as well as runoff/baseflow exports were representative but also had limitations as they were not calculated for the study water body, but rather are typical regional estimates.

- The TP loading estimate from septic systems was limited by the assumptions associated with this calculation described above and in the “Septic Systems” subsection of AECOM (2009) and the extrapolation of septic survey results to the entire population of septic systems within 250 feet of the lake.

- Water quality data for the Sunrise Lake tributaries are limited to concentration data, restricting calibration of the loading portion of the model. Collecting tributary flow data in conjunction with concentration data would allow calculation of loads which may improve the accuracy of the loading estimates generated by the model.

4.4 Lake Response to Current Phosphorus Loads

Total phosphorus load outputs from the LLRM Methodology were used to predict in-lake TP concentrations using empirical models. The models include: Kirchner-Dillon (1975), Reckhow (1977) and Nurnberg (1996) for TP. These empirical models estimate TP from system features, such as depth and detention time of the waterbody. The load generated from the export portion of LLRM was used in these equations to predict in-lake TP. The mean predicted TP concentrations from these models was compared to measured (observed) values. Input factors in the export portion of the model, such as export coefficients and attenuation, were adjusted to yield an acceptable agreement between measured and average predicted TP. Because these empirical models account for a degree of TP loss to the lake sediments, the in-lake concentrations predicted by the empirical models are lower than those predicted by a straight mass-balance where the mass of TP entering the lake is equal to the mass exiting the lake without any retention. Also, the empirical models are based on relationships derived from many other lakes and ponds. As such, they may not apply accurately to any one lake, but provide an approximation of predicted in-lake TP concentrations and a reasonable estimate of the direction and magnitude of change that might be expected if loading is altered. These empirical modeling results and mean field data are presented in Table 12.

Because freshwater systems are most frequently limited by TP, calibration of the lake model focused on matching predicted TP with field data.

The model also predicts Chl-*a*, Secchi transparency and the probability of algal blooms. Chlorophyll *a* was predicted by models from Vollenweider (1982) and NHDES (2009) while Secchi transparency was predicted by Oglesby and Schaffner (1978). The probability of algal blooms was predicted by Walker (1984).

Table 12: Predicted and Measured Water Quality Parameters in Sunrise Lake (2010-2019).

Water Quality Parameter	Sunrise Lake
Annual TP Load (kg/yr)	151
Predicted TP (µg/l)	9.3
Epilimnetic Measured TP (2010-2019)(µg/l)	9.0
Predicted Chl-*a* (µg/l)	4.3
Measured Chl-*a* (2015-2019)(µg/l)	4.9
Predicted Secchi (m)	4.2
Measured Secchi transparency (2015-2019)(m)	2.9
Predicted Probability of Algal Bloom > 10 µg/l (% of time)	2.7

The TP loads estimated using the LLRM methodology translates to predicted annual mean in-lake TP concentration of 9.3 µg/l for Sunrise Lake. This concentration is moderate and would be expected to fuel some algal growth in the lake. Chl-*a* (a measure of the amount of algae) measurements are moderate and slightly underpredicted by the model and the Secchi transparency of Sunrise Lake is also lower than predicted. The apparent disconnect between TP concentrations and Secchi transparency may be a function of the species of algae present. Some species of cyanobacteria can regulate buoyancy allowing them to capture nutrients at depth (i.e., from the hypolimnion) or directly from the sediment and then rise in the water column. The model predicts that the lake will occasionally experience algal bloom conditions (chlorophyll *a* > 10 µg/l) which is generally consistent with observations over the past several years.

The empirical lake models predict an annual average concentration of TP. Comparison of modeled results to field data (summer epilimnetic concentrations) often results in modeled predictions that are slightly higher than observed concentrations. Collection of samples throughout the year (in particular, spring turnover samples) would give a better approximation of annual average TP concentrations that may more closely match model results.

4.5 Natural Background Scenario

This scenario is a representation of the best possible water quality for Sunrise Lake and was generated by converting all watershed land cover to forest and eliminating septic systems. While it is not realistic to expect the entire watershed to revert to forest, this scenario provides an estimate of the best possible water quality for the lake. Under this scenario, the lake would have been expected to have total TP concentrations approximately 2.3 µg/l and would support a trophic classification of oligotrophic or very low productivity (Table 13). Water quality would be excellent under this scenario.

Table 13: Predicted Water Quality Parameters Under Natural Background as Compared to Current Conditions

Scenario	TP (µg/l)	Chl-a (µg/l)	Secchi Transparency (m)	Probability of Algal Bloom > 10 µg/l (% of time)	TP Load (kg/yr)
Natural Background	2.3	1.2	12.1	0	39
Current Conditions	9.3	4.3	4.2	2.7	151

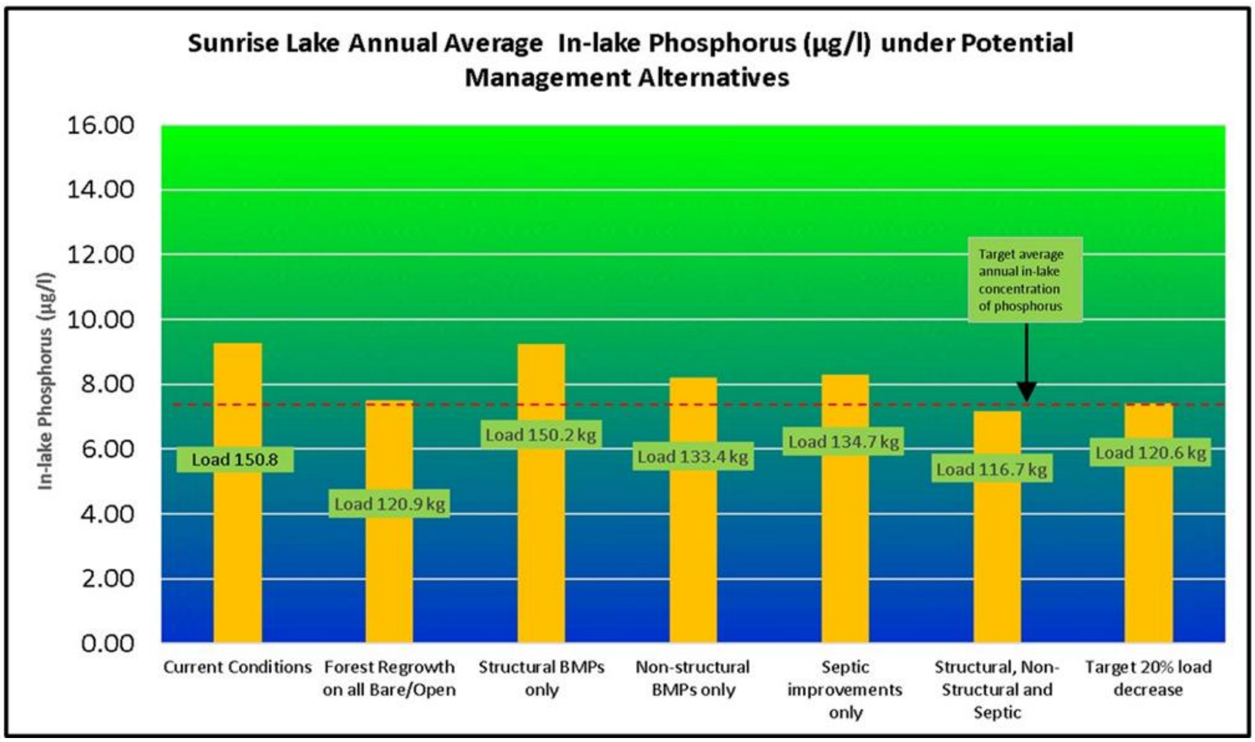
4.6 Load Reduction Scenarios

The LLRM model was used to evaluate the impact of potential structural and non-structural BMPs and associated reductions in loading to Sunrise Lake. In general, structural BMP's are constructed or retrofitted projects to capture TP. Non-structural BMPs include zoning, ordinances, and land conservation among other measures. Septic upgrades include an assumed upgrade or replacement of 3 septic systems per year for the next 10 years. An additional scenario was run assuming that all the currently open/bare land primarily attributed to recent logging was reforested. It is expected that this will occur over the next 5-10 years however, new logging will likely occur over that same time period and likely result in similar levels of TP export. While it is unreasonable to expect all logging to cease in the watershed, this scenario illustrates the importance of logging with best practices for erosion control and buffers. Results of these scenario simulations are presented in Table 14 and Figure 12. These simulations demonstrate the value of TP loading reductions and the influence of such reductions on in-lake conditions including a reduced probability of algal bloom occurrence.

Table 14: Predicted Water Quality Parameters Under Various Management Scenarios as Compared to Current Conditions and the Water Quality Target

Scenario	TP (µg/l)	Chl-a (µg/l)	Secchi Transparency (m)	Probability of Algal Bloom > 10 µg/l (% of time; number of days)	TP Load (kg/yr)
Current Conditions	9.3	4.3	4.2	2.7 (10)	150.80
Forest Regrowth on all Bare/Open	7.5	3.5	4.9	1.0 (4)	120.90
Structural BMPs only	9.2	4.3	4.2	2.6 (9)	150.20
Non-structural BMPs only	8.2	3.8	4.6	1.5 (5)	133.40
Septic improvements only	8.3	3.9	4.6	1.6 (6)	134.70
Structural, Non-Structural and Septic	7.2	3.4	5.1	0.8 (3)	116.70
Target 20% load decrease	7.4	3.5	5	0.9 (3)	120.60

Figure 12. Predicted Water Quality Parameters Under Various Management Scenarios as Compared to Current Conditions and the Water Quality Target



The proposed structural BMPs would result in modest reductions in TP concentrations in Sunrise Lake, as well as a slightly lower probability of algal blooms (Chl-a in excess of 10 µg/l). Reaching the water quality goal concentration of a 20% decrease in the TP load can only be reasonably be met by addressing structural and non-structural BMPs as well as septic systems.

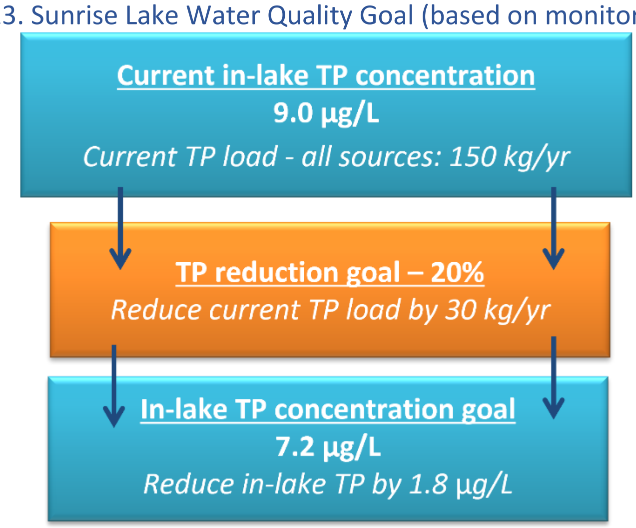
5.0 Water Quality Goals for Sunrise Lake (Element B)

Water quality goals are a critical component of watershed management plans. The goals are the "yardstick" by which management success is measured. The water quality goals describe the pollutant load reductions needed to see improvement in the lake's water quality. The establishment of water quality goals for Sunrise Lake were guided by state water quality assessment standards, modeling conducted for the plan, an analysis of water quality data, and input from watershed residents on the attainment of desired uses for the lake.

Nutrient loading has led to periodic algal and cyanobacteria blooms in Sunrise Lake. Nutrient limitation of algae and cyanobacteria growth in freshwater is primarily related to TP; therefore, lake management efforts to control blooms in Sunrise Lake will focus on managing sources of TP.

The Sunrise Lake watershed goal setting process determined that reducing TP loading to meet an in-lake concentration of nine micrograms per liter would reduce the frequency of cyanobacteria blooms such that the lake would meet water quality standards. Based on the output from the LLRM modeling update conducted for the watershed management plan, it is estimated that a 20 percent reduction of TP from the current load to the lake is needed to meet the water quality goal (Figure 13). Additionally, reaching the in-lake water quality goal would result in a threefold reduction in algal bloom frequency.

Figure 13. Sunrise Lake Water Quality Goal (based on monitoring data)



To attain the water quality goals for Sunrise Lake, TP load reductions will be needed from many sources. The management actions proposed for the direct drainage area as described in this first phase of watershed management plan will result in modest reductions in TP concentrations in Sunrise Lake, as well as a slightly lower probability of algal blooms. Therefore, it is critical that additional phases of watershed planning and management are implemented over time to meet the water quality goals for the lake.

6.0 Management Actions to Control Phosphorus (Elements C, D, and E)

This section presents recommendations for management actions to control and reduce TP loading to the lake in the direct drainage area. Recommendations for controlling TP loading are presented in the following four categories:

- Category 1: Structural Controls
- Category 2: Non-structural Controls
- Category 3: Septic Systems
- Category 4: Regulations
- Category 5: Watershed Outreach

Management measures to address sources of TP are presented for each management action category, including a description of the approach, location, costs, partners, and pollution load reduction estimates (if known). Further, Section 10.0 of this plan offers a list of potential funding sources to implement the management actions.

The impact of load reductions from management actions implemented in upstream sub-watersheds is somewhat less than that of actions located in the lake's direct drainage area as attenuation along the watershed's flow path reduces the load to Sunrise Lake as it travels downstream. Examples of upstream features that would attenuate the TP load delivered to Sunrise Lake include the presence of lakes or ponds, wetlands, well drained soils/groundwater recharge areas or existing controls. Due to this phenomenon, focusing on the lake's direct drainage area in early phases of watershed plan implementation should be a priority.

6.1 Structural Controls (Category 1)

Structural BMPs are a critical management tool for reducing pollutant loads delivered to Sunrise Lake from stormwater runoff. Typically, structural BMPs are stationary and permanent. Many structural BMPs rely on natural elements such as vegetation and soil processes to trap and remove pollutants. Additionally, structural BMPs designed to use infiltration mechanisms can also reduce the volume of stormwater runoff which can help to reduce the erosive force of runoff.

6.1.1 Structural Stormwater Management

Examples of structural stormwater management BMPs include raingardens, swales, bioretention units, constructed wetlands and other similar practices. To function properly, however, structural BMPs require on-going maintenance and implementation efforts must take this critical need into consideration when working with partners to build BMPs – all structural BMPs need an "owner" that is willing to maintain the practice.

To identify potential stormwater structural control opportunities for Sunrise Lake, Geosyntec and UNH Stormwater Center staff conducted a watershed assessment in the direct drainage area during the summer of 2021 to identify locations where structural approaches could be implemented to reduce TP loading to Sunrise Lake. The assessment focused on identifying areas in the direct drainage where erosion, stormwater runoff, impervious cover, lack of vegetated buffer or other factors were potentially contributing to nutrient loading to the lake. The team then developed recommendations for actions to address pollutant loading for identified problem areas. The BMPs were prioritized based on potential to reduce TP loading to the lake, costs, and relative ease of implementation (Table 15).

Table 15: Sunrise Lake Watershed Plan – Prioritization of Structural BMP Opportunities

Site	Location	BMP Description	Property Ownership	Sub-watershed	TP Load Reduction[1,2] (lb/yr)	Capital Cost[3,4]	Cost per Pound TP Removed ($/lb TP)	Cost Effectiveness for Load Reduction	Proximity to Lake	Public Visibility & Education	Feasibility to Construct & Operate	Site Priority
1	Hampshire Shores Boat Launch	Install a raingarden with educational signage to treat stormwater from the parking area	Hampshire Shores Association	Northeast Direct Drainage	0.6	$ 16,000	$ 26,700	Low	High	Medium	Medium	Medium
2	Canoe Launch	Install an infiltration swale to treat stormwater from Route 153 prior to entering the lake	NHDOT, Town of Middleton	East Tributary	0.1	$ 10,000	$ 100,000	Low	High	High	Low	Low
		Install measures to stabilize boat access to the lake.	Town of Middleton	East Tributary	0.2	$15,000-$30,000	$75,000-$150,000	Low	High	High	Low	Low
3	Jones Beach	Install a raingarden with educational signage to treat stormwater and reduce erosion from the parking area and picnic area	Town of Middleton	East Tributary	0.5	$ 15,000	$ 30,000	Low	High	High	Medium	Medium
4	Sunrise Lake Lands Association Beach	Repair compromised drainage infrastructure adjacent to the beach which during storm events is causing erosion of the beach area	Sunrise Lake Lands Association	West Direct Drainage	-	-	-	Low	Medium	Low	Medium	Low

Notes:

[1] Credit calculated following methodology in NH MS4 Permit, Appendix F Attachment 3

[2] Credit calculated using EPA Region 5 methodology for Estimating Load Reductions for Agricultural and Urban BMPs for stabilization of the boat access area in Site 2

[3] For sites 1 and 3, based on a unit cost per volume of storage with an adjustment factor of 2 (EPA, 2016). Cost represents capital cost of construction/installation of the BMP and includes a 35% design/engineering/contingency cost.

[4] For site 2, based on a best engineering judgement and previous projects. Capital cost which includes design, engineering, and installation.

6.1.2 Residential Stormwater Management

In 2021, the NHDES Soak Up the Rain (SOAK) program partnered with Sunrise Lake watershed residents to conduct stormwater assessments to identify opportunities to reduce TP loading to the lake from residential properties. The goal of the SOAK program is to engage home and small business owners to do their part to help protect and restore clean water in the state's lakes, streams, and coastal waters from the negative impacts of stormwater pollution.

The SOAK program was presented to sixteen interested residents on June 5, 2021, at the Sunrise Lake Lands Association's beach on Lakeshore Drive. Staff from NHDES provided attendees with an overview of the watershed management process and how they could get involved with a simple do-it-yourself stormwater project. As a result, five people signed up for SOAK evaluations (Table 16), which were conducted on August 3, 2021, and focused on properties closest to the lake with the potential to directly contribute runoff. While some of the sites did not qualify for the program for various reasons, the visiting Soak Up the Rain team members met with residents and offered solutions. Proposed solutions for managing stormwater runoff from these properties include:

- Erosion control
- Infiltration trenches
- Raingardens
- Vegetation (plantings)
- Water diversion devices

Due to the small drainage areas for each SOAK property, the estimated TP load reductions achieved for a single SOAK installation are not high (0.10 – 0.20 lbs/yr per installation); however, as solutions are implemented around the lake over time, load reductions will add up. Small, simple changes in residential property management can have a big impact on water quality (NHDES, 2016).

For future phases of the Sunrise Lake project, additional SOAK surveys are recommended to identify more properties for SOAK project implementation.

Table 16: Residential Stormwater Management Opportunities – Direct Drainage Area

Site #	Date	Address	Town	Problem Summary	Recommendations Summary	SOAK Priority		
						Low	Medium	High
1	8/10/21	Sunrise Drive	Middleton	Runoff washing onto the property from Sunrise Drive creating or contributing bare areas and lightly eroded areas on the eastern half of the property.	Address runoff from road and lightly eroded areas; install driveway infiltration trench; and continue vegetation management.	X		
2	8/10/21	Shore Drive	Middleton	Rivulets running throughout the beach area.	Address beach rivulets by redirecting water to a rain garden; install driveway infiltration trench; and investigate erosion control mulch.	X		
3	8/10/21	Sunrise Drive	Middleton	Property is entirely undeveloped and wooded and did not result in any recommendations.	N/A	-	-	-
4	8/10/21	Gary Road	Middleton	No typical residential stormwater issues appropriate for the SOAK program.	Follow up emails were sent to property owners with additional landscaping resources.	-	-	-
5	8/10/21	Dowling Road	Middleton	No typical residential stormwater issues appropriate for the SOAK program.	Follow up emails were sent to property owners with additional landscaping resources.	-	-	-

More detailed information on each site including results of the site screening field sheets and specific recommendations, which included estimated cost level and technical level needed for installation, can be found in the Appendix.

6.1.3 Shoreline Stabilization

Shoreline buffers, areas of natural vegetation along a lake's shoreline, have many benefits. They provide habitat, filter pollution from runoff, stabilize eroding soils, and are aesthetically pleasing. Lake management programs strive to encourage shorefront property owners to maintain or establish vegetated buffers to provide these beneficial services to the lake.

For areas of the lake's shoreline where vegetation has been removed, living shoreline management approaches are recommended to help restore the lake's vegetated buffers. Living shorelines provide a natural approach to reducing impacts from erosion, ice damage, stormwater runoff, and wave action. Living shorelines use techniques that incorporate the use of natural materials including logs, rocks, native vegetation, and live staking techniques (Figure 14). Living shorelines are often designed and constructed to accommodate low-impact access from the upland to the waterfront.

Figure 14. Shoreline Stabilization with Plantings

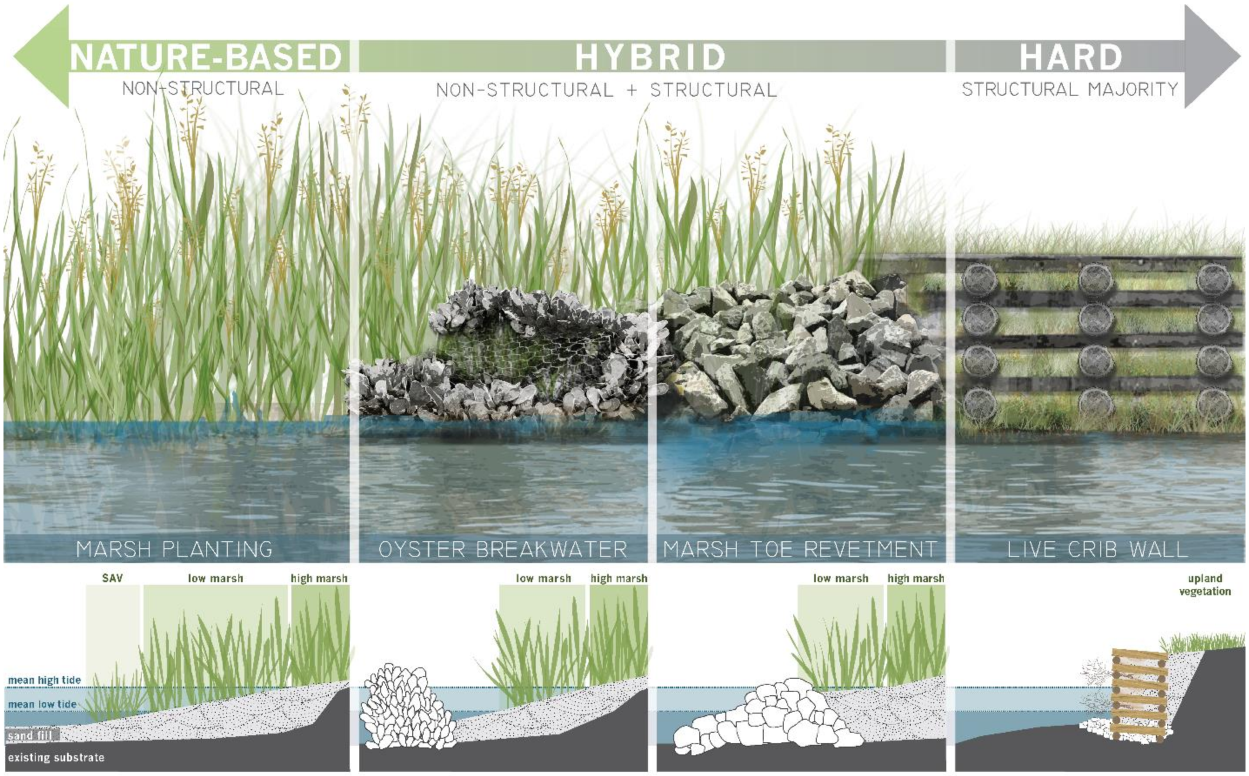


Illustration by Liz Podowski King. Original content developed by Carolyn LaBarbiera and Liz Podowski King with support from the New York Department of State. Adapted for use by the NHDES Coastal Program

Table 17: Shoreline Stabilization Recommendations

Action Item	Description	Partners	Estimated Cost	Results
Identify living shoreline projects	Conduct planning and outreach to identify living shoreline projects	SRPC, NHDES, and Interested Landowners	$1,000	List of potential projects
Living shoreline demonstration project(s)	Work with willing landowners to establish 1 -3 living shorelines using natural techniques	SRPC, NHDES, and Interested Landowners	Up to $15,000	2 – 4 lbs/yr of TP removed per project*

**Load reduction estimate based on outcomes from similar efforts conducted in NH*

6.2 Non-Structural Controls (Category 2)

Non-structural BMPs typically do not involve construction and are often more broadly applied throughout a watershed. Often these BMPs can result in significant pollutant load reductions. Examples of non-structural BMPs include:

- **Municipal "good housekeeping" practices** such as street sweeping, catch basin cleaning, and leaf litter collection programs can reduce TP loading by reducing transport of pollutants through stormwater systems.

- **Regulations** can be used to help affect behavior change and manage land uses practices; examples of regulatory tools include stormwater management regulations, septic system ordinances, fertilizer regulations, pet waste removal requirements, and more.
- **Outreach and education** can also be used to help change behavior and reduce pollutant loading by encouraging and promoting activities that reduce or prevent pollutant loading such as fertilizer reduction incentives, pet waste pick-up programs, lake-friendly landscaping workshops and more.

- **Land conservation** is a common tool that can be used to prevent loading from land conversion activities.

As part of the watershed planning effort for Sunrise Lake, Geosyntec, and the UNHSC, conducted an assessment and prioritization of non-structural BMP opportunities for the Sunrise Lake watershed. The results of this assessment are summarized in Table 18. Additional non-structural approaches are described in the following sections of the action plan: Category 4 – Regulations, and Category 5 – Outreach.

Table 18: Sunrise Lake Watershed Plan – Prioritization of Non-Structural Practices

BMP	Goal Description	Responsible Party	TP Load Reduction (lbs/yr)	Potential for TP Reduction	Educational Benefits	Ease of Implementation	Priority
Fertilizer Program[1]	Switch to phosphorus-free fertilizer and certify that no phosphorus has been applied to pervious developed areas throughout the watershed. Assume 20% of the developed pervious area is managed.	Town Highway Dept., Lake Associations, Private	9.64	High	High	Medium	High
Street Sweeping[1]	Optimize street sweeping locations and frequency to achieve a frequency equivalent to two times per year sweeping (in Spring and Fall) of 50% of roads within 650-feet of the shoreline, using vacuum assisted sweeper.	Town Highway Dept., NHDOT	1.13	Low	Low	Medium	Low
Leaf Litter Management[2]	Provide leaf collection at least 4 times during October and November for properties within 650-feet of the shoreline. Within 24 hours of leaf collection, collect remaining leaf litter on paved streets using street cleaning machines, such as a mechanical broom or vacuum assisted street cleaner. Assume 80% of the developed land is managed.	Town Highway Dept., NHDOT, Lake Associations, Private	4.24	Medium	High	Medium	Medium
Shoreline Buffer[3]	Retrofit developed areas along shoreline with 20-ft no-mow/no-alteration buffer for properties within 425-feet of the shoreline. Assume 50% of the developed land is managed.	Town Staff, Conservation Groups, Lake Associations, Private	8.05	High	High	Medium	Medium
Catch Basin Cleaning[1]	Remove accumulated materials from catch basins in the watershed such that a minimum sump storage capacity of 50% is maintained throughout the year. Assume 10% of the impervious cover is maintained.	Town Highway Dept., NHDOT	0.21	Low	Low	High	Medium
Regulations	Establish municipal regulations to enable/promote improved stormwater management, buffer protections, and shoreland controls.	Town Planning Staff	NA	Medium	Medium	Low	High
Land Conservation	Coordinate with groups to prioritize land conservation goals/target parcels to reduce future load associated with new development.	Town Planning Staff	NA	Low	High	Medium	Low
Impervious Disconnection[4]	Divert runoff from impervious areas such as roadways, parking lots and roofs, and discharge it to adjacent vegetated permeable surfaces that are of sufficient size with adequate soils to receive the runoff without causing negative impacts to adjacent down-gradient properties. Assume 20% of the impervious area within 425-feet of the shoreline is managed.	Town Highway Dept., NHDOT, Lake Associations, Private	15.04	High	Medium	Medium	Medium

[1] Credit calculated following methodology in NH MS4 Permit, Appendix F Attachment 3
[2] Wisconsin Interim Municipal P Reduction Credit for Leaf Management Programs (March 2018)
[3] UNH Stormwater Center, "Pollutant Removal Credits for Restored or Constructed Buffers in MS4 Permits", June 2019
[4] Rhode Island Department of Transportation, Impervious Disconnection, draft for EPA Approval, June 2020

6.2.1 Waterfowl Management Actions

Although most waterfowl are native species and depend on the habitat Sunrise Lake provides, water quality problems can develop as populations increase or birds begin congregating in local areas of the lake – such as near swimming beaches and docks. Birds can become accustomed to people and residential areas with tender grass and manicured lawns can be attractive feeding areas for waterfowl such as ducks and geese. Problems related to waterfowl include unhealthy accumulations of bird droppings on nearshore areas and in the water, shoreline erosion due to overgrazing, and an increased prevalence of swimmers itch (duck itch) which is caused by a parasite that spends part of its life cycle in waterfowl.

Approximately 4 kg/yr of TP loading to the lake is attributed to waterfowl. While this is a small percentage of the overall loading to the lake, waterfowl have been observed to congregate in localized areas of the lake indicating that waterfowl loading may be a component of the TP budget that can be beneficially addressed through simple, locally-targeted practices. Potentially effective waterfowl management approaches include landscape modifications to discourage birds from congregating and feeding in nearshore areas (especially recreational use areas) and outreach programs for residents regarding the water quality and human health impacts of feeding waterfowl.

Based on other watershed planning efforts conducted in New Hampshire, management actions to reduce TP loading from waterfowl can be effective (CEI, 2014). For example, modifications to nearshore landscapes, such as establishment of shoreline buffers and no-mow areas, are known to discourage geese and ducks from gathering on shoreline properties. These practices can be up to 70 percent effective at preventing TP loading from waterfowl.

Education efforts about the negative impacts of feeding waterfowl may also be effective. Wild waterfowl are adept at finding food on their own and do not need “handouts” from humans to survive. Concentrated feeding by humans encourages birds to congregate in greater numbers – often near docks and swimming areas. The birds then defecate in the water or on land, which is problematic for water quality and human health. In New Hampshire, lake associations have conducted education campaigns to encourage residents to refrain from feeding waterfowl and several communities have enacted “no feeding” regulations to help discourage waterfowl from congregating on town-owned land adjacent to lakeshores.

Lastly, it may be worthwhile for Sunrise Lake residents to conduct a waterfowl assessment to develop a better understanding of local waterfowl populations and their effect on lake water quality. A summary of waterfowl management actions described above is provided in Table 19.

Table 19: Waterfowl Management Actions

Management Action	TP Load Reduction*	Cost
Shoreline modifications such as buffers, no mow zones, etc.	1 – 4 lbs/project	$0 - $5,000
Education programs to discourage waterfowl feeding	1-2 lbs/project	$500 - $1,000
Waterfowl assessment	None	$500 - $1,000
*Load reductions and cost estimates based on outcomes from similar New Hampshire projects		

6.3 Septic Systems (Category 3)

This section provides an assessment and recommendations related to priority areas for potential subsurface wastewater management upgrades and wastewater alternative treatment strategies within the Sunrise Lake watershed. The watershed's population is served entirely by on-site septic systems, many of which are older and very close to the lake. Septic systems represent approximately 22 percent of the contributing load of TP load to Sunrise Lake. Compared to other sources of TP, septic systems are one of the larger contributors of nutrients to the lake. Managing TP loading from septic systems will be a critical strategy for improving water quality.

Septic systems function to treat wastewater to protect human health and water quality. However, systems that are poorly maintained, older, and those that are located without adequate separation to groundwater present a risk to the health of Sunrise Lake. When septic systems do not function properly it is likely that either they were installed before current standards were in effect (1967) or they were not adequately designed, sited, constructed, or maintained. NHDES estimates that between eight and ten percent of current septic system approvals address repair or replacement of existing systems (NHDES, 2020). As a result of a law (RSA 485-A:39) passed in 1993, evaluation of systems within 200 feet of a great pond or fourth order or higher river is required before the property changes hands; however, upgrading substandard systems is not required.

Modest reductions in TP loading to the lake could be achieved if homeowners take responsibility to inspect their septic systems and conduct necessary maintenance or upgrades. Management measures to control TP loading from septic systems are described later in this section and include outreach, septic system pump-outs, regulations, and replacement of older systems.

6.3.1 Background

Subsurface wastewater disposal septic systems provide a cost effective and efficient way of disposing of domestic waste. However, even properly designed, installed, and maintained septic systems provide inadequate treatment for TP. Treatment of wastewater effluent is essential for the protection of ground and surface waters.

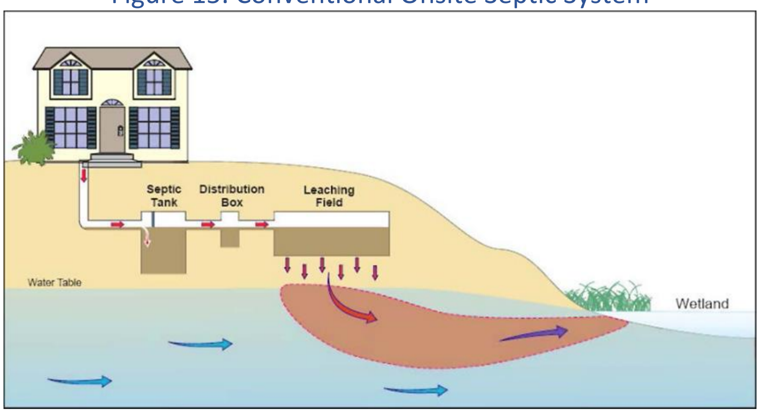
A conventional septic system includes a septic tank that collects the effluent from a home or business and a drainfield that disperses the effluent to the subsurface (Figure 15). Septic systems receive effluent from a variety of sources including toilet flushing, sink and shower drains, and washing machines. In a conventional septic system, TP removal starts with pretreatment in the septic tank. The primary removal mechanism is the settling of solids containing TP in the sludge or floating of soaps, although some precipitation may occur as well. This removal is typically 20 to 30 percent.

The remaining TP is removed from the septic tank effluent by two processes: surface adsorption and mineral precipitation. The characteristics of the soil, wastewater and site influence the degree to which phosphate is retained beneath the leachfield. If the soil treatment system has adequate mineral content and a sufficient zone of separation before limiting conditions such as water tables, bedrock or coarse soils, and proper setbacks are maintained from surface waters, then problems from TP movement to surface water or groundwater should be minimal. In situations where these characteristics don't exist, additional steps in the pretreatment prior to the soil may be needed.

Surface adsorption is usually limited by a fixed availability of sorption sites in a particular soil that eventually will be used up if sewage loading occurs over long periods. When the adsorption sites are filled, newly added TP must travel deeper in the soil to find fresh sites. Soils that are higher in clay content have more surface area and binding sites on the soil particles than soils that are high in sand.

Mineral precipitation involves the formation of a three-dimensional solid phase arrangement of molecules from the solution phase. Iron, calcium, and aluminum are minerals that chemically bind with phosphates. Compared to absorption, precipitation is potentially sustainable, provided that the supply of minerals necessary to complete the reaction is sufficient.

Figure 15. Conventional Onsite Septic System



6.3.2 Alternative Treatment Systems

Alternative systems are typically traditional septic systems with added components that reduce nutrient concentrations from the effluent before it is discharged to the ground. They are installed at an individual home, or cluster of homes, and usually cost more to operate and maintain than a traditional septic system. The increased O/M costs are due to power needs for the system (e.g., pumps, aerators), required water quality sampling, and other elements that are not needed for a traditional onsite system.

<u>Alternative Toilets</u>

Composting toilet systems offer a different solution to wastewater by eliminating much of the liquid waste. On a basic level, composting toilets retain solid and liquid excrement in a contained unit that facilitates the natural breakdown of material, or composting. Whether done completely within the eco-toilet unit, or transported and completed offsite, this process results in 'finished' compost free of pathogens and disease, with the potential to serve as a soil amendment. There are many different types of composting systems that range in cost, size, and maintenance requirements. The types of composting toilets include large bin, batch composting, self-contained, urine diversion, and hybrid composting toilets.

Urine in the waste can either be separated or is evaporated in the process of composting. For composting to act as a meaningful control for TP, the compost and any remaining liquid fraction not evaporated (commonly called "tea") must be managed properly. Proper management merely includes measures that prevent the entry of the nutrients into the groundwater or surface waters in locations that would encourage over eutrophication. As with urine management, compost may offer, under certain circumstances, an opportunity to obtain nutrients as fertilizer for those locations where productivity is desired (agriculture, silvaculture, or nursery operations). Composting toilet technology faces many of the cultural barriers posed by urine separation. Like urine separation, however, the costs of traditional large wastewater treatment technology and advanced onsite treatment technology should compel a serious consideration of this technology and a meaningful attempt to address the public aversions as well as the infrastructural support requirements. Infrastructural support features include collection and transport, processing locations and the development of markets for the final compost product.

The cost of upgrading a residential property to alternative toilets varies greatly and is based on a number of factors including: number of bathrooms, extent of remodeling work required, greywater management (i.e., hand and dish washing, showers, laundry, etc.), permitting requirements, and the type of system. Table 20 summarizes the potential cost range of these factors.

Table 20: Estimated Alternative Toilet Costs

Cost Element	Cost Range
Materials	$2,000 - $10,000
Design and Installation	$2,000 - $4,000
Greywater Management	$1,000 - $5,000
Permitting	$1,000 - $3,000
Source: EPA, 2013	

Cluster or Neighborhood Treatment Systems

Cluster or shared systems provide an opportunity for cost savings in both the construction and operation of the system. Building and operating one larger system is often less expensive than operating many small individual systems unless the homes using the system are far apart and the costs to connect are high. Cluster systems also provide an opportunity to offset TP discharges from other systems where upgrades are less feasible.

While cluster systems can be easily implemented for new development, retrofitting an existing area to a cluster system may pose both financial and engineering challenges. For example, the cost of piping and/or pumping the wastewater from each individual property to the cluster system could be a significant expense, particularly in low density areas. The construction of new collection systems and the availability of land for cluster systems also pose engineering challenges. Dense areas or areas with historical failures might provide the most opportunities for retrofitting conventional systems to cluster systems.

The cost for implementation of a cluster system to meet the current state-of-the-practice is approximately $35,000 to $48,000 per property served (HW, 2015; CCC, 2013). These cost estimates are highly dependent on site-specific factors.

6.3.3 Recommendations for Wastewater Management

The Sunrise Lake Watershed population is served entirely by on-site septic systems, which represents approximately 22% of the contributing load of TP load to the lake. Management strategies associated with septic systems are anticipated to be an important part of the long-term approach to achieving and maintaining the TP concentration goals established as part of this watershed plan. Establishment of a tiered approach to addressing onsite subsurface wastewater systems is recommended, based on system proximity to a waterbody. Using the management strategies described above, reduction of the TP load from septic systems is achievable. Septic systems are currently regulated at the State level and alternative treatment practices have not yet been approved. Therefore, regulatory changes at the State level are needed to allow for implementation of alternative treatment practices.

Modest reductions in TP loading to the lake could be achieved if homeowners take responsibility to inspect their septic systems and conduct necessary maintenance or upgrades. Management measures to control TP loading from septic systems include outreach, septic system pump-outs, and replacement of older systems (Table 21).

Table 21: Management Actions to Reduce TP Loading from Septic Systems

Action Item	Description	Lead Partner	Estimated Cost	Results
Septic system outreach	Provide educational information about proper septic system operation and maintenance	SLLA, HS, SLE, SLVD	$1,000	Residents engage in proper septic maintenance and best practices
Pump-out program	Coordinate group discounts for septic system pumping in the watershed	SLLA, HS, SLE, SLVD	N/A until program is developed	Potential TP loading is reduced
Septic system upgrades	Identify, prioritize and upgrade 15% of septic systems within 250 feet of the lake within ten years	SLLA, HS, SLE, SLVD	$5,000 - $20,000 per system	Up to 35 lbs. of TP annually*
Septic system regulations	Several septic system regulatory mechanisms can be implemented. See Table 22 for more information.	Planning Board, Board of Selectmen, and SRPC	$5,000 - $10,000	N/A
*Estimate derived from review of modeled outcomes from recent New Hampshire septic system replacement projects; final load reductions are based on age of systems and proximity to lake				

6.4 Regulations (Category 4)

Municipal land-use regulations are a guiding force for where and what type of development can occur in a watershed, and therefore, how water quality is affected because of this development. Action items related to this element include the adoption of new or revisions to existing ordinances or incorporation of new standards that will directly protect water resources such as groundwater/aquifers, and surface waters and wetlands and their buffer areas. Regulatory options include zoning ordinances and land development regulations which are summarized in Table 22.

Table 22: Municipal Land Use Regulations, Policies, and Land Conservation

Action Item	Description	Responsible Party	Funding	Schedule
Develop a regulation pertaining to inspection and replacement of failing septic systems in the Sunrise Lake watershed	This regulation, which would be adopted by the Town's Health Officer, would help determine if there are failed septic systems in proximity (~250ft) to the lake, conduct inspections, and enforce any necessary replacements and/or upgrades	SLLA, HS, SLE, SLVD, Health Officer, Board of Selectmen, SRPC	NHDES grants	Propose within the next 3-5 years
Develop a pump out regulation in the Sunrise Lake watershed	This regulation, which would be adopted by the Town's Health Officer, would require lakefront property owners to pump their septic tanks at least once every three years	SLLA, HS, SLE, SLVD, Health Officer, Board of Selectmen, SRPC	NHDES grants	Propose within the next 3-5 years
Review the Town's environmental regulations, such as the Wetland Conservation District and Open Space Conservation/ Cluster Development	Conduct an audit on existing regulations using the latest guidance to make recommended amendments that may include ways to provide additional protections to the lake, such as a 50ft no-disturb vegetative buffer and impervious coverage limitations.	SLLA, HS, SLE, SLVD, Planning Board, SRPC	NHDES grants	Propose within the next 2-3 years
Review Town's base zoning, specifically the Sunrise Lake District, and performance standards for areas with the Shoreland District	Conduct an audit on existing regulations using the latest guidance to make recommended amendments that may include additional dimensional requirements for the Sunrise Lake District and restrictions that go beyond the state's shoreland protection act	SLLA, HS, SLE, SLVD, Planning Board, SRPC	NHDES grants	Propose within the next 2-3 years
Review Town's site plan and subdivision regulations	Conduct an audit on existing land use regulations to make recommended revisions that may include improvements to development standards, landscaping, and stormwater management	SLLA, HS, SLE, SLVD, Planning Board, SRPC	NHDES grants	Propose within the next 2-3 years
Explore partnerships at the regional and statewide level to obtain funding for additional land conservation efforts around the lake	Regional and statewide land conservation organizations, such as SELT, MMRG, the Forest Society, TNC and the Lakes Region Conservation Trust, can help provide funding and stewardship for land protection activities.	SLLA, HS, SLE, SLVD, Conservation Commission, SRPC	NHDES, LCHIP, and other grants	Propose within the next 2-3 years

Each regulatory option described above has its specific process for adoption and jurisdictional limitations. Zoning ordinances apply to all land and activities that take place on it whether a permit is required or not (e.g. Zoning Board, Planning Board or Building Permit). Land development regulations apply to development for which a permit is sought from the Planning Board including, subdivision of land or Site Plan Review, which covers all non-residential and multi-family development.

Zoning ordinance amendments are approved by voters by warrant article at town meeting. Typically, quite a lot of public outreach is implemented in advance of proposing a warrant article and the final vote. Site Plan Review Regulation and Subdivision Regulation amendments are administered and approved by the Planning Board through a public hearing process and the amendment process can occur at any point in the year.

6.5 Watershed Outreach (Category 5)

As previously mentioned in Section 1.3.3, there are a several ongoing watershed outreach campaigns that are aimed at increasing public education on impacts affecting the lake and efforts that can be done to protection and improve the water quality of the lake, including participation in VLAP, milfoil mitigation, and the distribution of the Sunrise Lake Chronicle. In addition to these efforts, other entities in the watershed such as neighboring municipalities, SRPC, NHDES, NH LAKES, the Cocheco River Local Advisory Committee, UNH, regional land trusts such as Southeast Land Trust (SELT) and Moose Mountains Regional greenways (MMRG), and others will likely have a role to play in communicating important information about lake water quality, restoration, and protection.

The importance of education and outreach cannot be understated. Outreach programs will enhance public understanding of the issues facing the lake and will encourage informed, engaged community-wide participation to ensure that the management actions in the plan are implemented. Table 23 below provides an overview of potential outreach activities and partners for implementation.

Table 23: Outreach Matrix

Action Item	Description	Responsible Party	Funding	Schedule
Continue using Sunrise Lake Chronicle	Publicize opportunities for funding and ways to implement plan	SLLA, HS, SLE	N/a	Quarterly
Expand Lake Association Annual Meetings	Educate landowners on upcoming events, presentations from water quality experts, and review existing goals in plan	SLLA, HS, SLE	N/a	Yearly
Update Town of Middleton website	Consider moving all the Sunrise Lake information from the Conservation Commission's page to its own page	Town staff	N/a	6 months

Action Item	Description	Responsible Party	Funding	Schedule
Encourage Highway Department staff to participate in Green SnowPro and SALT applicator certification	Participation in this training to employ best management practices in snow and ice management in the communities	Road Agent	$60 per person for municipalities	6 months – 1 year
Consider creating one lake association	It may make sense to create one lake association for a more centralized, coordinated effort to implement actions in the plan	SLLA, HS, SLE	N/A	1 – 2 years

7.0 Schedule and Milestones (Elements F and G)

The project schedule and milestones presented in this section will enable project partners to track management activities over time as the Sunrise Lake Watershed Management Plan is implemented.

The schedule is designed to ensure that nonpoint source management measures presented in the plan are implemented in a timeframe that is reasonably expeditious. The milestones are a set of success indicators for determining if management measures or other control measures are being implemented. Both elements are critical tools for tracking programmatic success over time.

7.1 Schedule

An Implementation Schedule for the Sunrise Lake Watershed Management Plan is presented in Table 24. The schedule will be evaluated annually and revised as needed according to actual progress.

Table 24: Implementation Schedule

Implementation Task	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
1.0 Finalize Sunrise Lake plan and distribute											
2.0 Implement structural BMPS											
2.1 BMP implementation assessment & planning											
2.2 Round 1 BMP implementation											
2.3 Continue planning and implementing BMPs											
2.4 BMP operation and maintenance tracking											
4.0 Implement non-structural BMPs, septic system projects, and outreach											
5.0 Monitor water quality											
6.0 Review progress and report to project partners											

7.2 Milestones

A description of interim, measurable milestones for determining if NPS management measures are being implemented, is presented in Table 25.

Table 25: Sunrise Lake Watershed Implementation Milestones

Management Measure	Milestones
Watershed plan development	• The Sunrise Lake Watershed Management Plan is complete and publicly available • Efforts are underway to conduct outreach for the plan and build capacity for implementation
Structural BMP implementation	• Number of BMPs implemented and pollutant load reduction estimates documented • Operation and maintenance plans developed and tracked
Non-structural BMP implementation	• Annual metrics tracked and documented • Pounds per year pollutant load reduction tracked and credited for non-structural practices
Septic systems	• Number of systems upgraded • Pollutant load reduction estimates documented
Watershed outreach	• Number of outreach materials and events produced • Number of participants in outreach events tracked
Water quality monitoring	• Monitoring conducted annually and reports/data evaluated to assess progress toward attaining water quality goals
Implementation tracking	• Plan implementation progress tracked and reported to stakeholders every two years • Adaptive management approaches developed, if needed

8.0 Success Indicators and Evaluation (Element H)

Success Indicators are a set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining the plan's water quality goal. If goals are not being met, evaluation methods are provided for determining whether the plan needs to be revised.

As discussed in Section 4, the current average summer epilimnetic in-lake TP concentration for Sunrise Lake is nine micrograms per liter from monitoring data. In order to see fewer cyanobacteria blooms, a water quality goal was set for the plan with a target epilimnetic in-lake concentration target of 7.2 micrograms per liter. To meet this goal, the annual TP load to the lake from all sources needs to be reduced by approximately 30 kilograms per year.

This water quality goal established provides a framework for establishing numeric and narrative restoration indicators to 1) measure whether the in-lake TP concentration becomes lower as restoration measures are implemented, and 2) track the frequency of cyanobacteria blooms to determine if bloom frequency is reduced as TP loads decline.

To determine if lake management measures are effective in attaining water quality goals, the restoration indicators and targets shown in Table 26 will be measured and tracked as this watershed plan and future phases are implemented.

Table 26: Success Indicators and Evaluation Measures

Water Quality Indicator	Current Conditions	Target
Annual TP load (modeled)[1]	150 kg/yr	120 kg/yr
Annual average TP concentration (measured)[1]	9.0 µg/l	7.2 µg/l
Annual average chlorophyll-a (measured)	4.3 µg/l	3.5 µg/l
Secchi disk transparency depth (measured)	4.2 m	5 m
Days of algal bloom (modeled)[1,2]	10 days	3 days
Evaluation methods: If regular progress reporting as shown in **Table 24 – Implementation schedule** shows that the restoration targets are not being met, project partners will convene to evaluate and develop adaptive management approaches for meeting water quality goals and standards.		
[1] Values based on Sunrise Lake LLRM output (DKWRC 2021) [2] Current probability of algal bloom >10 µg/l is 2.7% (10 days/yr); predicted future probability is 0.9% (3 days/yr)		

9.0 Monitoring Plan (Element I)

The goals of the watershed plan are primarily expressed in terms of lake water quality. To determine progress towards the goal, a robust monitoring program as programs to reduce TP input are implemented. These efforts will represent a substantial increase in efforts from the past. Results of these efforts will also help the implementation to proceed in an adaptive manner which may result in modifications or additions to the plan to encourage actions that have been helpful and less emphasis on those that are not effective.

In-lake monitoring following NHVLAP (NHDES 2014) protocols should occur in the deep spot of the lake as soon as practicable after ice-out and monthly from mid-May through mid-October. After mid-October, monitoring should occur include one event after turnover before the lake freezes. It is estimated that this will result in 5 lake monitoring events over the course of a typical year. If the lake is stratified, even weakly, TP samples should be collected both by epilimnetic core and near the sediments (within 0.5 meter) otherwise, epilimnetic core samples are sufficient. These data can be used to assess the variability of water quality in Sunrise Lake and detect seasonal change which is not currently possible since monitoring typically only takes place once per year. Continued monitoring of the phytoplankton community of Sunrise Lake, particularly during blooms is critical to understanding the dynamics of the various groups of phytoplankton and the implications for designated uses of the lake.

A recommended schedule is presented in Table 27 and a list of parameters is presented in Table 28. It should be noted that both the location and frequency of monitoring should be reevaluated at least annually and can be adjusted over time in response to changes in field conditions, evaluation of data and management priorities.

Tributary monitoring should be conducted at a minimum three times each year at Hampshire Brook, Tanglewood Brook and the Unnamed Brook. Monitoring will target three separate runoff events roughly coinciding with spring, summer and fall depending on precipitation patterns. Since flow in many of the small tributaries is primarily storm related, monitoring will occur as soon as practicable after a rainfall of at least 0.25 inches or a period of snowmelt. One event will occur in spring prior to leaf-out. The second event will occur in the mid-summer and the third event will occur in the mid-fall. Sample analyses will be performed by NHVLAP. This monitoring is expected to be shore based with grab sample collection. Tributary samples should be collected as close to the point of discharge to the lake as possible without sampling water from the lake. A schedule is presented in Table 27 while parameters are in Table 28. Consistently high readings of one or more parameters may trigger additional investigation upstream in the tributary to identify the source of the high readings.

Table 27: Recommended Baseline Monitoring Schedule

Target Period	Frequency	Target Conditions	Location
Within 2 weeks of ice out	Once/yr	Spring turnover-well mixed	Deep station (2 depths if stratified)
Spring	Once/yr	Pre leaf-out spring runoff	Tributary stations
May through mid-October	Three times (mid-June, early August, mid-September)	Growing season	Deep station (2 depths if stratified)
Summer	Once/yr	Summer rain event	Tributary Stations
Late fall	Once/yr	Fully mixed pre-winter	Deep station (2 depths if stratified)
Late summer/early fall	Once/yr	Fall runoff event	Tributary Stations

Table 28: List of Parameters Recommended for the Sunrise Lake Baseline Monitoring Program

Laboratory Parameter	Field Parameter
Lake Deep Station	
Chlorophyll-*a* (Chl-a) (epilimnetic core only) Dissolved color Total phosphorus as P (TP) Phytoplankton identification/counts during blooms only	Temperature (T) (profile) Dissolved Oxygen (DO) (profile) pH (from epilimnetic core) Secchi transparency Specific conductance (profile)
Optional Phytoplankton identification (from epilimnetic cores)	*Optional* Phycocyanin (from epilimnetic core) Flow from major tributaries
Tributary Stations	
TP	Temperature Specific Conductance

Consideration should be made to evaluate flow into Sunrise Lake via the major tributaries. This can be accomplished through installation of staff gages and development of calibration curves for each gage. This will allow calculation of TP loads from each tributary when tributary TP concentrations are combined with flow data.

Evaluation of the limited historic water quality data suggests that while there have been episodes of poorer water quality throughout the time period, most of the time water quality supported the designated uses of Sunrise Lake. A goal that includes supporting designated uses all of the time is a worthy one to pursue. Reaching that goal will require a commitment to watershed management as well as water quality monitoring.

10.0 Funding for Future Watershed Planning Phases and Implementation

Implementation of BMP projects, management recommendations, and additional phases of planning for Sunrise Lake will require significant financial support from diverse sources. State and federal grants, local contributions, private funding, and grants from other sources such as foundations will be required to conduct implementation activities and future phases of planning.

As the plan evolves, formation of a funding subcommittee would be a critical step for building local ownership and capacity for fundraising and project management. The following list summarizes potential sources of funding; however, this is list is not exhaustive and efforts should be made at the local level to continue to identify potential sources of support for watershed planning and management.

- **Aquatic Resource Mitigation Fund (ARM)**
  When there are unavoidable impacts to streams and wetlands, the ARM Fund offers an alternative to permittee-responsible mitigation. An In-Lieu Fee (ILF) payment may be made to the ARM Fund to compensate for losses to aquatic resources and functions from a project. The funds are pooled according to nine watersheds called Service Areas, and then made available as competitive grants to fund preservation, restoration, and enhancement activities across the state. As the ILF sponsor, NHDES holds and manages the collected funds, and announces a grant round (i.e., Request for Proposals) annually. The goal of the program is to support conservation activities that are ecologically important and will effectively sustain aquatic resource functions in the watershed for the long term.

  Aquatic Resource Mitigation Fund | NH Department of Environmental Services

- **Land & Community Heritage Investment Program (LCHIP)**
  The New Hampshire Land and Community Heritage Investment Program (LCHIP) is an independent state authority that makes matching grants to NH communities and non-profits to conserve and preserve New Hampshire's most important natural, cultural, and historic resources. Through this investment Program every $1 in resources brings back more than four times local, private, federal funds, and helps to secure NH's greatest business advantage: The quality of life and traditional values of our state.

  LCHIP works in partnership with New Hampshire municipalities and non-profits to acquire land and cultural resources, or interests therein, with local, regional, and statewide significance. The legislatively mandated mission of the program is to ensure the perpetual contribution of these resources to the economy, environment, and quality of life in New Hampshire

  Land & Community Heritage Investment Program

- **NH State Conservation Committee (SCC) Grant Program (Moose Plate Grants)**
  County Conservation Districts, municipalities (including commissions engaged in conservation programs), and qualified nonprofit organizations are eligible to apply for the SCC grant program. Projects must qualify in one of the following categories: Water Quality and Quantity; Wildlife

Habitat; Soil Conservation and Flooding; Best Management Practices; Conservation Planning; and Land Conservation.

Conservation Grant Program | State Conservation Committee | NH Department of Agriculture, Markets and Food

- **Great Bay Resource Protection Partnership: Land Transaction Grant Program**
  The Great Bay Resource Protection Partnership offers the Land Protection Transaction Grant Program. The matching grants program assists with the costs for permanent land protection projects (donation and/or acquisition of full fee and conservation easements) within the coastal watershed including coastal New Hampshire and part of southern Maine. Eligible applicants include qualified nonprofit tax-exempt 501(c)(3) conservation organizations and units of government.

  Great Bay Resource Protection Partnership: Land Transaction Grant Program

- **Clean Water State Revolving Loan Fund (CWSRF)**
  This fund offered through NHDES provides low-interest loans to communities, nonprofits, and other local government entities to improve and replace wastewater collection systems with the goal of protecting public health and improving water quality. A portion of the CWSRF program is used to fund nonpoint source, watershed protection and restoration, and estuary management projects that help improve and protect water quality in New Hampshire.

  Clean Water State Revolving Fund | NH Department of Environmental Services

- **Milfoil and Other Exotic Plant Prevention Grants**
  NHDES provides funding each year for eligible projects that prevent new infestations of exotic plants, including outreach, education, Lake Host Programs, and other activities

  Invasive Species | NH Department of Environmental Services

- **New England Grassroots Environmental Fund**
  The Grassroots Fund's grant programs are designed to energize and nurture long term civic engagement in local initiatives that create and maintain healthy, just, safe and environmentally sustainable communities.

  https://grassrootsfund.org/

- **New Hampshire Charitable Foundation**
  A statewide community foundation that awards multiple types of grants, including ones for environmental projects.

  Home - NH Charitable Foundation (nhcf.org)

- **Water Quality Planning Grants**
  Water Quality Planning grants are available to Regional Planning Commissions and/or the Connecticut River Joint Commissions for water quality planning purposes.

  https://www.des.nh.gov/business-and-community/loans-and-grants/watershed-assistance#faq37046

- **Watershed Assistance Grants**
  Competitive grant program offered annually through the NHDES Watershed Assistance Section for communities, nonprofits, and local government entities to support implementation of restoration actions to restore impaired waters and protect high-quality waters as described in completed "a – i" watershed-based management plans.

  https://www.des.nh.gov/business-and-community/loans-and-grants/watershed-assistance#faq37046

Conclusion

Watershed residents, landowners, business owners, and recreationalists alike have a vested interest in improving the long-term water quality of Sunrise Lake so that everyone can have access to clean water, free of toxic cyanobacteria blooms. As described in the plan, the lake has experienced declines in water quality in recent years and is currently classified as mesotrophic or moderately enriched with nutrients. The primary goal of the Sunrise Lake Watershed Management Plan has always been to make strides toward limiting nutrient loading to the lake such that the frequency of nuisance algal blooms is reduced.

The plan identifies management and planning goals for improving the water quality of Sunrise Lake over the next 10-15 years (2021-2036). The long-term goal is to improve the water quality and prevent the future occurrence of toxic cyanobacteria blooms. Success would mean reducing the amount of phosphorus entering the lake by 20 percent. Implementation of this plan over the next ten years will require the dedication and hard work of state and municipal employees, watershed groups, and volunteers to ensure that the actions identified in this plan are carried out accordingly.

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