LEBANON CONSERVATION COMMISSION
JUNE 11, 2026 - 6:30 PM
COUNCIL CHAMBERS, CITY HALL OR REMOTE VIA VIRTUAL PLATFORM
LEBANONNH.GOV/LIVE

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1. Call to Order

A. To participate in this meeting, please join live via Microsoft Teams or call 929-229-5356 (access code: 350 010 976#). If you have trouble accessing this meeting, please email Mark Goodwin

2. Approval of Minutes

A. May 14, 2026

3. Open to the Public

4. Permit Review

A. None

5. Study Items

A. Discussion and Comment on 2026 Mascoma Lake Watershed-Based Management Plan

B. Discussion and Comment on Natural Resource-related recommendations from the 2024 North Lebanon Community Plan

6. Committee Reports

A. Biodiversity Group (Invasives) - Garlic Mustard, Two Rivers Conservation Efforts, Highlighted Invasive - Black Swallow Wort

B. Stewardship
- Ranger
-Trail Coordinator
-Monitors and Stewards

C. Wild about Lebanon

D. Amphibian Crossings

E. LUCT/Current Use

F. Other Subcommittees

7. Other Business

A. FYIs

B. Follow Up

C. Workshops and Educational Opportunities

8. Future Agenda Items

A. Management plan for Two Rivers Conservation Area

B. Natural Resource "Checklist" for Planning Board Applications

C. Invasives Management Policy

9. Adjournment

The order of agenda items is subject to change.

Meetings are open for in-person and remote attendance. Members of the public who wish to attend remotely may do so by going to LebanonNH.gov/Live where you will find instructions on how to enter the meeting. Members of the public will be able to participate and ask questions through the City's virtual platform or by phone. Please note: Should technical difficulties occur during the meeting that disrupt virtual or phone connection(s), the meeting will continue without remote access capabilities.
Any person with a disability who wishes to attend this public meeting and needs additional accommodation, please contact the ADA coordinator at City Hall by calling 603-448-4220 at least 72 hours in advance so that the City can make any necessary arrangements.

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LEBANON CONSERVATION COMMISSION
MEETING MINUTES
Remote Via Microsoft Teams
LebanonNH.gov/Live
May 14, 2026
6:30 PM

MEMBERS PRESENT: **Sarah Riley (Chair), Andrew Faunce, Erling Heistad, Alt., Barbara Hirai, Donald Lacey, Ernst Oidtmann, Pamela Lee, Alt., Lynnette Madsen, Alt.**

MEMBERS ABSENT: **Bruce James, Vice Chair, Susan Almy, Alt., Chris Johnson**

STAFF PRESENT: **Mark Goodwin (GIS Coordinator) , Brian Vincent, City Engineer**

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1. CALL TO ORDER:

A. Chair Riley called the meeting to order at 6:32PM.

Chair Riley welcomed Mr. Erling Heistad (long standing member of ConCom) back. He will now be participating as an Alternate, along with two new Alternate Conservation Commission members, Ms. Pamela Lee., and Ms. Lynnette Madsen.

2. APPROVAL OF MINUTES:

A. February 12, 2026

Mr. Ernst Oidtmann MOVED to approve the Minutes of February 12, 2026, as amended.
Seconded by Mr. Erling Heistad

****The MOTION was approved (5-0), 2 abstained***

B. April 9, 2026

Mr. Ernst Oidtmann MOVED to approve the minutes as amended
Seconded by Mr. Don Lacey

****The MOTION was approved (6-0), 1 abstained***

3. OPEN TO THE PUBLIC: None

4. PERMIT REVIEW:

A. *None
*Chair Riley stated that while ConCom does not have any permits to review this evening, they are potentially going to have one. There is a wetland application that the City has submitted for

some impacts to water retention basins, technically wetlands, at the landfill. They were created relatively recently and they are proposing to fill those. They total 2,888 square feet and will be impacted by the next phase of the landfill. Their function is water storage and that function will be met in other basins on the site. Chair Riley reviewed the application very thoroughly and decided to waive ConCom's right to intervene, thereby speeding up this process.

Mr. Goodwin explained the permit review process to the new members and said that the State of New Hampshire Department of Environmental process. ConCom intervenes on every application, by default, with the one exception, City projects. This saves the taxpayers money. This landfill that Chair Riley spoke about this evening in an example of this.

5. STUDY ITEMS: None

6. COMMITTEE REPORTS:

A. Biodiversity Group (Invasives)

Mr. Lacey said that Lynn Fisher is newly licensed as an herbicide applicator for focused applications, and she has some projects planned for Ticknor, Storrs Hill and Baker's Crossing. He explained to the new members that if used properly, they can be very tree hugger friendly.

Chair Riley then provided an update about garlic mustard**, which is an invasive plant. Pamela has a sample flyer that they've put out around the rail trail and the Mascoma River Greenway. ConCom teams up every May with the Recreational Department, to make and distribute signs and to publicize public pulling of garlic mustard. She and Ms. Hirai have been managing the pulled materials in those areas for about the past four years.

The strategy has been (and still is in most places) to black bag garlic mustard and take it to a landfill. It is labor intensive but very effective. Recently though, they used an alternative strategy of piling the garlic mustard only after pulling the plant out from its base with the roots, and then separate the stems at the base of the plants from the flowering stalks. This step is important because if it has already gone to flower and you pile up these plants, the stems will grow to the light and find their way to set seed. So it's important to manage the piles properly. They are seeing good progress and their new process is working.

Their efforts with public outreach are also working because residents are working on the trails, and in their own yards too. And of course Don Lacey has been the member working at this the longest. He acknowledged Nicole Corman saying she used to spend 10 hour days working with team to pull garlic mustard.

There will be a garlic mustard initiative event this Saturday, May 16th from 2-4PM at the Northern Rail Trail.

B. Stewardship

-Ranger

Mr. Goodwin introduced the Ranger concept. The Ranger is seasonal, and ConCom has a small budget for this role of stewardship for approximately 2,000 acres and this ranger clears the trails and makes sure that they are draining properly. He has a variety of other responsibilities such as blazing boundaries, investigating trespassing, making signs, etc. We have been fortunate the last two years to have Ranger Neil working part time for the City. This year he is completing his work early, by the end of May, because he will be starting his graduate program in Forestry Management in June. So far this year he has blazed three properties (identifies where property boundaries are but only last about 5 years/a red blotch

of paint). Contracting out for this is very expensive. He should be completely current on all boundary blazing before he leaves.

Also he has been up the Summit of Signal Hill trying to maintain the edges. Ron Bailey, a former ranger, has been helping him. They have two other priority projects, the buckhorns, and the signage, including completing kiosks with maps.

We will pause this work for the summer and then reassess needs in the Fall and possibly bring a ranger back in again at that time. Mr. Goodwin confirmed that they have purchased an electric chainsaw for Neil to use for smaller diameter trees (6"-8"). Neil has had safety training with chain saws. Mr. Goodwin uses bigger equipment and gets out and helps Neil with larger diameter trees.

He added that all of our conservation properties have standing kiosks at the entryways. They include the name of the property along with a map of the area.

-Trail Coordinator

Our trail coordinator is Vice Chair Bruce James. At the last meeting he shared that the Mountain Bike Association is going to be working on Lakeside Trail, on May 20th, at 5:00PM.

-Monitors and Stewards

Ms. Hirai (Steward) said that she had coordinated with Holly at Hypertherm to work along with 22 volunteers tomorrow at Two Rivers Conservation Area. Hypertherm does this a 2-3 times each year, clearing trails and removing invasives, but the weather prediction is not good so they have moved this to May 29th. Hypertherm has made noticeable progress in this area.

Mr. Goodwin mentioned that volunteer forms are to be completed by all volunteers.

Another member noted that the form is only good for one year, and that it is a cumbersome form to complete electronically. The idea was posed of being able to use paper forms. Chair Riley and Mr. Faunce will discuss this topic further.

Mr. Lacey thinks he'll be able to get out and mow at Twin Rivers sometime after July 29th. He also mows at Baker's Crossing.

He has recently learned that he cannot be reimbursed for his own expenses, gas, wear and tear on his equipment, etc.

Mr. Faunce suggested that ConCom, along with other commissions and task force, come together to discuss their interests, needs, and overlapping challenges and then maybe together they come up with a solution and present a coordinated effort in a single conversation to inform the City Manager's office of what they need in their roles as volunteers.

Chair Riley said that they had a blueberry workday at Jackson Conservation on May 3rd. It went well and they had approximately 12 volunteers, with Lynn Fisher leading the charge. Also, John Collier, a repeat volunteer came with a battery powered long armed lopper and it helps him get a lot of work done. She added that the blueberry shrubs are looking great, and because of the mowing done last year, the paths are also in great shape.

Chair Riley said that the ash trees up on Starr Hill are getting hit hard by ash borer, in both the conserved and un-conserved areas. The vernal pools there are also full of egg masses, spotted salamanders, and wood frogs. She enjoys going up there.

She is concerned because she saw fresh wetland flags at the APD property. She is concerned they are looking to develop housing.

The City Manager suggested that ConCom arrange to do their own site visit at Martin Brook. Jason Berard with the Upper Valley Land Trust wrote about this in Field Notes Friday and showed some of the work that the foresters had done. The airport has a navigation easement so for safety concerns, they must be managed. Many of the trees here have been handled in an ecologically well thought out manner rather than going in and chopping everything down. Chair Riley said that mimicking natural blow downs and doing some girdling to create some standing dead is great for wildlife.

C. Wild about Lebanon None

D. Amphibian Crossings

Today Chair Riley asked DPW to take down the signs since the most exciting part of the season is over.

Looking ahead to next year, she plans to ask DPW to put the signs up earlier in the year, and to ask that the messaging be changed, as was discussed in a recent ConCom meeting. She has this as an action item.

She shared that a reporter from the Valley News had gone out with Chris Johnson, ConCom member, and published a short article along with some pictures, published on April 22nd. There was also a video on Instagram. She said Chris did a great job representing the Conservation Commission.

E. LUCT/Current Use

Chair Riley has again asked the Finance Department for more frequent and regular and comprehensive account statements. She is waiting to hear back from them.

F. Other Subcommittees

Mr. Faunce said since he is no longer the Chair of the Planning Board, she might want to get with Karen on any PB matters.

Chair Riley said that the Tree Board is very busy getting trees planted around the city. The next opportunity to help with this initiative is this Saturday morning, starting at 9:00AM. If anybody wants to dig in the ground, they are starting at Riverside, at the skate park on Glen Road. They'll be planting a number of trees there, replacing some trees that were vandalized and some to replace the anticipated demise of some ash trees that are currently on that site. From there they will go to the Memorial Pool and plant several trees there as well.

One of the recommendations of the Environmental Task Force was to bring a Soil Shop event to Lebanon. Soil Shop is a New Hampshire DES program that provides free soil screening for lead. They will be at the Farmers' Market May 28th and then also May 28th running through June 5th, so people can drop off their soil samples at the Kilton Library. This information will also be posted on the City's website.

7. **OTHER BUSINESS:**

Since there are new members, everyone was invited to introduce themselves and share a bit of their background.

Ms. Barbara Hirai previously served with LEAC (Lebanon Energy Advisory Commission) and subsequently joined ConCom several years ago. She was a high school biology teacher. She works a lot on invasives and enjoys walking.

Mr. Earling Heistad was at Dartmouth College for 39 years. He has served on several commissions and he also served as a City Councilor for numerous years. He said by serving, you understand a lot more about the City of Lebanon and what its needs are. He thanked the new members for serving.

Mr. Don Lacey has served on ConCom for many years. He does a lot of work with invasives, does much of the mowing and maintenance work needs on conserved lands, and he is expert on native plants as well. He is a retired physician.

Mr. Ernst Oidtmann has been serving on the Conservation Commission for 18 years, many of those years as the Chair. He started organizing the Mascoma River cleanups back in 1996 and did that for several years. He was a practicing family physician for 40 years and just retired in 2019. He used to make house calls and has seen a lot in his time.

He grew up in Holland. He likes to hike one to two hours each day. He is also a longstanding member of the Rotary Club and plays piano for them at their weekly meetings. Some of his model ships are on display at Dartmouth Hitchcock Medical Center.

Ms. Lynnette Madsen is a new Alternate member. She is pleased to be invited to join ConCom. She also serves on the Pedestrian & Bicycle Advisory Committee. She moved to the area about a year ago. She enjoys walking. She also has interest in helping with any ConCom ADA discussions or initiatives.

Mr. Andrew Faunce is a relatively new member to ConCom as a Council Representative. He is also a newly elected City Councilor, having previously served three years on the Planning Board, most recently as the Chair. He is also currently serving on the Lebanon Housing Task Force. He previously worked with the Lebanon Revitalization Committee. Additionally, he volunteers at Ava Gallery, where he also serves on the Board of Directors.

As a result of these roles, he believes that Conservation and Planning can work more functionally and beneficially by working together more.

Ms. Pamela Lee is also a new Alternate member and has been a resident of West Lebanon since 2005. She was invited here to work on her post-doctoral at Dartmouth Medical and subsequently got wonderful training with two local doctors for a few years. After that she went to the Veteran's Hospital in White River Junction and has been serving there for the past 19 years.

She feels like this place has given her so much as a home and she wanted to find a way to become involved in her community. In addition to her work, she is passionate about conservation, birds, and invasives. She is happy to be serving.

Chair Riley said that she has been serving on the Conservation Commission since 2017, first as an Alternate. Then when Mr. Oidtmann stepped down as Chair, she stepped into that role.
She also serves on the Tree Board and the Lebanon Housing Task Force, representing ConCom for both, and she is the acting Chair for the Mascoma River Local Advisory Committee (LAC).

She and her husband have lived in Lebanon since 2007. They have a 14 year old son. Since she lives only about ½ mile from City Hall, she is able to walk or ride to many meetings. Her background is in plant ecology.

Mr. Mark Goodwin, (GIS Coordinator, Planning office, City of Lebanon) is the staff liaison. He has been with the City for 23 years and came here from Flagstaff where he worked with the EPA as an international consultant. His background is in natural resource management as well as planning, and he completed his thesis on biodiversity and landscape ecology. Day to day he does a lot of property management and hands on stewardship himself, on the various City of Lebanon conserved properties

He's an empty nester now so he has the opportunity to get up at 4:30AM to enjoy and work on a 250 acre woodlot he has about an hour from Lebanon, along with the work he does for the City both in and outside the office.

Earlier in the meeting Ms. Hirai asked to revisit their Goals for 2026 and Chair Riley projected these on the room screen.

Chair Riley said they would cover this briefly and encouraged new members to familiarize themselves with the Conservation Commissions categories and goals.

The four categories (bolded) include:

Property Stewardship: Most recently they are working on obtaining a new City conservation land, the Rudder property, which is across the street from the Signal Hill property. The Land Trust will be implementing a plan for maintaining that land.

Conservation Commission is also responsible for trail maintenance and infrastructure needs of many conservation properties, trails, signage, kiosks, maps, etc. For example the work that Mr. Goodwin was describing earlier, work done by the Ranger, by Mr. Lacey, and by himself, and others.

Mr. Oidtmann mentioned handicap issues brought to light recently by a speaker who came to the Rotary meeting, she was in a wheelchair and was the Wheelchair Women's Champion in New Hampshire, and she pointed out many access things from the perspective of being handicapped.

There was much interest from this group and so Chair Riley agreed to include Ms. Madsen, Ms. Lee, and Ms. Hirai in on any pertinent communications or opportunities.

Chair Riley suggested a field trip to Distant Hills in Walpole, that has some accessible trails. All members are interested in participating.

Education/Outreach

ConCom played a small role in the 2025 Mascoma River Watershed Planning Study, and the final report is now complete. Mr. Goodwin said this will be discussed at an upcoming Planning Board meeting, and he will then update ConCom.

Mr. Goodwin had said in a previous meeting that this report is only a document, unless action is taken. They need someone to spearhead this initiative.

Mascoma River cleanup is done every two years and is currently in the pipeline, per Mr. Oidtmann.

She explained their interest in the Deer Management Assistance Program(DMAP). We need to try to manage our deer population, because the deer overpopulation is negatively impacting the structure and health of our forests. This is because the deer eat the tree seedlings or saplings that are trying to regenerate to become the next generation of canopy trees. This also has a negative effect on the understory.

Hanover is spearheading this DMAP project. Lebanon has enough land to qualify for this program and so ConCom needs to reach out to City Council and they also need to reach out to landowners.

Land Conservation

Chair Riley likened Land Conservation as their "marathon" and she encourages new members to look into the National Resources Inventory (NRI), which explains why certain places are special and what makes them special. This influences what they might want to protect.

She wants to work to implement some of the recommendations by the Northern Lebanon Study. They have been working in part with the UNH Extension to examine the applicability of a vernal pool overlay district which would add protections to not only the wetland itself but also maybe add a buffer.

Miscellaneous

Another important goal is to incorporate aquatic passage and wildlife friendly design into culvert replacement projects city-wide in line with NH Stream Crossing Initiative.

Working with DPW to reduce road salt use near sensitive habitat areas is also of concern. She has asked DPW questions online but hasn't looked to see if there are ways to further reduce our road salt use in sensitive areas.

It was noted that these goals were pulled from Chapter 5 in the Master Plan; which is also available to read.

A. FYIs

Regarding the unnamed stream crossing Hanover Street extension, DES has requested more information from the City. They've also asked for information on the Interstate 89 permit and reminded the applicants that they need to answer the Conservation Commission's question, which they have not done so far. They have a limited number of days to do so.

Mr. Goodwin shared that the Agenda goes out one week before each meeting, so if any members have anything they would like on the agenda, please let Mr. Goodwin and Ms. Taplin know. It is preferred and helpful to have these be submitted no later than the Wednesday before the following Thursday's meeting.

Mr. Ernst Oidtmann shared that he will not be renewing his ConCom membership when it expires. His last meeting will be in June. He shared that he might sit in the audience for some meetings. He added that he has enjoyed 18 years of being on the Conservation Commission.

B. Follow Up-None

C. Workshops and Educational Opportunities-None

8. FUTURE AGENDA ITEMS:

9. ADJOURNMENT:

Ms. Hirai MOVED for adjournment
Seconded by Mr. Heistad

****The MOTION was approved (7-0)***

The meeting adjourned at 8:58 PM.

Respectfully submitted,
Cinda Mersel
Recording Secretary

** Garlic mustard is a shade tolerant, aggressive plant and is known for crowding out native wildflowers and vegetation, and it also releases chemical into the soil that then inhibit the growth of other plants. It has no natural predators. It is edible.
*** ConCom 2026 Goals (Draft) can be found in the Agenda Packet for their January 8, 2026 meeting.

Agenda
Lebanon Conservation Commission
11 June 2026

Study Item

Mascoma Lake Watershed-Based Management Plan, published April 2026.

Discuss and recommend actions for City of Lebanon for (1) the Mascoma Lake watershed and (2) other watersheds in the city.

Link to the project page on the City's website:

Mascoma Lake Watershed Management Plan Project | Lebanon, NH

The direct link to the final plan: MascomaLakeWBMP_2026-04-29_withconcepts.pdf

A folder with all final deliverables for the project: Final Deliverables - Public

Focus discussion and comments on:

- **Recommendations listed in Table 19**, p86. Summary table of recommendations for natural resource protection based on the ordinance review for the municipalities of Lebanon, Enfield, and Canaan.
- **The Action Plan – sec 5.1, p101 and Table 21**, p101.

Here is a summary of the key goals, objectives, and broad action areas that are discussed in the plan.

The goal of the Mascoma Lake Watershed Based Management Plan (MLWMP) is to improve the water quality of Mascoma Lake such that it meets the state water quality standards for the protection of Aquatic Life Integrity and Primary Contact Recreation and substantially reduces the likelihood of harmful cyanobacteria blooms.

This goal will be achieved by accomplishing the following objectives related to phosphorus loading:

Objective 1: Reduce phosphorus loading from **existing** development by 4% (86 kg/yr) to Mascoma Lake.

Objective 2: Mitigate (prevent or offset) phosphorus loading from **future** development by 745 kg/yr to Mascoma Lake.

Treating all existing pollutant sources identified as coming from the external watershed load could reduce the phosphorus load to Mascoma Lake by approximately 86 kg/yr, which meets 100% of Objective 1.

Strategy 1: Remediate the 5 sites that the consultant identified along Mascoma Lake.
Contribution to Objective: prevent up to 1.5 kg/yr of phosphorus from entering Mascoma Lake.
Comment: These sites are all located in Enfield, so do not prompt action here in Lebanon. But are there similar sites with similar problems elsewhere in Lebanon, not necessarily in the Lake watershed?

Strategy 2: Treating vulnerable* shoreline sites as identified from the shoreline vulnerability analysis. See Map A-6 on p132 to get a sense of where these 100 sites are located; see section 3.1.3 on p63 for discussion.

> **Vulnerable indicates they may be more susceptible to erosion or contribute greater amounts of runoff from more densely developed areas or homes built closer to the shoreline. (Table 13).*

Contribution to Objective: could reduce the phosphorus load to Mascoma Lake by 30.4 kg/yr.
Comment: Recommendations largely include improving shoreline vegetated buffers. Encouraging landowners to plant and/or maintain vegetated buffers as a stormwater control measure along their shoreline, particularly in areas of bare soil, will help mitigate erosion and reduce sediment and nutrient loading to the lake.

Strategy 3: Upgrading the 222 known shorefront septic systems along Mascoma Lake (139) and Crystal Lake (83) that are older than 25 years.
Contribution to Objective: is estimated to reduce the phosphorus load to Mascoma Lake by 22.2 kg/yr.
Comment: Are any of these sites in Lebanon? Where in Lebanon do we have shorefront septic systems of that age?

Strategy 4: Mitigate the impacts of unpaved roads less than 50 feet from a surface water throughout the watershed
Contribution to Objective: could prevent about 30.6 kg/yr of phosphorus load to Mascoma Lake.
Comment: Find out where these roads are in Lebanon. How to mitigate impacts?

The report documented these Lebanon roads or sections of roads as problematic:

Paved

Street Name	Feet
Dartmouth College Hwy	393.34044260667
NH Route 4A	146.880371817854
Route 4A	54.3666949512038
Rudsboro Rd	703.085481213971

Unpaved

Street Name	Feet
Ice House Rd	107.361477104598
No Name	326.108047400613

Strategy 5: Stabilizing the banks around culverts assessed as vulnerable by NHDES in the watershed (n=4). See Table 14 on p59, figure 20 on p62.
Contribution to Objective: could prevent about 1.4 kg/yr in phosphorus load to Mascoma Lake.
Comment: Two of the four are in Lebanon.

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

Development should be restricted in areas with severe erosion hazards due to their inherent tendency to erode at a greater rate than what is considered tolerable soil loss.
Since a highly erodible soil can have greater negative impact on water quality, more effort and investment are required to maintain its stability and function within the landscape, particularly from BMPs that protect steep slopes from development and/or prevent stormwater runoff from reaching water resources. Other areas prone to erosion include steeply sloped areas and areas with roadways within 50 feet of the waterbody (Appendix A; Map A-8).

Section 4.2.2 Zoning and Ordinance Updates (p76) lists **strategies to minimize adverse effects associated with climate change**, several of which are partially addressed in existing ordinances but could be further strengthened and expanded:

1. Installing Green Infrastructure and Nature-Based Solutions
2. Using LID Strategies.
3. Minimizing Impervious Surfaces
4. Encouraging Riparian Buffers and Maintaining Floodplains
5. Protecting and Re-establishing Wetlands
6. Encouraging Tree Planting
7. Promoting Landscaping Using Native Vegetation
8. Slowing Down the Flow of Stormwater
9. Coordinating Infrastructure, Housing, and Transportation Planning

MASCOMA LAKE

WATERSHED-BASED MANAGEMENT PLAN

PREPARED BY FB ENVIRONMENTAL ASSOCIATES

in partnership with the City of Lebanon and Vanasse Hangen Brustlin (VHB)

April 2026

MASCOMA LAKE

WATERSHED-BASED MANAGEMENT PLAN

April 2026 | **FINAL**

Prepared by **FB ENVIRONMENTAL ASSOCIATES**
in partnership with the City of Lebanon and Vanasse Hangen Brustlin (VHB)

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Funding for this project was provided by the New Hampshire Department of Environmental Services under the Clean Water State Revolving Fund.

Cover Photo: © Mascoma Lake Association

ACKNOWLEDGEMENTS

STEERING COMMITTEE

Robert Buras, Water Treatment Superintendent, City of Lebanon
Rick Brown, Assistant Director of Public Works, City of Lebanon
Sarah Riley, Conservation Commission, City of Lebanon
Mark Goodwin, GIS Coordinator, City of Lebanon
Shirley Green, Conservation Commission Chair, Crystal Lake Association, Town of Enfield
Ed Morris, Town Manager, Town of Enfield
Christina Hall, Deputy Director of Engineering and Utilities, Town of Hanover
Dylan McDermott, Water Treatment Superintendent, Town of Hanover
Robert Barr, Treasurer, Mascoma Lake Association
James Martel, Mascoma Lake Association, Member
Dan Regan, Crystal Lake Association, Member
James Jukosky, Town of Canaan, Member
Meghan Butts, Executive Director, Upper Valley Lake Sunapee Regional Planning Commission

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Ben Miller, Project Engineer, VHB

For questions, comments, or additional information related to the Mascoma Lake Watershed-Based Management Plan, please contact the City of Lebanon.

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LIST OF ABBREVIATIONS

ACRONYM	DEFINITION
ACEP	Agricultural Conservation Easement Program
ALI	Aquatic life integrity
ALS	Amyotrophic lateral sclerosis (also known as Lou Gehrig's disease)
AIPC	Aquatic Invasive Plant Control, Prevention, and Research Grants
BMAA	β-methylamino-L-alanine (neurotoxin produced by cyanobacteria)
CAGR	Compound annual growth rate
CSP	Conservation Stewardship Program
CWSRF	Clean Water State Revolving Fund
EPA	United States Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
FBE	FB Environmental Associates
GCCD	Grafton County Conservation District
ILFP	In-lieu fee program
kg/yr	Kilograms per year
LCHIP	Land and Community Heritage Investment Program
LLRM	Lake Loading Response Model
LWCF	Land and Water Conservation Fund
MLA	Mascoma Lake Association
MS4	Municipal Separate Sewer Storm System
NAWCA	North American Wetlands Conservation Act
NEFRG	Northeast Forest and River Fund
NFWF	National Fish and Wildlife Foundation
NHDES	New Hampshire Department of Environmental Services
NHDOT	New Hampshire Department of Transportation
NRCS	Natural Resources Conservation Service
PCR	Primary Contact Recreation
ppb, ppm	parts per billion, parts per million
RCPP	Regional Conservation Partnership Program
SCM	Stormwater control measure
UVLT	Upper Valley Land Trust
VLAP	Volunteer Lake Assessment Program
WBMP	Watershed-Based Management Plan

DEFINITIONS

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

Anoxia is a condition of low dissolved oxygen.

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

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

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

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

Clean Water Act requires states to establish water quality standards and conduct assessments to ensure that surface waters are clean enough to support human and ecological needs.

Cyanobacteria are photosynthetic bacteria that can grow prolifically into blooms when enough nutrients are available. Some cyanobacteria can fix nitrogen and produce microcystin, which is highly toxic to humans and other life forms.

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

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

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

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

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

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

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

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

Internal phosphorus loading is the process whereby phosphorus bound to lake bottom sediments is released back into the water column during periods of anoxia. The phosphorus can be used as fuel for plant and algae growth, creating a positive feedback to eutrophication.

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

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

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

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

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

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

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

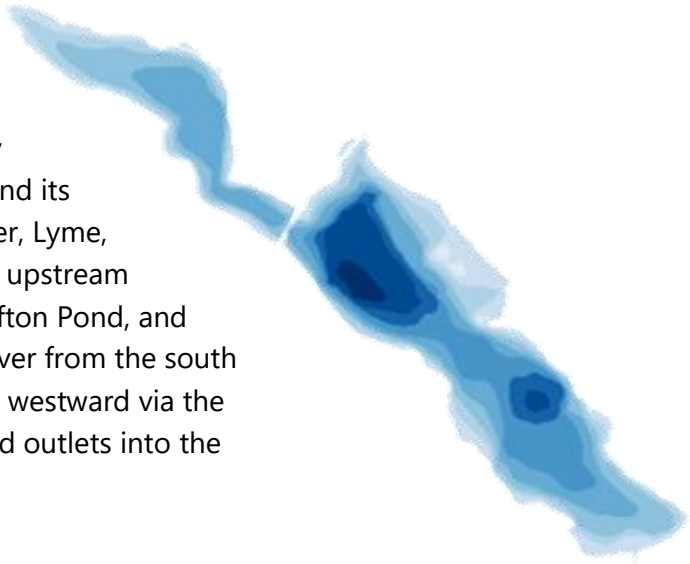
Stormwater control measures (SCMs) are practices designed to minimize discharge of nonpoint source pollution from developed land to lakes and streams. Watershed-based management plans should include both **non-structural** (non-engineered) and **structural** (engineered) SCMs for existing and new development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

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

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

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

EXECUTIVE SUMMARY



With a 98,232-acre watershed, Mascoma Lake is a 1,164-acre lake in western New Hampshire within the Upper Valley region. Mascoma Lake resides within Enfield and Lebanon, and its watershed extends into Canaan, Hanover, Orange, Dorchester, Lyme, Grafton, Springfield, and Grantham. Mascoma Lake is fed by upstream waterbodies including Goose Pond, Canaan Street Lake, Grafton Pond, and Crystal Lake. Main tributaries to the lake include the Knox River from the south and the Mascoma River from the east. Mascoma Lake drains westward via the Mascoma River, which flows through the City of Lebanon and outlets into the Connecticut River.

The Problem

Mascoma Lake is currently assessed by the New Hampshire Department of Environmental Services as an impaired waterbody under the federal Clean Water Act. Being impaired means the lake is not consistently meeting state water quality standards for designated uses. Mascoma Lake is assessed as impaired for two main reasons: (1) low dissolved oxygen, which can stress or harm fish and other aquatic life, and (2) cyanobacteria blooms, which can produce toxins that can pose health risks to people and pets during swimming and other recreational activities. Bloom frequency has increased in recent years (2022–2024), raising concerns about the lake's water quality. Cyanobacteria blooms pose risks to recreation due to potential toxin release. Since the lake feeds the Mascoma River, the primary drinking water source for the City of Lebanon, toxin exposure is a concern.

Cyanobacteria blooms are typically spurred by a combination of warming waters and excessive nutrients, in particular phosphorus, in surface waters. Sources of phosphorus in the watershed impacting the lake's water quality include stormwater runoff from developed areas largely from impervious cover, shoreline erosion, erosion from construction activities or other disturbed ground particularly along roads, excessive fertilizer application, failed or improperly functioning septic systems, leaky sewer lines, unmitigated agricultural activities, and pet, livestock, and wildlife waste. The model results revealed changes in phosphorus loading and in-lake phosphorus concentrations over time from pre-development through future conditions, showing that the water quality of Mascoma Lake is threatened by current development activities in the watershed and will degrade further with continued development in the future, especially when compounded by the effects of extreme weather events.

The Goal

The goal of the Mascoma Lake Watershed-Based Management Plan is to improve the water quality of Mascoma Lake such that it meets state water quality standards for the designated uses of aquatic life integrity and primary contact recreation for oligotrophic waterbodies and experiences substantially reduced likelihood of cyanobacteria blooms. This goal will be achieved by accomplishing the following objectives over the next 10 years and beyond:

Objective 1: Reduce phosphorus load from current watershed activities near Mascoma Lake by 86 kilograms per year (4 percent). This would result in a decrease in the average total phosphorus concentration in Mascoma Lake by 0.3 parts per billion.

Objective 2: Mitigate (prevent or offset) phosphorus loading from future development in the entire watershed by 475 kilograms per year to maintain the average total phosphorus concentration in Mascoma Lake over the next 10 years (2035).

It is important to note that, while the focus of the objectives for this plan is phosphorus, the treatment of stormwater and sediment erosion will result in the reduction of many other kinds of pollutants that may impact water quality. These pollutants include other nutrients (e.g., nitrogen), petroleum products, bacteria, road salt/sand, excessive organic material (such as raking/blowing leaves and grass cuttings into surface waters), and heavy metals (cadmium, nickel, zinc, etc.).

While any amount of phosphorus load reduction to the lake will be helpful for controlling cyanobacteria blooms, it is important to understand that the dominant cyanobacteria taxa in the lake can uptake phosphorus from sediments and store it for later use under more optimal growth conditions. Thus, the management implications for minimizing the risk of cyanobacteria blooms are not straightforward and depend on several factors, some out of our direct control. The physiological characteristics of these cyanobacteria taxa also mean that the typical application of the state's water quality standards for lakes in the form of assimilative capacity analysis may be less relevant for Mascoma Lake.

The Solution

As part of the development of the Mascoma Lake Watershed-Based Management Plan, a build-out analysis, land-use model, water quality and assimilative capacity analysis, septic system database development, shoreline desktop evaluation, and watershed survey were conducted to identify and quantify the sources of phosphorus and other pollutants to the lake. Results from these analyses were used to determine recommended management strategies for the identified pollutant sources in the watershed. An Action Plan (Section 5) was developed in collaboration with the Steering Committee comprised of key watershed stakeholders (see Acknowledgements). The following actions were recommended to meet the established water quality goal and objectives for Mascoma Lake:

WATERSHED STRUCTURAL STORMWATER CONTROL MEASURE IMPLEMENTATION: Sources of phosphorus from existing watershed development should be addressed through installation of stormwater control measures, stabilization techniques, buffer plantings, etc. for the following: stormwater infrastructure, the high priority sites (and the medium and low priority sites as opportunities arise) identified during the watershed survey (Section 3.1.2), the high and medium impact shoreline properties (and low priority properties as opportunities arise) identified during the desktop shoreline survey (Section 3.1.3), and any new or redevelopment projects in the watershed with high potential for soil erosion.

MONITORING: A long-term water quality monitoring plan is critical to evaluate the effectiveness of implementation efforts over time. Mascoma Lake Association, in concert with the New Hampshire Department of Environmental Services Volunteer Lake Assessment Program, should continue the annual monitoring program and consider incorporating additional monitoring recommendations laid out in this plan.

EDUCATION AND OUTREACH: Mascoma Lake Association, and other key watershed stakeholders, should continue all aspects of their education and outreach strategies and consider developing new ones or improving existing ones to reach more watershed residents. Examples include providing educational materials to existing and new property owners, as well as renters, by distributing them at various locations and through a variety of means, such as websites, newsletters, social media, community events, or community gathering locations. Educational campaigns should include raising awareness of water quality concerns, septic system maintenance, fertilizer and pesticide use, pet waste disposal, waterfowl feeding, invasive aquatic species, boat pollution, shoreline buffer improvements, gravel road maintenance, and stormwater runoff controls.

OTHER ACTIONS: Additional strategies for reducing phosphorus loading to the lake include: revising local ordinances such as setting low impact development requirements on new development, including setting limits on impervious cover; identifying and replacing malfunctioning septic systems; inspecting and remediating leaky sewer lines; using best practices for road maintenance and other activities including municipal operations such as infrastructure cleaning; conserving large or connective habitat corridor parcels; and improving agricultural practices. Future development should also be considered as a pollutant source and potential threat to water quality. Mascoma Lake is at risk for greater water quality degradation from new development in the watershed unless resiliency measures and low impact development strategies are incorporated into existing zoning standards.

The recommendations of this plan will be carried out by a diverse stakeholder group in the form of a dedicated committee, including representatives from Mascoma Lake Association, municipalities (e.g., select boards, planning boards), conservation commissions, state and federal agencies or organizations, non-profits, land trusts, schools and community groups, local business leaders, and landowners. The cost of successfully implementing the plan is estimated at $1.3 to $1.5 million over the next 10 or more years in addition to the dedication and commitment of volunteer time and support to manage plan implementation. However, many costs are still unknown or were roughly estimated and should be updated as information becomes available. This financial investment can be accomplished through a variety of funding mechanisms via both state and federal grants, as well as commitments from municipalities or donations from private organizations and residents. Of significant note, this plan meets the nine key planning elements required by the United States Environmental Protection Agency, and Mascoma Lake is now eligible for federal watershed assistance grants.

Important Notes

The success of this plan is dependent on the continued effort of a dedicated committee that meets regularly to coordinate resources for implementation, review progress, and make any necessary adjustments to the plan. Reducing nutrient loading is challenging because many diffuse sources of pollutants reach surface waters in the watershed. Success will require an integrated, adaptive approach involving many parts of the watershed community. Challenges include aging infrastructure, limited access to key lakefront areas, and restricted funding or volunteer and staff capacity.

Finally, we all have a common responsibility to protect our lakes for future generations to enjoy. Private landowners hold the greatest potential to restore and maintain excellent lake water quality. However, engaging them as a single stakeholder group can be challenging, and outreach often has limited reach, especially to those needing the most education. Mascoma Lake Association and other relevant stakeholders will continue to engage the public in implementing plan recommendations. These efforts aim to protect Mascoma Lake's water quality for long into the future.

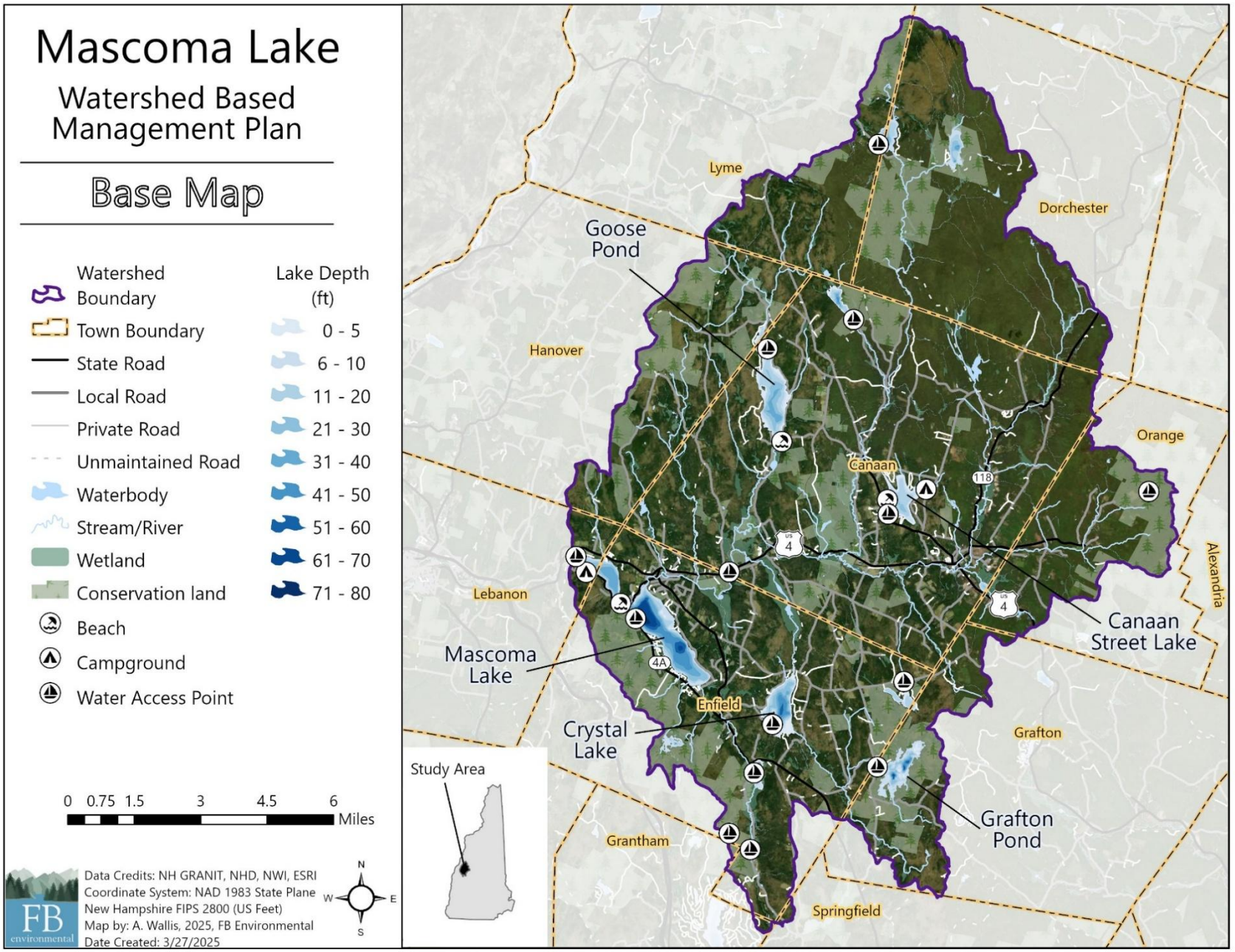


Figure 1. Mascoma Lake watershed base map.

1 INTRODUCTION

1.1 WATERBODY DESCRIPTION AND LOCATION

Mascoma Lake is a 1,164-acre (471-hectare) lake with a watershed spanning 98,232 acres (39,753 hectares) across the municipalities of Canaan (36 percent), Enfield (21 percent), Dorchester (15 percent), Hanover (9 percent), Orange (7 percent), Lyme (6 percent), Grafton (5 percent), Lebanon (1 percent), Grantham (0.1 percent), and Springfield (0.01 percent) (Figure 1). Mascoma Lake is fed by upstream waterbodies including Goose Pond (625 acres), Grafton Pond (319 acres), Canaan Street Lake (291 acres), Crystal Lake (401 acres), Reservoir Pond (159 acres), Cummins Pond (135 acres), Clark Pond (104 acres), Lary Pond (64 acres), George Pond (49 acres), and several additional smaller waterbodies. There are many streams that run through the watershed, including, but not limited to, Lovejoy Brook, Goose Pond Brook, Marshall Brook, Clark Pond Brook, Hoyt Brook, Indian River, Orange Brook, Haines Brook, Moose Brook, Bicknell Brook, Little Brook, and Crystal Lake Brook. The two main tributaries are the Mascoma River that drains most of the watershed and the Knox River that enters from the south. The lake outlets to the west via the Mascoma River, which eventually joins the Connecticut River.

The Mascoma Lake watershed is situated within a temperate zone of converging weather patterns from the hot, wet southern regions and the cold, dry northern regions of the continent, which result in various natural phenomena such as heavy snowfalls, severe thunder and lightning storms, and occasional hurricanes. Precipitation and air temperature data for the surrounding region of Mascoma Lake were collected from Oak Ridge National Laboratory's Daymet service from 1994-2023 (Figure 2). Annual air temperature (from average monthly data) generally ranges from 7 °F to 71 °F, with an average of 44.3 °F. The area experiences moderate to high rainfall and snowfall, averaging 49.0 inches of precipitation annually.

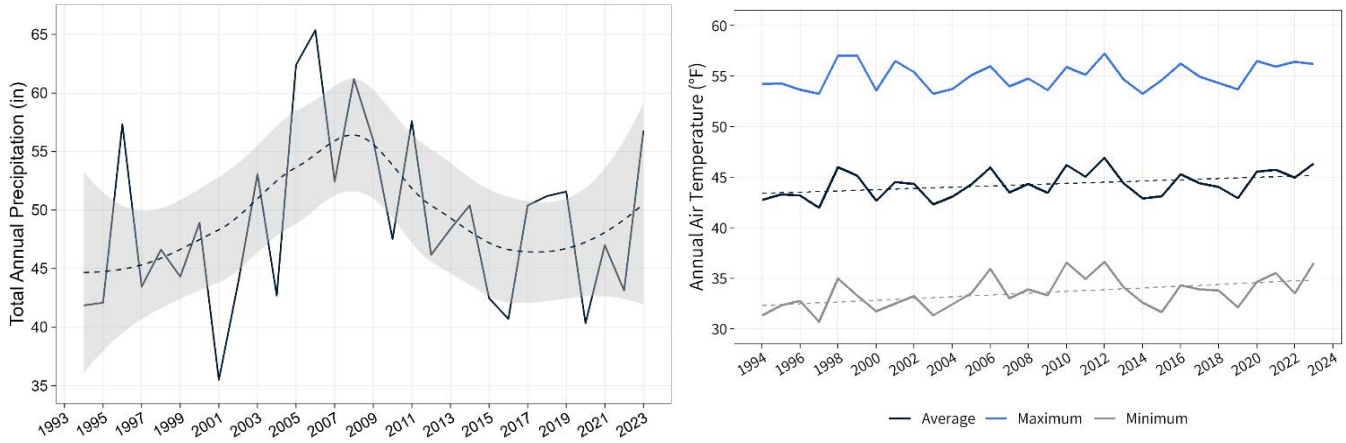


Figure 2. Total annual precipitation (top) and annual maximum, average, and minimum monthly air temperature (bottom) from 1994-2023 for the region. Data obtained from Daymet. The dashed line and grey shaded area for precipitation represents the Locally Estimated Scatterplot Smoothing regression and 95% confidence intervals, respectively. The dashed lines for air temperature indicate a statistically significant trend ($p < 0.05$) for minimum and average annual air temperatures.

The highest elevation in the watershed is located at Smarts Mountain at 3,220 feet above sea level, situated in Lyme and Dorchester in the northernmost portion of the watershed. West of Orange, Cardigan Mountain is the second tallest point at 3,150 feet above sea level. Mascoma Lake and the adjacent shoreline are approximately 750 feet above sea level.

The watershed is characterized primarily by mixed forest that includes both coniferous (e.g., white pine and eastern hemlock) and deciduous (e.g., beech, red oak, and maple) tree species. Fauna that use these forested resources include land mammals (moose, deer, black bear, coyote, bobcats, fisher, fox, raccoon, weasel, porcupine, muskrat, mink, chipmunks, squirrels, snowshoe hares, and bats), water mammals (muskrat, otter, and beaver), land and water reptiles and amphibians (turtles, snakes, frogs, and salamanders), various insects, birds (herons, loons, geese, multiple species of ducks, wild turkeys, ruffed grouse, cormorants, bald eagles, and song birds), and fish.

1.2 WATERSHED PROTECTION GROUPS

The **Mascoma Lake Association** (MLA) is a non-profit group founded in 1923 "to protect Mascoma Lake and its environment, to promote the responsible and sustainable enjoyment of the lake by all its users, and to educate the public on issues related to these objectives."

The **Mascoma River Local Advisory Committee**, composed of residents of Lebanon, Enfield, and Canaan, was authorized by state law to advise on the management and protection of the Mascoma River. Mascoma River Local Advisory Committee members were local citizens interested in the river who were nominated by their municipality and appointed to a three-year term by the Commissioner for the New Hampshire Department of Environmental Services. Mascoma River Local Advisory Committee was established to promote recognition and appreciation of the Mascoma River and wise stewardship of its resources. In 2012, the Mascoma River Local Advisory Committee developed a corridor management plan as a resource to protect the Mascoma River and its watershed by outlining actions and goals for municipalities and community partners. There is movement to reactivate the Mascoma River Local Advisory Committee.

The **Crystal Lake Association** is a volunteer-based group dedicated to the protection of Crystal Lake in Enfield. The Town of Enfield funds monitoring through the University of New Hampshire Lakes Lay Monitoring Program.

The **Canaan Street Lake Association** protects the health of Canaan Street Lake for both the environment and future generations. It promotes watershed education, community engagement, and partnerships to support water quality, recreation, and conservation efforts. A Watershed Protection Plan was developed in 2006, which evaluated current and historical water quality, identified contamination sources, and provided management recommendations to protect the future of the Town's drinking water supply.

Led by an elected board, the **Goose Pond Lake Association** holds a passion for the pond and works to protect its environment. Initiatives include the Weed Watcher Program to monitor invasive plants, a water quality program that tests key indicators, and biannual roadside clean-ups.

Friends of Grafton Pond is an "informal association of boaters, fishers, conservationists, regulators, law enforcement agents, and other stakeholders united in a singular cause: the protection, preservation, and sustainable use of Grafton Pond in Grafton, NH."

Across 45 towns in Vermont and New Hampshire, the **Upper Valley Land Trust** (UVLT) works to permanently protect the region's farms, forests, wildlife habitats, and scenic landscapes. By partnering with local conservation groups, UVLT provides expertise and technical assistance to landowners and stewards permanent conservation agreements. The trust also prioritizes ensuring public access to natural areas.

Established in 1963, the **Upper Valley Lake Sunapee Regional Planning Commission** is one of New Hampshire's nine Regional Planning Commissions and serves 27 municipalities to provide planning assistance in the Upper Valley Lake Sunapee Region. They collaborated with the Mascoma River Local Advisory Committee to develop the Mascoma River Corridor Management Plan in 2012.

The **Grafton County Conservation District** (GCCD) is one of 10 county conservation districts in New Hampshire that operate as resource management agencies and a subdivision of local governments. The GCCD supports sustainable land management by providing technical assistance, conservation programs, and educational outreach to landowners. Partnering with the USDA Natural Source Conservation Service (NRCS) and other agencies, it helps address local environmental concerns through workshops, farm demonstrations, and resource planning. All the municipalities within the Mascoma Lake watershed are part of GCCD (except for Grantham and Springfield which comprise 0.2 percent of the watershed and are part of the Sullivan County Conservation District).

The **New Hampshire Association of Conservation Commissions** works to provide educational assistance to conservation commissions throughout New Hampshire (217 in total). As a non-profit organization, the NH Association of Conservation Commission's mission is to instill responsible use of the available natural resources by promoting conservation and serving as the communication link between conservation commissions, while providing technical support on the logistics of conservation commission meetings and document language. Conservation commissions in the Mascoma Lake watershed include those of Hanover, Enfield, Lyme, Dorchester, Grantham, Canaan, Lebanon, and Springfield.

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

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

The **Connecticut River Conservancy** works to restore and protect the Connecticut River watershed through advocacy, restoration, and community engagement. Their efforts include dam removal, invasive species management, water quality monitoring, and improving habitat resilience. Through partnerships across four states, the Connecticut River Conservancy promotes science-based solutions for healthy, life-filled rivers from source to sea.

1.3 PURPOSE AND SCOPE

The purpose of the Mascoma Lake Watershed-Based Management Plan (WBMP) is to guide implementation over the next 10 years (2026-2035) to improve the water quality of Mascoma Lake. The plan aims to meet state water quality standards for the designated uses of aquatic life integrity (ALI) and primary contact recreation (PCR) for oligotrophic waterbodies and to reduce the likelihood of harmful cyanobacteria blooms in the lake. *Efforts to protect Mascoma Lake will also help protect downstream waterbodies, including the Mascoma and Connecticut Rivers.*

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

1.4 COMMUNITY INVOLVEMENT AND PLANNING

The plan was developed through collaborative efforts, including numerous meetings, public presentations, and conference calls. Participants included FB Environmental Associates (FBE), VHB, NHDES, representatives from the municipalities of Lebanon, Canaan, Hanover, and Enfield, representatives from the conservation commissions of the City of Lebanon and the Town of Enfield, lake associations, namely MLA and Crystal Lake Association, Upper Valley Lake Sunapee Regional Planning Commission, business owners, and private landowners (see Acknowledgments).

1.4.1 Plan Development Meetings

Several meetings were held over the duration of the plan development.

- **September 26, 2024:** Kick-off virtual meeting with FBE and the City of Lebanon.
- **October 3, 2024:** Kick-off virtual meeting with FBE, the City of Lebanon, and NHDES.
- **November 13, 2024:** Kick-off virtual meeting with FBE, NHDES, and the Steering Committee to introduce the watershed planning process.
- **April 15, 2025:** Steering Committee meeting to review and discuss outreach/education memo.
- **May 5, 2025:** Steering Committee meeting to identify potential SCM sites in the watershed.
- **June 24, 2025:** Steering Committee meeting to discuss SCM sites identified during VHB survey.
- **September 19, 2025:** Steering Committee meeting to discuss SCM site selection for designs.
- **October 28, 2025:** Steering Committee meeting to review the water quality analysis and modeling results and set the water quality goal.
- **January 15, 2026:** Steering Committee meeting to review the Action Plan.

1.4.2 Final Public Presentation

A final virtual public presentation was held on February 17, 2026, to summarize the analyses and recommendations detailed in the plan. The presentation was attended by 19 people, 13 online and six in-person. An opportunity for public feedback on the plan was offered. Written comments were received and incorporated into the final plan.

1.5 INCORPORATING EPA'S NINE KEY PLANNING ELEMENTS

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

A. **IDENTIFICATION OF THE CAUSES AND SOURCES OF NONPOINT SOURCE POLLUTION: Sections 2 and 3** highlight known sources of nonpoint source pollution to Mascoma Lake and describe the results of the watershed survey and other assessments conducted. These sources of pollutants must be controlled to achieve load reductions estimated in this plan, as discussed in item (B) below.

B. **ESTIMATION OF POLLUTANT LOADING AND LOAD REDUCTIONS EXPECTED FROM MANAGEMENT MEASURES: Sections 2 and 5** describe the calculation of pollutant loading to Mascoma Lake and the amount of reduction needed to meet the water quality goal, respectively.

C. **DESCRIPTION OF NONPOINT SOURCE MANAGEMENT MEASURES: Sections 4 and 5** identify ways to achieve the estimated phosphorus load reduction and reach water quality targets. The Action Plan focuses on several major topic areas categorizing action items that address nonpoint source pollution.

D. **ESTIMATION OF TECHNICAL AND FINANCIAL ASSISTANCE: Sections 5 and 6** includes a description of the associated costs, sources of funding, and primary authorities responsible for implementation. Funding sources should be diverse, including local, state, and federal grants, local organizations, private donations, and landowner contributions to support Action Plan implementation.

E. **DEVELOPMENT OF EDUCATION AND OUTREACH COMPONENT: Section 4** describes how the educational component of the plan is already being or will be implemented to enhance public understanding of the project.

F. **SCHEDULE FOR IMPLEMENTING THE NONPOINT SOURCE MANAGEMENT MEASURES: Section 5** provides a list of action items and recommendations to reduce the phosphorus load to Mascoma Lake. Each item has a set schedule that defines when the action should begin and/or end or run through (if an ongoing activity). The schedule should be adjusted by a oversight committee on an annual basis (see Section 4.4 Adaptive Management and Section 6.1 Plan Oversight). While phosphorus is the primary nutrient driving this plan, the MLA and municipalities should also consider reductions in sediment, nitrogen, and bacteria, where applicable, to support overall water quality improvements and align with broader reporting expectations.

G. **DESCRIPTION OF INTERIM MEASURABLE MILESTONES FOR MEASURING PROGRESS: Section 6** outlines indicators along with milestones for implementation success that should be tracked annually.

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

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

2 ASSESSMENT OF WATER QUALITY

This section provides an overview of the past, current, and future state of water quality based on the water quality assessment and watershed modeling. These analyses identified pollutants of concern and informed the water quality goals and objectives for Mascoma Lake.

2.1 WATER QUALITY SUMMARY

2.1.1 Water Quality Standards and Impairment Status

2.1.1.1 Designated Uses and Water Quality Criteria

The federal **Clean Water Act** requires states to determine designated uses for all surface waters within their jurisdiction. Designated uses define activities and services that surface waters should support, including ALI, fish consumption, shellfish consumption, drinking water supply, PCR (swimming), secondary contact recreation (boating and fishing), and wildlife. The designated uses of **PCR and ALI are the two major uses for lakes – ALI being the focus of this plan.** In New Hampshire, all surface waters are also legislatively classified as Class A or Class B, most of which are Class B (Env-Wq 1700). **Mascoma Lake is classified as a Class B water in the State of New Hampshire**. Additionally, NHDES conducted lake trophic surveys for Mascoma Lake in 1976, 1985, 2000, and 2008 to determine **trophic state** (**oligotrophic**, **mesotrophic**, or **eutrophic**) (NHDES, 1976; NHDES, 1985; NHDES, 2000; NHDES, 2008). The trophic surveys evaluated physical lake features, as well as chemical and biological indicators. **For Mascoma Lake, the trophic state was determined to be mesotrophic for the 1976, 1985, and 2000 surveys,** indicating moderate levels of aquatic plant growth, algal growth, nutrients, and clarity**. The trophic state was determined to be oligotrophic for the 2008 survey**. This change from mesotrophic to oligotrophic assessment was due to a measured increase in bottom dissolved oxygen conditions. This reclassification may also have been a product of the construction of a sewer treatment system for the Town of Enfield in the 1980s, which prevented raw sewage and industrial waste from being directly discharged to the lake.

Water quality criteria are developed to protect designated uses. They serve as a "yardstick" for identifying water quality exceedances and evaluating the effectiveness of pollution control and prevention programs. Water quality criteria vary depending on the designated use and type of waterbody. Criteria may be stricter or more lenient if the waterbody is Class A or B, or oligotrophic, mesotrophic, or eutrophic, respectively. To determine if a waterbody is meeting its designated uses, water quality criteria for various parameters (e.g., **chlorophyll-*a***, **total phosphorus**, **dissolved oxygen**, **pH**, and toxins) are applied to the water quality data. If a waterbody meets or is better than the water quality criteria, the designated use is supported. The waterbody is considered impaired for the designated use if it does not meet water quality criteria. Water quality criteria for each classification and designated use in New Hampshire are found in RSA 485 A:8, IV and the surface water quality criteria are set forth in NHDES administrative rules Env-Wq 1700. According to the NHDES 2024 Section 303(d) list of impaired surface waters, **Mascoma Lake is currently assessed as impaired for the designated use of ALI due to low dissolved oxygen saturation, low pH, and the presence of a non-native aquatic plant (i.e., Eurasian milfoil, *Myriophyllum spicatum*). Mascoma Lake, including several associated beach assessment units, is**

also currently assessed as impaired for the designated use of PCR due to elevated cyanobacterial hepatotoxic microcystins. Several impaired parameters are classified as Category 5-M, indicating that a Total Maximum Daily Load is required. A Total Maximum Daily Load calculates the maximum amount of pollutant a waterbody can receive while still meeting water quality standards. This requirement by the Clean Water Act ensures states identify and address waterbodies that fail to meet these standards.

Other waterbodies in the Mascoma Lake watershed can impact the water quality of Mascoma Lake because they contribute water, and therefore nutrients, to the lake (Table 1). Crystal Lake generally has good water quality and has been classified as oligotrophic for all three trophic surveys (1978, 1987, and 2005) and is not listed on the NHDES 303(d) list for the designated uses of ALI or PCR (NHDES, 1978; NHDES, 1987; NHDES, 2005). However, three cyanobacteria warnings (for a total of 20 days) and three watches were issued in 2023, which may indicate changes to the water quality in recent years. Both Goose Pond and Canaan Street Lake are assessed as impaired with a Total Maximum Daily Load required (5-M) for pH and cyanobacteria hepatotoxic microcystins. Clark Pond is similarly assessed as impaired for pH, and Reservoir Pond is assessed as impaired for chlorophyll-*a* and total phosphorus. The most recent reported blooms in Canaan Street Lake occurred in 2010 and Goose Pond in 2022.

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

Assessment Unit Name	AUID	Area *(acres)*	Water Quality
NHLAK801060105-04-01	Mascoma Lake	1,154.8	Poor
NHLAK801060105-04-02	Mascoma Lake - Shakoma Beach	0.5	Poor
NHLAK801060105-04-03	Mascoma Lake - Crescent Beach	1.3	Likely Bad
NHLAK801060105-04-04	Mascoma Lake - Dartmouth College Beach	0.2	Poor
NHLAK801060105-04-05	Mascoma Lake - Lakeview Condominium Association Beach	0.7	Likely Bad
NHLAK801060105-01	Cole Pond	16.5	Poor
NHLAK801060105-02	Enfield Reservoir	21.1	No Data
NHLAK801060105-05	Smith Pond	62.7	No Data
NHLAK801060105-06	Bear Pond	12.9	No Data
NHLAK801060103-01	Goose Pond	623.0	Poor
NHLAK801060103-02	Little Goose Pond	18.3	Poor
NHLAK801060104-01	Crystal Lake	399.7	Likely Bad
NHLAK801060104-02	Grafton Pond	318.1	Poor
NHLAK801060104-03	Unnamed Pond	6.9	No Data
NHLAK801060101-01-01	Canaan Street Lake	290.1	Poor
NHLAK801060101-01-02	Canaan Street Lake - Town Beach	0.44	Poor
NHLAK801060101-01-04	Canaan St Lake - Crescent Campsites	0.2	No Data

Assessment Unit Name	AUID	Area *(acres)*	Water Quality
NHLAK801060101-02	Clark Pond	103.9	Poor
NHLAK801060101-03	Cummins Pond	134.5	Poor
NHLAK801060101-04	Modgetts Pond	9.9	No Data
NHLAK801060101-05	Reservoir Pond	158.3	Poor
NHLAK801060101-06	Little Clark Pond	10.5	No Data
NHLAK801060102-01	Lary Pond	64.2	No Data
NHLAK801060102-02	Mirror Pond	21.5	No Data
NHLAK801060102-03	Spectacle Pond	95.0	Likely Bad

2.1.1.2 Antidegradation Provisions

The Antidegradation Provision (Env-Wq 1708) in New Hampshire's water quality regulations serves to protect or improve the quality of the state's waters. The provision outlines limitations or reductions for future pollutant loading. Certain development projects, such as those requiring an Alteration of Terrain Permit or 401 Water Quality Certification, may undergo an Antidegradation Review to ensure compliance. The Antidegradation Provision is often applied during permit reviews for projects near waters designated as impaired, high-quality, or outstanding resource waters. While NHDES has not formally designated high-quality waters, unimpaired waters are treated as high quality with respect to issuance of water quality certificates. Antidegradation requires that a permitted activity cannot use more than 20 percent of the remaining assimilative capacity of a high-quality water. This is on a parameter-by-parameter basis. For impaired waters, antidegradation requires that permitted activities discharge no additional loading of the impaired parameter.

2.1.2 Water Quality Data Collection

Mascoma Lake has been primarily monitored during the 1976, 1985, 2000, and 2008 NHDES lake trophic surveys and has been sampled through the NHDES Volunteer Lake Assessment Program (VLAP).

Water quality data for Mascoma Lake and upstream waterbodies were obtained from the NHDES Environmental Monitoring Database and the University of New Hampshire Lakes Lay Monitoring Program. There were 10 water quality monitoring stations identified within Mascoma Lake and an additional station in Crystal Lake. Figure 3 shows the locations for a subset of stations. Key stations summarized in this plan include:

- **MASENF1D (Mascoma Lake Eastern Deep Spot):** Epilimnetic composite and discrete-depth samples have been collected since 1991, with routine sampling two times per year in 1991–1992 and three times per year from 1993–2024. Parameters analyzed include total phosphorus, chlorophyll-*a*, apparent color, chloride, specific conductivity, pH, alkalinity, turbidity, and Secchi disk transparency. Phytoplankton net tow samples were taken infrequently (2017, 2019, 2022). Temperature and dissolved oxygen profiles have been collected annually since 1991 and up to three times per year since 2007, totaling 72 profiles. Recent data within the last 10 years include 25 profiles, with 16 meeting Class B timing requirements and showing no epilimnetic dissolved oxygen violations.

- **MASENF2D (Mascoma Lake Western Deep Spot):** Epilimnetic composite samples and variable-depth grab samples were collected between 2017 and 2022 for total phosphorus, chlorophyll-*a*, apparent color, total nitrogen, alkalinity, turbidity, chloride, specific conductivity, and pH. Using a water quality instrument (YSI EXO2), profiles were collected in 2017 and 2018 for temperature, dissolved oxygen, specific conductivity, pH, oxidation-reduction potential, turbidity, chlorophyll-*a* fluorescence, phycocyanin fluorescence, and total dissolved solids.
- **CRYENFD/1 (Crystal Lake Deep Spot):** Volunteers collected weekly Secchi disk transparency readings and seasonal (1–3 times per year) epilimnetic composite samples for total phosphorus, chlorophyll-*a*, apparent color, and alkalinity. University of New Hampshire Lakes Lay Monitoring Program collected variable-depth total phosphorus samples throughout the water column (1–15 meters) and select-depth samples (1, 7, 15 meters) for chlorophyll-*a*, alkalinity, pH, turbidity, and specific conductivity. Only three recent temperature/dissolved oxygen profiles exist for this station.

Table 2. Station ID and description. Refer to Figure 3 for locations of all stations.

Station ID	Station Description	Waterbody	Station Type
MASENF2D	MASCOMA LAKE-STATION 2 DEEP SPOT	Mascoma Lake	Lake/Pond
MASENF1D	MASCOMA LAKE-STATION 1 DEEP SPOT	Mascoma Lake	Lake/Pond
MASENFK	MASCOMA LAKE-KNOX RIVER INLET	Mascoma Lake	River/Stream
MASENFL3	MASCOMA LAKE-LASALETTE #3	Mascoma Lake	River/Stream
MASENFM	MASCOMA LAKE-MASCOMA RIVER INLET	Mascoma Lake	River/Stream
MASENFRT4A	MASCOMA LAKE-RT 4A BRIDGE	Mascoma Lake	River/Stream
MASENFS	MASCOMA LAKE-SUCKER BROOK	Mascoma Lake	River/Stream
MASENFS1	MASCOMA LAKE-SHAKER BROOK	Mascoma Lake	River/Stream
MASENFS2	MASCOMA LAKE-SMITH POND BROOK	Mascoma Lake	River/Stream
MASENFB	MASCOMA LAKE-BROWNS BROOK	Mascoma Lake	River/Stream
CRYENFD	CRYSTAL LAKE-DEEP SPOT	Crystal Lake	Lake/Pond

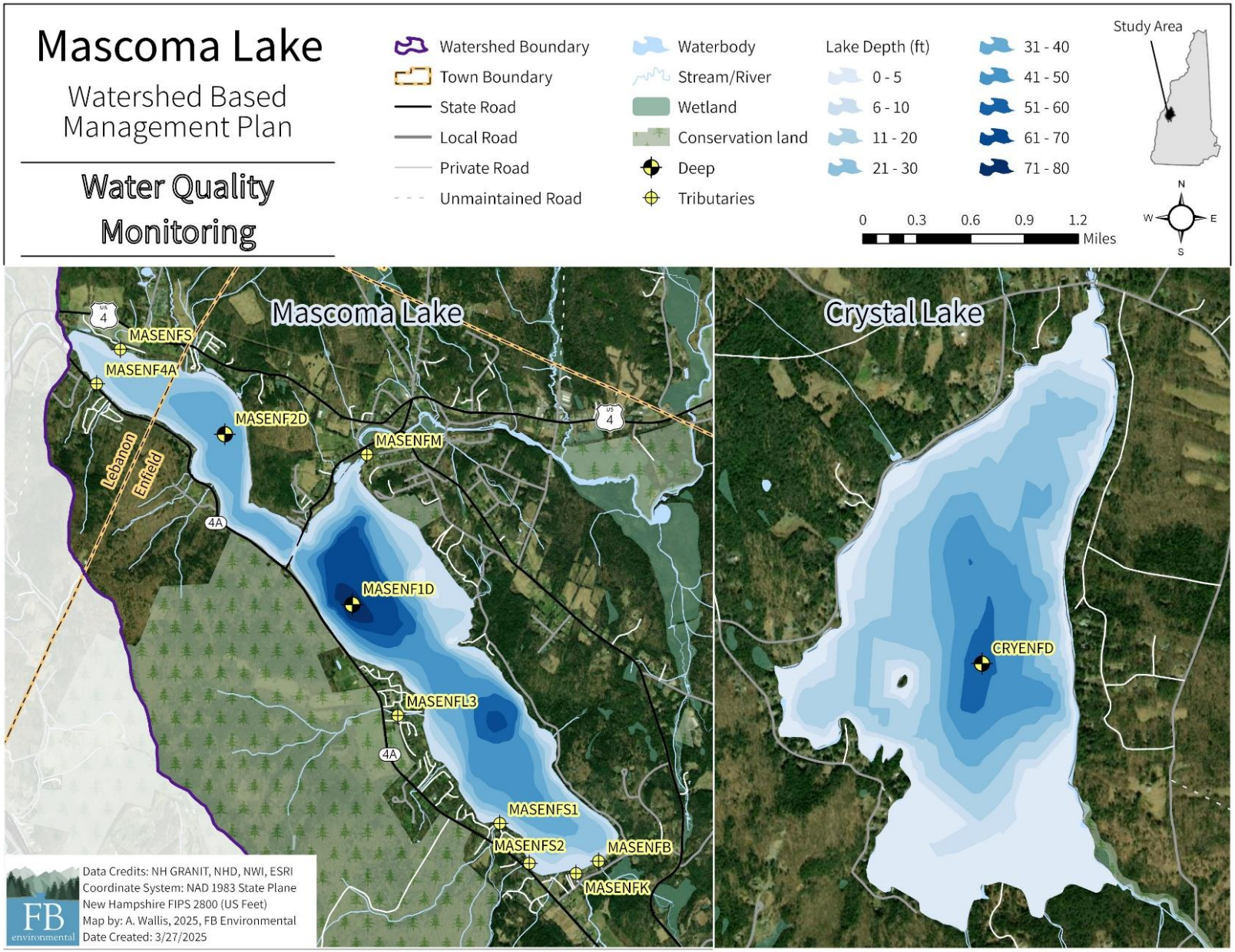


Figure 3. Water quality monitoring stations in Mascoma Lake and Crystal Lake. Stations on other waterbodies are not included. Refer to Table 2 for station descriptions.

2.1.3 Trophic State Indicator Parameters

Total phosphorus, chlorophyll-*a*, and Secchi disk transparency are trophic state indicators, reflecting biological productivity in lake ecosystems. The combination of these parameters helps determine the extent of **eutrophication** in lakes and helps signal changes in lake water quality over time. For example, changes in Secchi disk transparency may reflect shifts in algae communities (from increased phosphorus) or variations in dissolved and particulate materials in the lake. Such changes are likely the result of human disturbance or other impacts on the lake's watershed.

In Mascoma Lake, higher total phosphorus concentrations were most often measured in the **hypolimnion** compared to the **epilimnion**, indicating that some amount of **internal phosphorus loading** is likely occurring (Figure 4). Comparison between recent (2015-2024) and historical (1991-2014) total phosphorus concentrations at the eastern deep spot [MASENF1D] shows minimal differences between historical and current phosphorus concentrations. Total phosphorus concentrations at the western, shallower deep spot [MASENF2D] were more variable for all depth zones and reached a maximum of 66 parts per billion (ppb) in the hypolimnion, which suggests that internal loading may be occurring even in shallower areas of the lake (with a maximum depth of 10 meters). The eastern and western portions of the lake are bisected by Main Street in Enfield and are connected by a shallow area (~3 meters) that is freely flowing under a bridge. Differences in water chemistry between the two basins may in part be related to the morphometric and morphological differences between the two areas. No recent data exist for the western deep spot [MASENF2D], with samples last collected in 2011. Additional sampling could reveal changes in internal loading since the last sampling events.

For the available time period, 1985-2024, no statistically significant trends were found for median epilimnetic total phosphorus, chlorophyll-*a*, or Secchi disk transparency at either deep spot of Mascoma Lake [MASENF1D, MASENF2D] nor the deep spot of Crystal Lake [CRYENFD] (Figure 5). The 2023 VLAP Individual Lake Report for Mascoma Lake also found stable trends for total phosphorus, chlorophyll-*a*, and Secchi disk transparency, though higher concentrations of total phosphorus and chlorophyll-*a* were observed in 2023 due to extreme summer rainfall.

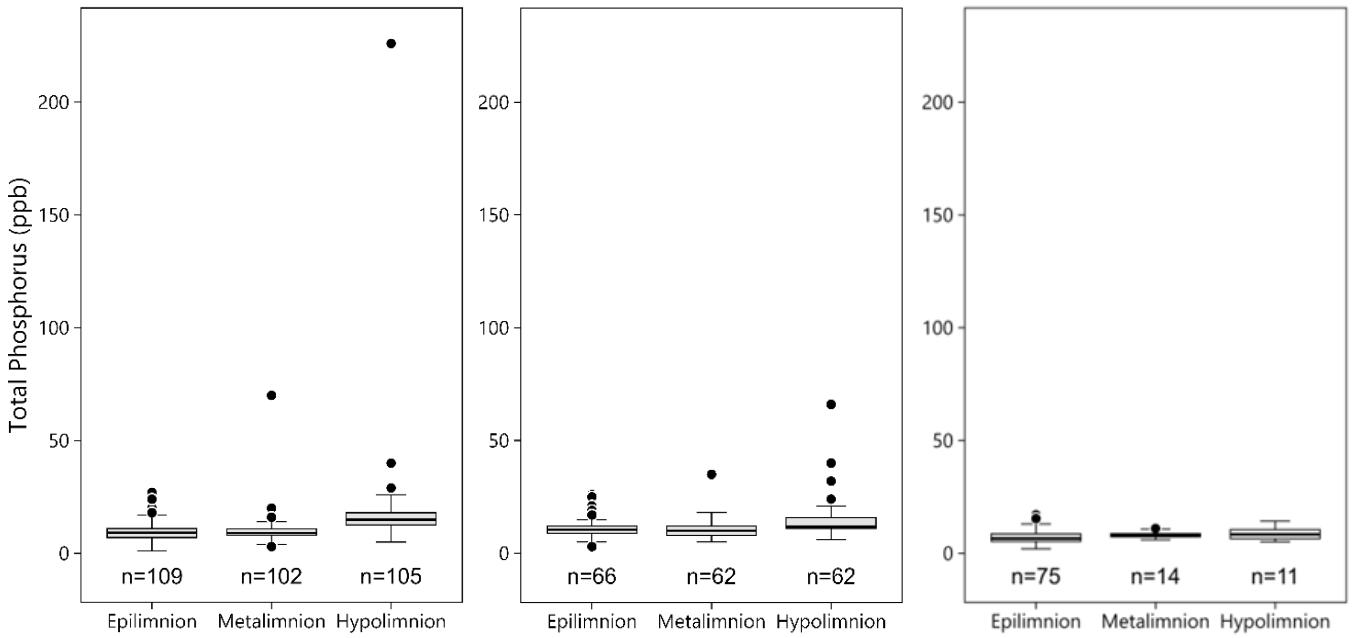


Figure 4. Boxplots showing median total phosphorus concentration in the epilimnion, metalimnion, and hypolimnion of the eastern deep spot of Mascoma Lake [MASENF1D] from 1985-2024 (left), the western deep spot of Mascoma Lake [MASENF2D] from 1985-2011 (middle), and the deep spot of Crystal Lake [CRYENFD/1 Deep] from 1987-2024 (right). Boxplots show the data distribution, with the median (middle horizontal line) and first (25th) and third (75th) quartiles (upper and lower boundaries) for the box representing the interquartile range and the whiskers representing 1.5 times the interquartile range. Dots represent outliers. Labels (e.g., n=11) indicate number of samples.

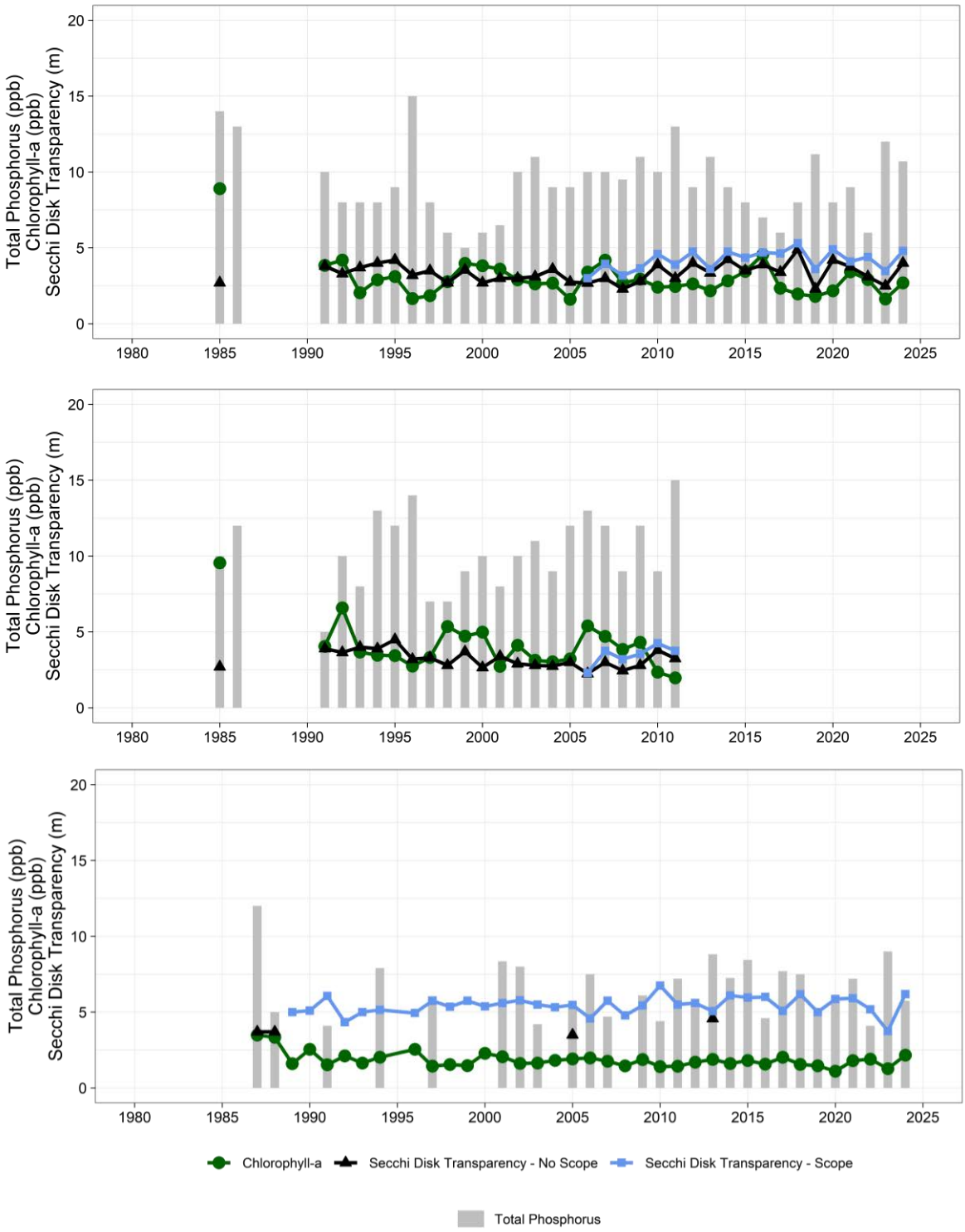


Figure 5. Median epilimnion grab/composite total phosphorus, median composite epilimnion chlorophyll-*a*, and median water clarity (Secchi disk transparency depth for scope and no scope methods) measured at the Mascoma Lake eastern deep spot [MASENF1D] (top), Mascoma Lake western deep spot [MASENF2D] (middle), and Crystal Lake deep spot [CRYENFD/1 Deep] (bottom). Sample depths for total phosphorus were 0-5 meters for Mascoma Lake sites and 0-6.5 meters for Crystal Lake sites. Sample depths for chlorophyll-*a* were 0-9 meters [MASENF1D], 0-5 meters [MASENF2D], and 0-6.5 meters [CRYENFD/1 Deep]. No statistically significant trends were detected for any sites using the *rkt* package in R Studio.

2.1.4 Dissolved Oxygen and Water Temperature

A common occurrence in lakes is the depletion of dissolved oxygen in the deepest part of the lake throughout the summer months. This occurs when **thermal stratification** prevents warmer (less dense), oxygenated surface waters from mixing with cooler (denser), oxygen-depleted bottom waters in the lake. Chemical and biological processes occurring in bottom waters deplete the available oxygen throughout the summer, and because these waters are colder and denser, the oxygen cannot be replenished through mixing with surface waters. Dissolved oxygen levels below 5 parts per million (ppm) (and water temperature above 24°C) can stress and reduce habitat for cold-water fish and other sensitive aquatic organisms. In addition, **anoxia** (low dissolved oxygen) at the lake bottom can result in the release of sediment-bound phosphorus (otherwise known as internal phosphorus loading), which can become a readily available nutrient source for algae and cyanobacteria. While thermal stratification and depletion of oxygen in bottom waters are a natural phenomenon in dimictic lakes such as Mascoma Lake, it is important to track these parameters to make sure the extent and duration of low oxygen does not change drastically because of human disturbance in the watershed resulting in excess phosphorus loading.

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

Figure 6 shows temperature and dissolved oxygen profiles for both deep spot stations on Mascoma Lake [MASENF1D, MASENF2D] averaged across sampling dates during thermal stratification largely in summer (between spring and fall turnover). For the true deep spot [MASENF1D], data are available for 1991-2024. The change in temperature, seen most dramatically between 5 and 10 meters, indicates thermal stratification in the water column. The average dissolved oxygen of less than 2 ppm at 21-23 meters depth indicates the possibility of internal loading under anoxic conditions. Dissolved oxygen less than 5 ppm may reduce fish habitat in Mascoma Lake; this was measured typically around 15 meters and as shallow as 6 meters. Historic recordings of temperature and dissolved oxygen profiles included multiple water column profiles per sampling season which provide insight into seasonal changes in the lake. Additional profiles in the early autumn months (September and October) can provide further insight into possible internal phosphorus loading in Mascoma Lake.

Dissolved oxygen patterns differ slightly from the western deep spot [MASENF2D], which is in a smaller portion of the lake west of Main Street in Enfield. The two sides of the lake are bisected by the street and are connected by a shallow area (about 3 meters) that flows freely under a bridge. The western deep spot [MASENF2D] typically experiences oxygen less than 5 ppm beginning at 7 meters and oxygen less than 2 ppm as shallow as 8 meters, according to profiles taken between 1991 and 2011 (Figure 6). No recent profiles are available for this sampling station. After discussing with the City of Lebanon, staff suggested this may be due to limited volunteer availability or reduced funding, but the exact reason is unknown. Shallower anoxia (low oxygen) at the western deep spot may be influenced by sinking and decomposing detritus at the sediment-water interface that depletes oxygen levels.

Crystal Lake [CRYENFD/1 Deep] has similar temperature and dissolved oxygen dynamics to Mascoma Lake, with the change in temperature most evident between 4 and 9 meters. The dissolved oxygen profiles show a metalimnetic maximum, an area of elevated dissolved oxygen in the **metalimnion**, which suggests photosynthetic activity by algae. Dissolved oxygen is also depleted in the hypolimnion of Crystal Lake, regularly reaching below 5 ppm (threshold for the designated use of ALI) and occasionally below 2 ppm (increased risk of internal loading).

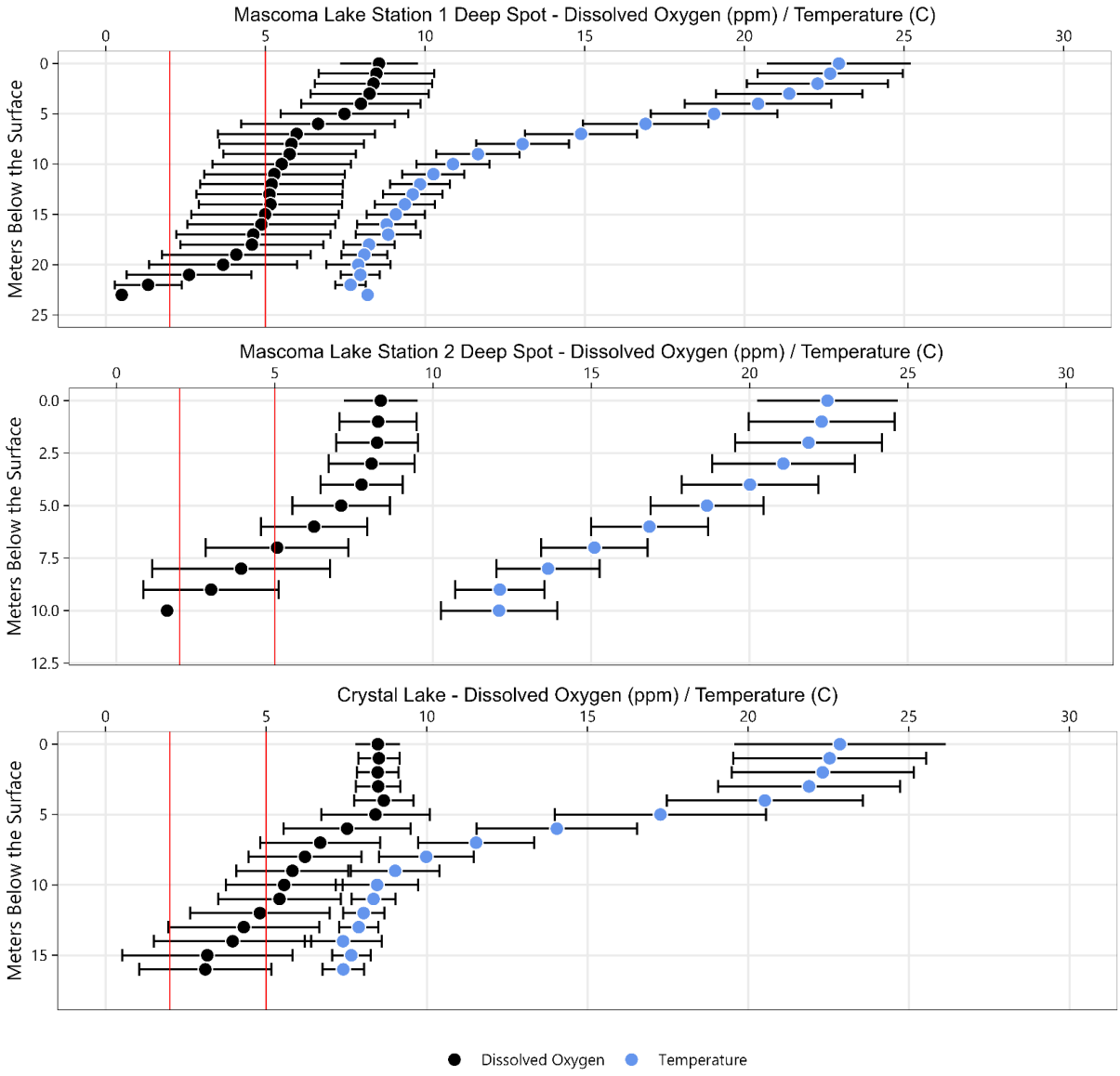


Figure 6. Dissolved oxygen (black) and water temperature (blue) profiles for the (top) eastern deep spot of Mascoma Lake [MASENF1D] with data representing profiles collected from 1991 to 2024 (n=72); (middle) western deep spot of Mascoma Lake [MASENF2D] with data representing profiles collected from 1991 to 2011 (n=35); and (bottom) deep spot of Crystal Lake [CRYENFD/1 Deep] with data representing profiles collected between 1987 to 2024 (n=12). Dots represent average values across sampling dates for each respective depth, and bars represent standard deviation for all figures. Red lines at 5 parts per million (ppm) and 2 ppm represent thresholds for the designated use of ALI and internal phosphorus loading risk, respectively, due to low dissolved oxygen. Temperature is in degrees Celcius (C).

2.1.5 Phytoplankton (Cyanobacteria) and Zooplankton

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

Cyanobacteria are small photosynthesizing, sometimes nitrogen-fixing, single-celled bacteria that grow in colonies in freshwater systems. Cyanobacteria can, but do not always, produce microcystins and other toxins that pose health risks to humans, pets, livestock, and wildlife. Health risks include neurological, liver, kidney, and reproductive organ damage, gastrointestinal illness, vomiting, eye, ear, and skin irritation, mouth blistering, tumor growth, seizure, or, in rare cases, death. Blooms can form dense mats or surface scum that can occur within the water column, attached to bottom sediments, or along the shoreline. There are several different species of cyanobacteria common to Mascoma Lake:

- ***Dolichospermum*** (formerly *Anabaena*): typically observed as filaments, can produce microcystins, anatoxins, saxitoxins, and cylindrospermopsins. Documented in Mascoma Lake in 2009, 2022, 2023, and 2024.
- ***Microcystis***: typically observed as variations of small-celled colonies, can produce microcystins and anatoxins. Documented in Mascoma Lake in 2013 and 2023.
- ***Woronichinia***: typically forms dense colonies, can produce microcystins. Documented in Mascoma Lake in 2023.

Cyanobacteria are increasingly common in low-nutrient lakes, likely due to increased frequency and intensity of storms, runoff events, and droughts, along with warming effects such as higher water temperatures and prolonged thermal stratification. Cyanobacteria can thrive and outcompete other phytoplankton species during periods of prolonged stratification and reduce mixing due to low inflows and outflows (Przytulska, Bartosiewicz, & Vincent, 2017; Paerl, 2018; Favot, et al., 2019). Many cyanobacteria can regulate buoyancy and move vertically in the water column to optimize sunlight and sediment phosphorus capture, even during stratification or anoxic conditions. In addition, some cyanobacteria can also fix atmospheric nitrogen, if enough light, phosphorus, iron, and molybdenum (chemical that is essential for life in small amounts and is found in soils and water) are available for the energy-taxing process of nitrogen fixation. Some taxa are also able to store excess nitrogen and phosphorus intra-cellularly for later use under more favorable conditions. Because of these traits and a warming atmosphere in the northeast, cyanobacteria are increasingly prevalent and dominant in lakes. They can drive positive feedbacks that accelerate eutrophication, even in low-nutrient lakes, and hinder recovery from eutrophic states (Dolman, et al., 2012; Cottingham, Ewing, Greer, Carey, & Weathers, 2015). A better understanding of cyanobacteria's role in nutrient feedbacks is therefore essential for developing more effective lake restoration strategies.

2.1.5.1 Phytoplankton/Zooplankton Surveys

The 2023 VLAP Individual Lake Report for Mascoma Lake shows phytoplankton population (relative percent cell count per taxa) for 2013, 2015, 2017, 2019, and 2022. These data suggest that Mascoma Lake is typically dominated by diatoms and golden-brown algal groups. In 2013, approximately 70 percent of the phytoplankton population was comprised of cyanobacteria. Phytoplankton samples collected on 6/20/2017, 6/11/2019, and 6/21/2022 show that species such as *Dinobryon* (golden-brown), *Asterionella* (diatom), *Tabellaria* (diatom), and *Rhizosolenia* (diatom) are common. Cyanobacteria in these samples were dominated by *Anabaena*/*Dolichospermum*, which are the most common cyanobacteria taxa found in Mascoma Lake. Dominant phytoplankton species noted in NHDES lake trophic survey reports from 1976, 1985, 2000, and 2008 are similar to those from more recent VLAP phytoplankton samples (Table 3) and include *Coelosphaerium* (cyanobacteria) and *Ceratium* (dinoflagellate). *Coelosphaerium* is a type of cyanobacteria but seldom produces blooms in New Hampshire. *Ceratium* is a motile, mixotrophic algae, meaning it both consumes other algae and produces its own energy through photosynthesis.

The dominant zooplankton species in the 1976, 1985, 2000, and 2008 surveys were *Nauplius* larvae (copepod), *Kellicottia* (rotifer), *Cyclopoid* (copepod), *Polyarthra* (rotifer), *Keratella* (rotifer), and *Daphnia* (cladoceran). Copepods are small crustaceans that eat phytoplankton and provide an important food source to fish. Rotifers are small zooplankton whose population can respond quickly to environmental changes. *Daphnia* are among the most efficient grazers of phytoplankton but were only shown to be a dominant zooplankton (17 percent) on 7/10/2008. A diverse balance of phytoplankton and zooplankton is typically an indicator of a healthy lake ecosystem.

Table 3. Plankton results for Mascoma Lake from the 1976, 1985, 2000, and 2008 lake trophic survey reports.

Date	Phytoplankton Species *(percent total)*	Total Phytoplankton Count *(cells per milliliter)*	Zooplankton Species *(percent total)*	Total Zooplankton Count *(cells per milliliter)*
2/4/1976	Very sparse, none	No Data	*Cyclopoid* copepod (60%)	No Data
7/19/1976	*Tabellaria* (90%)	No Data	*Nauplius* larva (30%) *Polyarthra* (25%)	151
8/20/1985	*Anabaena* (90%)	No Data	*Kellicottia* (30%) *Polyarthra* (15%)	150
2/12/1986	*Asterionella* (75%)	No Data	Sparse, none	17
8/28/2000	*Tabellaria* (50%) *Rhizosolenia* (25%) *Asterionella* (20%)	No Data	*Kellicottia* (22%) *Nauplius* larva (22%) *Polyarthra* (15%)	119
2/15/2001	*Tabellaria* (50%) *Asterionella* (30%) *Coelosphaerium* (10%)	No Data	*Nauplius* larva (38%) *Kellicottia* (29%) *Cyclopoid* copepod (19%)	21

Date	Phytoplankton Species *(percent total)*	Total Phytoplankton Count *(cells per milliliter)*	Zooplankton Species *(percent total)*	Total Zooplankton Count *(cells per milliliter)*
7/10/2008	*Dinobryon* (40%) *Ceratium* (20%) *Anabaena* (15%)	No Data	*Nauplius* larva (31%) *Polyarthra* (17%) *Daphnia* (17%)	150
3/4/2009	*Coelosphaerium* (45%) *Tabellaria* (20%) *Asterionella* (20%)	No Data	*Keratella* (31%) *Nauplius* larva (15%) *Cyclopoid* copepod (15%)	13

2.1.5.2 Cyanobacteria Bloom History

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

Mascoma Lake has had seven officially reported NHDES cyanobacteria bloom warnings, the first of which was issued in 2009 (Table 4). It also had six cyanobacteria watches, which were documented via photograph but not officially enumerated. All bloom warnings lasted eight days or less, suggesting that Mascoma Lake does not experience long-lasting, whole-lake blooms. However, bloom frequency appears to have increased in recent years, with 2020, 2021, 2022, and 2024 having one bloom warning/watch each, and 2023 having a total of five warnings/watches. Most blooms have been reported to be dominated by *Dolichospermum* with cell counts between 100,800 and 1,279,400 cells per milliliter . One *Microcystis* bloom was observed in August 2013, which lasted 4 days and had a cell count of 1,300,000 cells per milliliter . A bloom recorded in August 2023 was comprised of a diverse mix of *Woronichinia*, *Dolichospermum*, and *Microcystis*. *Dolichospermum* (formerly *Anabaena*) can outcompete other phytoplankton with its ability to obtain atmospheric nitrogen, a critical nutrient for growth but usually not the most limiting. All three cyanobacteria can regulate their buoyancy throughout the water column, allowing them to capture surface light and access nutrients in deeper water for growth. These taxa all have the potential to produce toxins. Mascoma Lake experienced one cyanobacteria bloom in 2024 which lasted eight days, consisting of *Dolichospermum* with a cell count of 176,800 cells per milliliter .

Crystal Lake's blooms were similarly short and primarily composed of *Dolichospermum* and *Microcystis*. *Aphanizomenon* are a taxon observed in Crystal Lake that were not observed in Mascoma Lake; these cyanobacteria appear like grass clippings in the water and are able to fix nitrogen. The 9/6/2023 bloom

on Crystal Lake had the highest cell count observed (2,950,000 cells per milliliter), and the 10/9/2023 bloom had the same diversity of cyanobacteria found in Mascoma Lake (Table 4).

Table 4. Cyanobacteria bloom warnings for Mascoma Lake and Crystal Lake as reported by NHDES.

Lake	Warning Date	Duration *(days)*	Dominant Taxa	Total Cell Concentration *(cells per milliliter)*
Mascoma Lake	June 17, 2009	7	*Dolichospermum (Anabaena)*	>70,000 or >50%
	August 15, 2009	3	*Dolichospermum (Anabaena)*	1,259,600
	August 30, 2013	4	*Microcystis*	1,300,000
	June 3, 2022	7	*Dolichospermum*	1,279,400
	July 14, 2023	7	*Dolichospermum*	100,800
	August 4, 2023	7	*Woronichinia, Dolichospermum, Microcystis*	641,600
	June 19, 2024	8	*Dolichospermum*	176,800
Crystal Lake	August 9, 2023	7	*Dolichospermum, Aphanizomenon*	291,500
	September 6, 2023	7	*Dolichospermum, Microcystis*	2,950,000
	October 9, 2023	6	*Dolichospermum, Microcystis, Woronichinia*	596,800

It is impossible to fully eradicate cyanobacteria in Mascoma Lake as they are naturally occurring bacteria that have been on the planet for millennia and are resilient to environmental changes. Some cyanobacteria can become dormant in sediment and jump-start cell reproduction once conditions are favorable (warm water temperatures and plenty of sunlight and nutrients). Given the long-term trend of increasing air, water temperatures, and increased phosphorus loading from development in the watershed, the likelihood of blooms will continue and possibly accelerate, though year-to-year variability in weather may determine the availability of phosphorus and/or the presence of other oxygen compounds such as nitrates and thus determine the timing, extent, and severity of blooms in any given year. Despite this, conditions favorable for blooms can be substantially minimized by reducing nutrient-rich runoff from the landscape. Water level and flow influence bloom dynamics by either flushing cyanobacteria and nutrients downstream during high-flow events or, conversely, by limiting upstream nutrient inputs during lower-flow conditions, which can reduce the nutrient availability needed to sustain bloom growth.

2.1.6 Cyanotoxins

Studies in New Hampshire have suggested a potential link between cyanobacteria blooms and elevated rates of amyotrophic lateral sclerosis (ALS). Research on residents around Lake Mascoma and Crystal Lake documented ALS incidence 10-25 times higher than expected, with significantly greater risk of ALS for individuals living within 0.5 miles of lakes with current or historical cyanobacteria blooms (Caller, et al., 2009). Cyanobacteria are known to produce the neurotoxin β-methylamino-L-alanine (BMAA), which has been implicated in ALS globally, and possible exposure routes include ingestion of lake water or fish, and

inhalation of aerosolized toxins during recreation or daily household activities (Caller et al., 2009). While early sampling from Mascoma did not detect BMAA, subsequent studies confirmed the presence of BMAA, its isomers (DAB and AEG), and microcystins in fish tissue, lake sediments, and even air filter samples collected lakeside (Banack, et al., 2015). These findings highlight that cyanotoxins are present in regional waterbodies and may pose exposure risks to nearby residents, although current evidence demonstrates spatial associations rather than direct causality between cyanobacteria and ALS (Caller, et al., 2009; Banack, et al., 2015).

2.1.7 Chloride and Specific Conductivity

Chloride pollution can cause harm to aquatic organisms and disrupt internal mixing processes when chloride concentrations reach toxic levels. The State of New Hampshire sets a chronic water quality threshold of 230 ppm for chloride (which roughly equates to 835 microsiemens per centimeter for specific conductivity). Chloride concentrations in Mascoma Lake are well below the chronic threshold, with both chloride and specific conductivity low (10 ppm and 61 microsiemens per centimeter , respectively), which is typical for a high-quality lake (most New Hampshire lakes are around 4 ppm or 40 microsiemens per centimeter). However, both chloride and specific conductivity show statistically significant increasing trends over the record from 1976-2023 across all depth zones (Figure 7). The increasing trend indicates that chloride from winter salting practices for de-icing roads and other surfaces in the watershed may be contaminating the lake.

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

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

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

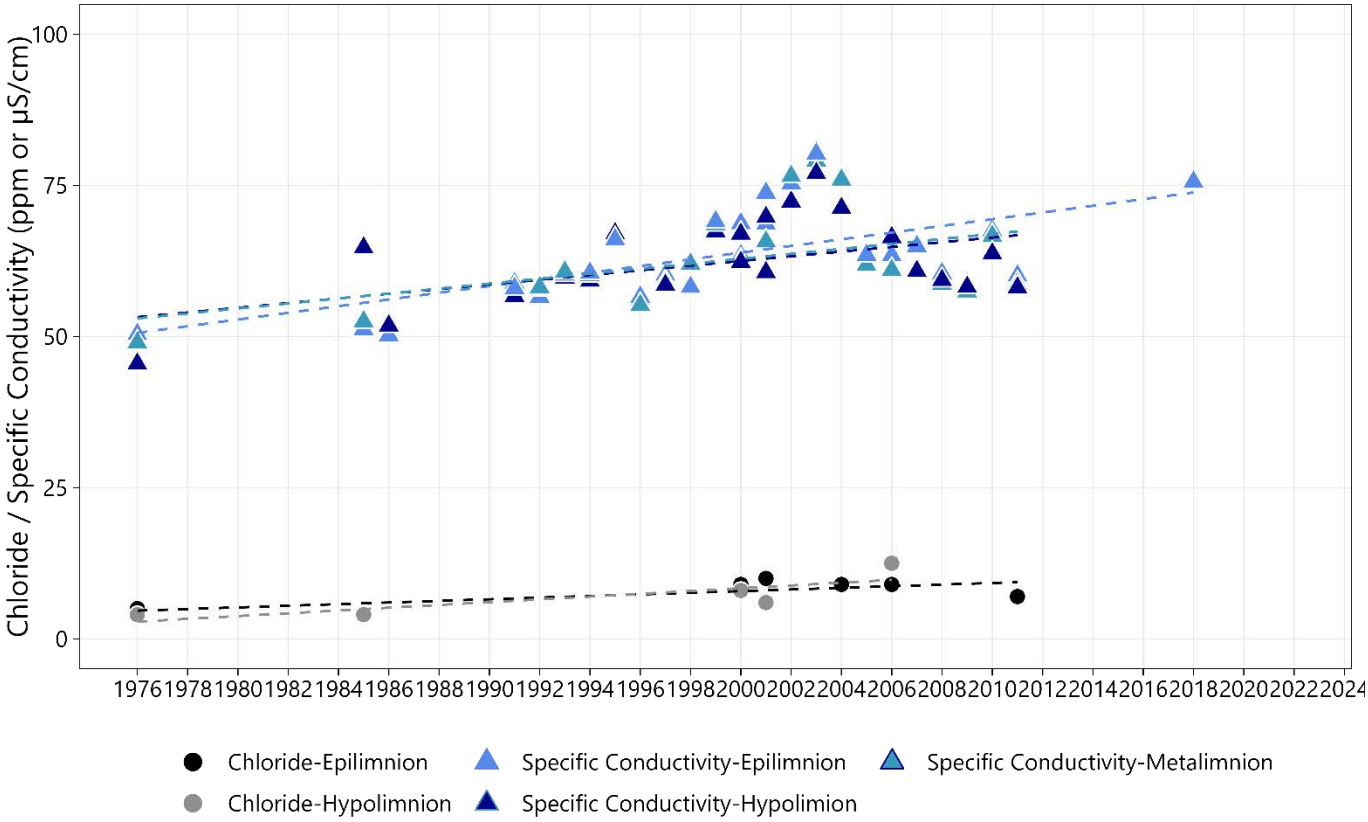


Figure 7. Yearly median of monthly medians for chloride (in parts per million) and specific conductivity (in microsiemens per centimeter) at the deep spot of Mascoma Lake [MASENF1D]. Dashed lines indicate a statistically significant increasing (degrading) trend.

2.1.8 Fish

Fish are important in ecosystem food webs and for providing recreational opportunities. Mascoma Lake supports populations of warm and cold water species, including, but not limited to, lake trout, rainbow trout, landlocked Atlantic salmon, smallmouth bass, largemouth bass, pickerel (Eastern), black crappie, white and yellow perch, and pumpkinseed (common sunfish). Common carp are also found in Mascoma Lake, though they do not appear to be a dominant species. Carp are hardy fish that can tolerate a wide range of water conditions and can be seen near shallow, weedy areas where they forage along the bottom.

Benthic or bottom-feeding fish, such as carp, impact lake water quality by disturbing bottom sediments during feeding and spawning. This can resuspend particles, worsen water clarity, and release nutrients like phosphorus into the water column (Huser, Bajer, Chizinski, & Sorensen, 2016a). In addition to impacting lake sediment and nutrient concentrations, common carp have also been found to decrease submerged macrophyte abundance, decrease benthic invertebrates, reduce native fish diversity and abundance, compete with waterfowl for food, decrease large zooplankton, increase the biomass of phytoplankton, and alter phytoplankton community structure (Badiou, Pascal, Goldsborough, & Wrubleski, 2011). The effects of carp are more pronounced in shallow, polymictic lakes, while deeper, thermally stratified lakes show less impacts (Bajer & Sorensen, 2014). Understanding the biological community in Mascoma Lake is important when evaluating water quality and determining SCMs, as

factors like fish size can influence nutrient dynamics. One study found carp size to be the strongest determinant of total phosphorus concentration (Driver, Closs, & Koen, 2005). Ultimately, a detailed study of carp mass and density, or data from local fishermen, would provide more insights into lake dynamics and help guide decision-making for Mascoma Lake.

2.1.9 Aquatic Plants

NHDES conducted aquatic plant surveys in Mascoma Lake as part of the 1976, 1985, 2000, and 2008 lake trophic surveys, providing a time-series of aquatic plant data that chronicles the arrival of the invasive Eurasian milfoil (*Myriophyllum spicatum*) in 2000. Across all four surveys, aquatic plant abundance is sparse to scattered, which aligns with its morphometry (i.e., deep water lake with small littoral zone). The 1976 plant survey showed sparse aquatic plant populations, with water sedge (*Cyperaceae*) being scattered throughout the entire shoreline; other plants such as water lilies (*Nymphaea* & *Nurphar*) and cattails (*Typha*) were confined to the northwestern basin of the lake. By 1985, aquatic plants were more abundant, with three-square (*Scirpus americanus*) being scattered around much of the shoreline. Muskgrass and stonewort (*Nitella*) were common along the southernmost cove of the lake, and Spike rush (*Eleocharis*) was most common in the northwestern bay. A large stand of aquatic plants was located along the western shoreline associated with recent land clearing, consisting of muskgrass, stonewort, pondweed (*Potamogeton*), waterweed (*Elodea*), and arrowhead (*Sagittaria*). The survey also noted massive growths of filamentous green algae in the southernmost cove, in the area associated with muskgrass and stonewort.

In 2000, spike rush was the most common aquatic plant, which was sparsely scattered across much of the shoreline. Grasses (*Gramineae*), cattails, water lilies, and purple loosestrife (*Lythrum salicaria*) were mostly confined to the northwesternmost portion of Mascoma Lake. Invasive Eurasian milfoil, which was first identified in Mascoma Lake in this year, had established itself only in the southernmost bay of the lake, along the eastern shoreline. By 2008, Eurasian milfoil had not spread far beyond its extent in 2000 and had established a few small stands along the eastern shoreline of Mascoma Lake. Other plants were more abundant, such as multiple taxa of pondweed, tape grass (*Vallisneria americana*), cattails, purple loosestrife, and water lilies. The results from the 2008 survey indicate that Eurasian milfoil, while invasive, had not taken over/outcompeted other aquatic plant species within that time frame. According to NHDES, Eurasian milfoil typically thrives in waterbodies with higher pH. With Mascoma Lake being assessed as impaired due to low pH, the growth and spread of Eurasian milfoil may be hindered by this facet of Mascoma Lake's water chemistry. Mascoma Lake is one of only six waterbodies in New Hampshire with this species of aquatic invasive plant.

2.1.10 Invasive Species

The introduction of non-indigenous invasive aquatic plant and animal species to New Hampshire's waterbodies has been on the rise. These invasive aquatic plants are responsible for habitat disruption, loss of native plant and animal communities, reduced property values, impaired fishing and degraded recreational experiences, and high removal costs. Once established, invasive species are difficult and costly to remove. NHDES indicates in its Lake Information Mapper that Eurasian milfoil has been documented in Mascoma Lake. Refer to Section 2.1.9 for more details on its extent and history. The MLA has an active volunteer scuba diving group that removes and manages Eurasian milfoil in Mascoma Lake.

The MLA, Goose Pond Lake Association, Canaan Street Lake Association, Crystal Lake Association, and Friends of Grafton Pond are involved in the NHDES Weed Watchers program for early detection of invasive species and NH Lakes' Lake Host program for invasive species prevention. Volunteers affiliated with the Volunteer River Assessment Program monitor the Mascoma River for invasive species on an informal basis.

2.2 ASSIMILATIVE CAPACITY

The assimilative capacity of a waterbody describes the amount of pollutants that can be added to a waterbody without causing a violation of the water quality criteria and is based on lake trophic designation. Mascoma Lake is a borderline oligotrophic/mesotrophic waterbody; however, the lake is currently assessed as oligotrophic. The previous mesotrophic designation in 1976, 1985, and 2000 was largely attributed to low dissolved oxygen in the bottom waters which had improved by 2008. For enhanced protection of water quality, the oligotrophic designation was selected for running the assimilative capacity analysis for Mascoma Lake (and other upstream waterbodies for which data were summarized). For oligotrophic waterbodies, the water quality criteria are set at 8.0 ppb for total phosphorus and 3.3 ppb for chlorophyll-*a*, above which the waterbody is considered impaired (Table 5). NHDES requires that 10 percent of the difference between the best possible water quality and the water quality standard be kept in reserve; therefore, total phosphorus and chlorophyll-*a* must be at or below 7.2 ppb and 3.0 ppb, respectively, to achieve Tier 2 High Quality Water status. Support determinations are based on the nutrient stressor (phosphorus) and response indicator (chlorophyll-*a*), with chlorophyll-*a* dictating the assessment if both chlorophyll-*a* and total phosphorus data are available and the assessments differ (Table 6).

Results of the assimilative capacity analysis show that Mascoma Lake is achieving Tier 2 (High Water Quality) status for the oligotrophic class designation, based on low chlorophyll-*a* levels (Table 7). However, the existing median total phosphorus concentrations exceed the oligotrophic threshold, suggesting that factors other than total phosphorus (e.g., light) may also be responsible in part for controlling algal growth. Elevated total phosphorus levels indicate that reductions in the total phosphorus load are likely needed to maintain the chlorophyll-*a* concentration below the 3.0 ppb threshold and reduce the frequency of cyanobacteria blooms.

Table 5. Aquatic life integrity nutrient criteria ranges by trophic class in New Hampshire. Chlorophyll-*a* is a surrogate measure for algae. ppb = parts per billion.

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

Table 6. Decision matrix for aquatic life integrity assessment in New Hampshire. TP = total phosphorus. Chlorophyll-*a* is a surrogate measure for algae biomass.

Nutrient Assessments	TP Threshold Exceeded	TP Threshold *NOT* Exceeded	Insufficient Info for TP
Chlorophyll-*a* Threshold Exceeded	Impaired	Impaired	Impaired
Chlorophyll-*a* Threshold *NOT* Exceeded	Potential Non-support	Fully Supporting	Fully Supporting
Insufficient Info for Chlorophyll-*a*	Insufficient Info	Insufficient Info	Insufficient Info

Table 7. Assimilative capacity analysis results for the Mascoma Lake deep spot [MASENF1D] and other waterbodies throughout the watershed with sufficient data. ppb = parts per billion.

Site	Parameter	Assimilative Capacity Threshold *(ppb)*	Existing Median *(ppb)**	Remaining Assimilative Capacity *(ppb)*	Results
MASCOMA LAKE – STATION 1 DEEP SPOT [MASENF1D	Total Phosphorus	7.2	9.0	-1.8	Tier 2 (High Water Quality)
	Chlorophyll-*a*	3.0	2.6	0.4	
CRYSTAL LAKE-DEEP SPOT [CRYENFD/1 Deep]	Total Phosphorus	7.2	6.4	0.8	Tier 2 (High Water Quality)
	Chlorophyll-*a*	3.0	1.7	1.3	
CANAAN STREET LAKE-DEEP SPOT [CANCAND]	Total Phosphorus	7.2	6.3	0.9	Tier 2 (High Water Quality)
	Chlorophyll-*a*	3.0	1.8	1.2	
GOOSE POND-DEEP SPOT [GOOCAND]	Total Phosphorus	7.2	7.0	0.2	Tier 1 (Within Reserve)
	Chlorophyll-*a*	3.0	3.0	0.0	
SPECTACLE POND-VLAP DEEP SPOT [SPEENFD2]	Total Phosphorus	7.2	8.8	-1.6	Tier 1 (Within Reserve)
	Chlorophyll-*a*	3.0	3.2	-0.2	
RESERVOIR POND-DEEP SPOT [RESDORD]	Total Phosphorus	7.2	5.7	1.5	Impaired
	Chlorophyll-*a*	3.0	5.0	-2.0	

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

2.3 WATERSHED MODELING

2.3.1 Lake Loading Response Model

Environmental modeling is the process of using mathematics to represent the natural world. Models are created to explain how a natural system works, to study cause and effect, or to make predictions under various scenarios. Environmental models range from simple equations that can be solved with pen and paper, to complex computer software requiring teams of people to operate. Lake models, such as the Lake Loading Response Model (LLRM), can make predictions about phosphorus concentrations, chlorophyll-*a* concentrations, and water clarity under different pollutant loading scenarios. These types of models play a key role in the watershed planning process. EPA guidelines for watershed plans require that pollutant loads and sources to a waterbody be estimated.

The LLRM is an Excel-based model that uses environmental data to develop a water and phosphorus loading budget for lakes and their tributaries (AECOM, 2009). Water and phosphorus loads (in the form of mass and concentration) are traced from various sources in the watershed through tributary basins and into the lake. The model incorporates data about watershed and sub-watershed boundaries, land cover, point sources (if applicable), septic systems, waterfowl, rainfall, volume and surface area, and internal phosphorus loading. These data are combined with coefficients that quantify nutrient inputs from different sources, attenuation factors that account for nutrient loss, and equations from scientific literature on lakes, rivers, and nutrient cycles to generate annual average predictions of total phosphorus, chlorophyll-*a*, Secchi disk transparency, and algal bloom probability. The model can be used to identify current and future pollutant sources, estimate pollutant limits and establish water quality goals, and guide watershed improvement projects. A detailed description of the methodology employed for the Mascoma Lake LLRM is provided in the *Mascoma Lake Loading Response Model Report* (FBE, 2025a).

2.3.1.1 Lake Morphology and Flow Characteristics

The morphology (shape) and bathymetry (depth) of lakes and ponds are considered reliable predictors of water clarity and lake ecology. Large, deep lakes are typically clearer than small, shallow lakes as the differences in lake area, number and volume of upstream lakes, and **flushing rate** affect lake function and health.

The surface area of Mascoma Lake is 1,164 acres (471 hectares), with a maximum depth of 79 feet (24 meters) and volume of 39,706,676 cubic meters (Appendix A, Map A-1). The **areal water load**, or the depth of all inflowing water that would cover the entire lake surface area, is 176 feet per year (53.6 meters per year). The flushing rate, or the number of times that the lake's volume is replaced, is 6.4 times per year.

2.3.1.2 Land Cover

Characterizing land cover within a watershed on a spatial scale can highlight potential sources of nonpoint source pollution that would otherwise go unnoticed in a field survey of the watershed. For instance, a watershed with large areas of developed land (i.e., impervious cover) and minimal forestland will likely be more at risk for nonpoint source pollution than a watershed with well-managed development and large tracts of undisturbed forest and/or protected forest, particularly along headwater

streams. Land cover is also the essential element in determining how much phosphorus is contributing to surface water via stormwater runoff and baseflow.

Current land cover in the Mascoma Lake watershed was determined by FBE using a combination of wetlands from the National Wetlands Inventory, waterbodies from the National Hydrography Dataset, roads from the New Hampshire Department of Transportation (NHDOT), and building footprints from the publicly available Microsoft building footprints layer. All data were acquired from New Hampshire's data clearinghouse, New Hampshire Geographically Referenced Analysis and Information Transfer System. FBE edited the land cover file to add residential and commercial development, logging, excavation, and other land uses using Environmental Systems Research Institute World Imagery and Google Earth satellite imagery. For more details on methodology, see the *Mascoma Lake Loading Response Model Report* (FBE, 2025a). Refer also to Appendix A, Map A-2.

As of the most recent aerial imagery, development accounts for 5 percent (1,670 hectares) of the watershed, while forested and natural areas account for 83 percent (29,816 hectares). Wetlands and open water represent 10 percent (3,434 hectares) of the watershed, not including the surface areas of Mascoma Lake and Crystal Lake. Agriculture represents 2 percent (931 hectares). Land cover for the Crystal Lake watershed shows that development accounts for 5 percent of the watershed, while forested and natural areas accounted for 84 percent of the watershed. Like the Mascoma Lake watershed, wetlands and open water accounted for 10 percent of the watershed, but for the Crystal Lake watershed agriculture only accounted for 1 percent of the watershed land cover.

Figure 8 shows a breakdown of land cover by major category for the entire watershed (not including waterbody areas), as well as total phosphorus load by major land cover category. Developed areas cover 5 percent of the entire watershed and contribute 48 percent of the entire total phosphorus watershed load to Mascoma Lake. Developed areas in the Crystal Lake watershed cover 5 percent of the direct watershed and contribute 50 percent of the direct total phosphorus watershed load. Development and associated **impervious surfaces** are concentrated along the shoreline of Mascoma Lake and downtown Enfield and represent a significant impact on water quality by contributing contaminated runoff with minimal treatment directly to Mascoma Lake.

Developed areas within the Mascoma Lake watershed are characterized by impervious surfaces, including asphalt, concrete, compact gravel, and rooftops that force rain and snow that would otherwise soak into the ground to run off as stormwater. Stormwater runoff carries pollutants to waterbodies that may be harmful to aquatic life, including sediments, nutrients, pathogens, pesticides, hydrocarbons, and metals. Research consistently shows that higher levels of effective impervious cover in a drainage area are associated with declining water quality and degraded aquatic habitat in receiving waters. Current New Hampshire stormwater guidance emphasizes minimizing directly connected impervious surfaces and preserving natural vegetated areas to maintain watershed function and protect aquatic resources (NHDES, 2025). While an impervious cover analysis was not completed for this plan, impervious cover in the direct watershed to Mascoma Lake is less than 5 percent since developed land cover (at 5 percent) reflects all human-impacted areas in addition to impervious surfaces and includes non-impervious but developed areas, such as lawns.

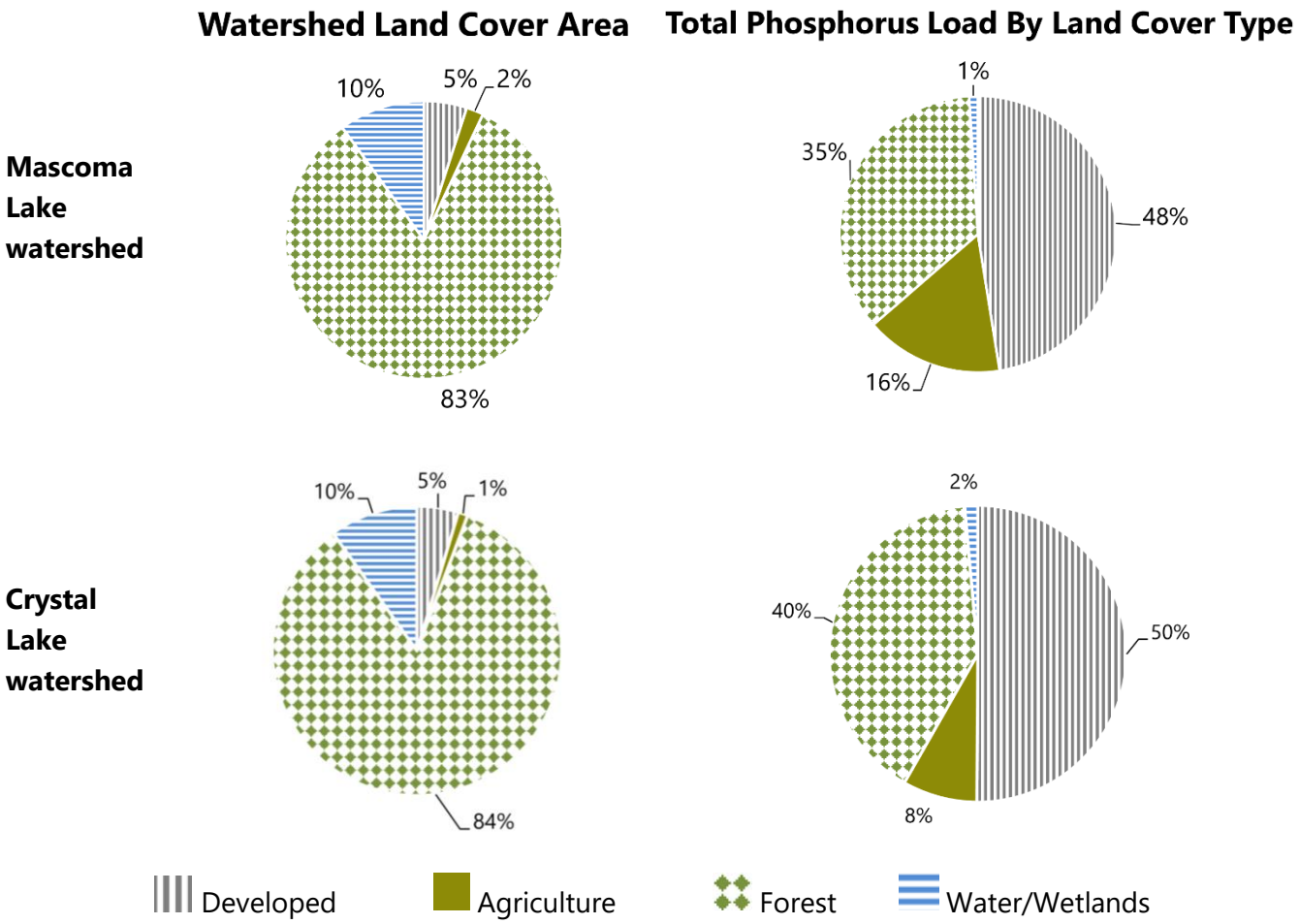


Figure 8. Watershed land cover area by major category (agriculture, developed, forest, and water/wetlands) and total phosphorus watershed load by major land cover category for the Mascoma Lake and Crystal Lake watersheds. The water/wetlands category does not include the lake area of Mascoma Lake or Crystal Lake.

2.3.1.3 Internal Phosphorus Loading

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

Internal loading estimates were derived from a combination of sediment and water quality data. The City of Lebanon funded the collection and analysis of sediment cores from Mascoma Lake during development of this plan, the results of which helped to refine the internal phosphorus load and determine applicability of any in-lake treatment options.

Although internal phosphorus loading was determined to be a currently minor contributor to total phosphorus loads, in-lake treatment approaches were evaluated to determine whether phosphorus inactivation, sequestration, or filtration methods could be appropriate for Mascoma Lake under current

or future conditions. Available in-lake treatment technologies were reviewed in the context of water quality monitoring results, assimilative capacity analyses, and modeling. Based on this evaluation, no in-lake treatment options are recommended as a primary management strategy at this time. In-lake treatments, such as phosphorus inactivation via aluminum sulfate, are typically not recommended until internal loading comprises at least 20% of the total phosphorus load. As a result, management actions in this plan focus on reducing external phosphorus inputs from the watershed, rather than in-lake treatments. A summary of potential in-lake treatment alternatives is provided in Section 4.1.2.

2.3.1.4 Sediment Analysis

On August 19, 2025, FBE collected sediment cores from 14 sites around Mascoma Lake representing a gradient of water depths (Figure 9, Figure 10). Using a gravity corer, the top 10 cm of sediment was collected from each site, deposited in a labeled bag, double-bagged, and placed in a cooler on ice for transport. FBE shipped samples overnight to the University of Wisconsin-Stout Center for Limnological Research and Rehabilitation Laboratory for analysis of moisture content, wet and dry bulk density, loss on ignition or organic content, total phosphorus, and biologically labile phosphorus by sequential lab extractions (Psenner & Puckso, 1988)[1].

2.3.1.4.1 Sediment Characterization

Sediment cores collected from Mascoma Lake were characterized as largely loose (or watery), brown, smooth silt with occasional redoximorphic features evident and noticeable color gradations from reddish at the top to gray at the bottom. Organic content was generally uniform throughout the lake sediment samples, ranging between 7 percent - 16 percent (Figure 11, Table 8). Redoximorphic features provide visual evidence of oxygen fluctuations in the sediment, with reddish-orange, oxidized (oxygen-rich) areas and greyish-black, reduced (oxygen-poor) areas. Certain cores (namely ML-12 and ML-6, which represent the deep spots of the two respective basins) had an odor indicative of sulfur reduction at the lake bottom, which suggests that the reducing conditions required for phosphorus release were present at the time of sampling. Refer to photos.

[1] Phosphorus fractions analyzed included loosely bound phosphorus, iron bound phosphorus, labile organic phosphorus, and aluminum bound phosphorus and respectively represent the increasing degree in which phosphorus is bound in the sediment. Loosely bound phosphorus is the most readily available fraction for uptake by biota. Iron bound phosphorus is phosphorus bound to iron which can be released under low oxygen conditions. Labile organic phosphorus is phosphorus bound to organic matter that is slowly released during microbial decomposition and is generally less available than loosely and iron bound phosphorus fractions but can still be a significant contributor to the internal phosphorus load. Aluminum bound phosphorus is phosphorus bound to aluminum which is generally considered permanently retained within sediments except under high pH conditions. The remaining fraction of phosphorus is considered “refractory,” including calcium bound phosphorus, and is permanently retained within sediments.

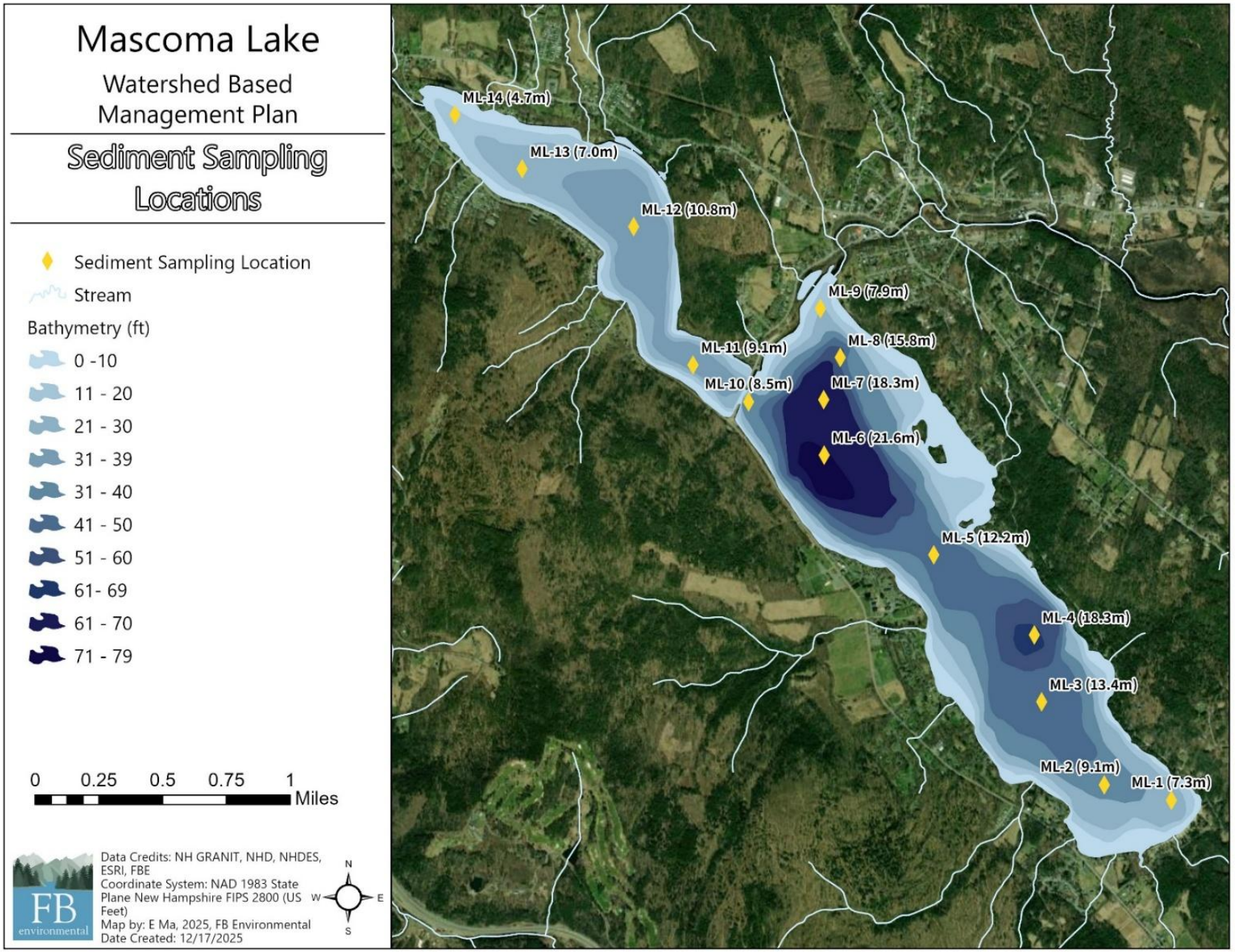


Figure 9. Sediment core sample locations around Mascoma Lake.

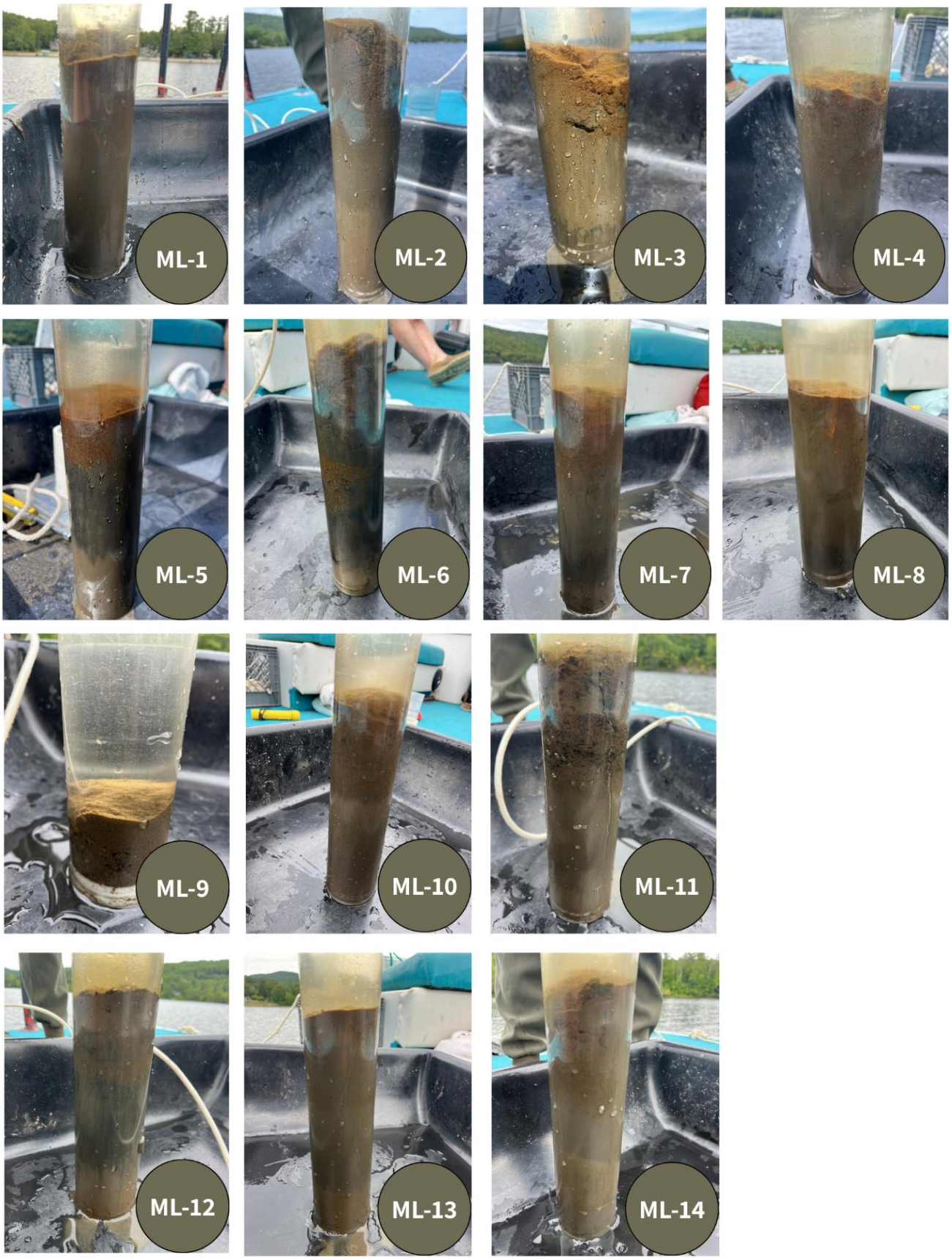


Figure 10. Photos of sediment cores collected from all sites. Refer to Figure 9 for locations.

Partially decomposed plant material was only found in one sediment core (ML-14, 4.7m); other sites were generally too deep for aquatic vegetation to grow. Organic content in the cores was low and relatively constant across depths (7 to 16 percent) (Figure 11). The percentage of solids in the cores was also consistent across sites, without any geographic or depth-related patterns. Though the two sites (ML-9, ML-10) with the highest percent solids content were located near outflows with influence from road washout and settling. These sediment cores also had relatively high wet bulk density across sites, meaning there was a relatively high mass of sediment in the space it takes up (sediment is dense). The sediment cores were all characterized by smooth, silty soil, sometimes with black speckles indicating the presence of organic matter. Only one core had grit (indicative of sand and gravel), which was ML-11, in the northwestern basin of the lake. Notably, two sediment cores had higher clay content at the bottom of the 10-centimeter core (ML-4, ML-6), both of which are in deep holes where sediment from the watershed and organic matter can "focus" or concentrate.

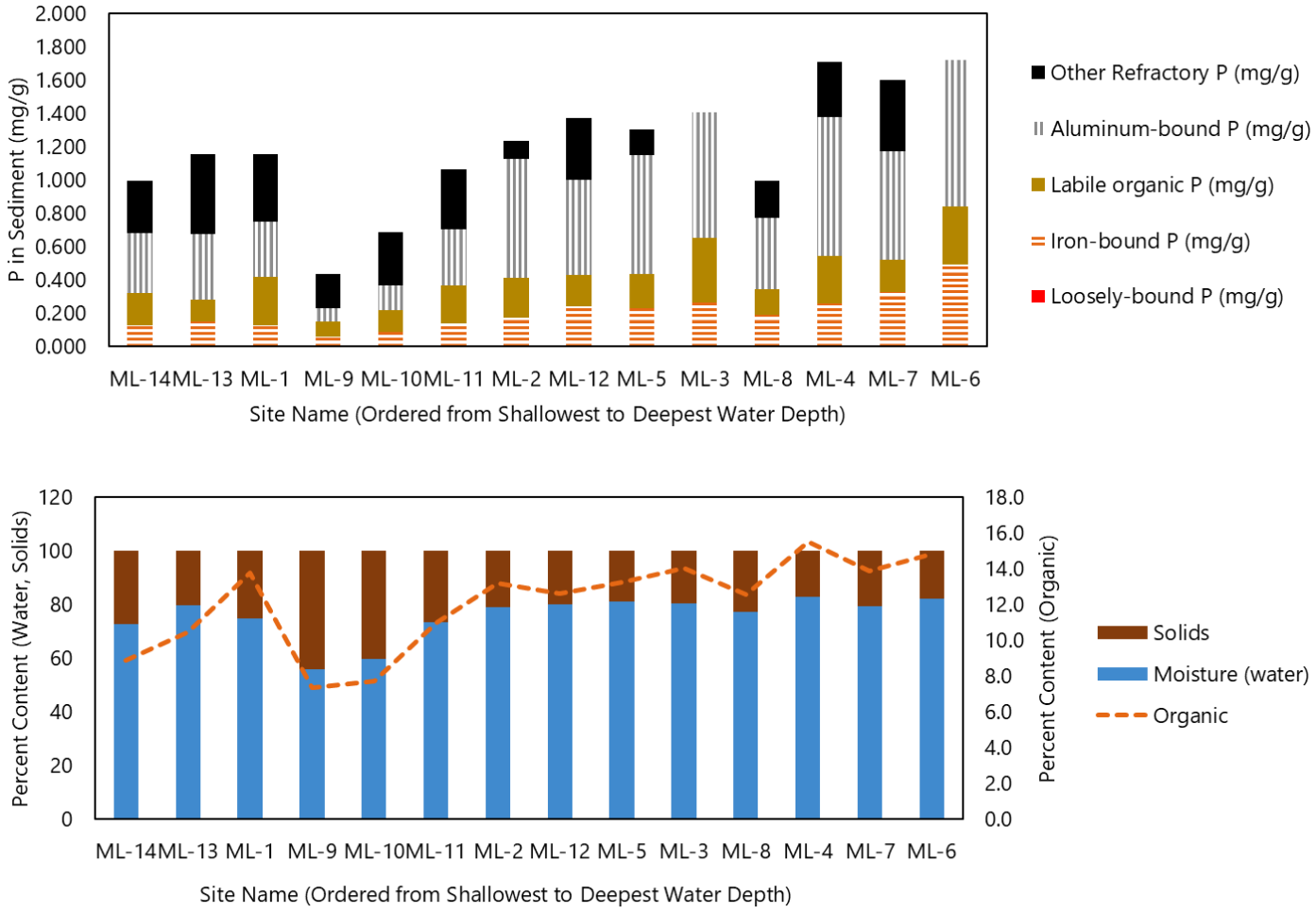


Figure 11. [Top] Phosphorus (P) fractions and [bottom] water, solids, and organic matter content (percent, percent) in sediment cores (representing top 10 centimeters) at various water depths across Mascoma Lake. Refer to Table 8 for data and Figure 9 for locations. Sites are ordered from shallowest to deepest water depth.

2.3.1.4.2 Mobile Phosphorus Mass Available

Mobile phosphorus in sediments is the sum of loosely bound, iron bound, and labile organic phosphorus, with loosely bound and iron bound being the most readily available fractions under anoxic conditions (10-30 percent of which is typically released per year) and labile organic phosphorus being available following decay over longer time periods (5-10 percent of which is typically released per year). In general, deeper sites in Mascoma Lake tended to have higher total phosphorus concentrations, with the exception of shallower sites located in the northwestern basin of the lake (ML-14, ML-13) and one nearshore site on the southeastern tip of the lake (ML-1) (Figure 11, Table 8). The amount of mobile phosphorus (both the iron bound and labile organic fractions of phosphorus) also generally increased with depth. The iron-bound phosphorus and the slow-decaying labile organic phosphorus comprised relatively equal portions of the mobile phosphorus in sediment across sites. Iron-bound phosphorus was generally within the expected range, between 0.056 – 0.487 milligrams per gram. For reference, iron bound phosphorus can range from 0.1 - more than 1 milligrams per gram in deep lakes (like Mascoma Lake) where phosphorus can "focus" in the deepest part of the lake. Mascoma Lake has three deep holes (in depth order, ML-12, ML-4, and ML-6), all of which have the highest sediment total phosphorus concentrations in their respective basins.

Dissolved oxygen/temperature profiles collected for the northwestern basin and main lake of Mascoma Lake (near sediment sites ML-12 and ML-6, respectively) show stark differences between areas of the lake that are hydrologically separated by a major road. Profiles for the northwestern basin (site MASENF2D) were collected from 1991-2011 and show anoxia extending as shallow as 7 meters. Anoxia establishes in bottom waters (around 9 meters) beginning in June and peaks in August. Because this basin is shallower and appears to be slightly disconnected from the main lake, the water column appears to have a slightly different mixing regime, and the water column begins to destabilize in September. More data are needed in shoulder months to confirm. In the main lake (site MASENF1D), anoxia is observed to begin in July, extend as shallow as 10 meters, and peak in September (closer to lake turnover).

The average concentration of loosely bound and iron bound phosphorus in sediment in regularly anoxic areas of the lake (more than 7 meters for the northwestern basin and more than 10 meters for the main lake) is 0.177 milligrams per gram and 0.288 milligrams per gram, respectively (Table 8). The average concentration of all three mobile fractions in sediment is 0.360 milligrams per gram and 0.557 milligrams per gram in the regularly anoxic zones for the northwestern basin and main lake, respectively. Loosely bound and iron bound phosphorus typically drive internal phosphorus loading in lakes, but labile organic phosphorus can also play a significant role. These mobile phosphorus concentrations in sediment are similar to those of other lakes in the region that experience significant internal phosphorus loading (especially the iron-bound phosphorus concentration).

2.3.1.4.3 Internal Phosphorus Loading Estimate

The partial net estimate of the internal phosphorus load to Mascoma Lake was estimated at 20.8 kilograms per year (kg/yr) representing about 1 percent of the total phosphorus load to the lake, according to the modeling performed for this WBMP (see Section 2.2). The internal phosphorus load estimate was highly variable and warrants continued monitoring to refine the estimate. Details on recommended monitoring are provided in Section 6.4.

As an alternate check on the internal phosphorus loading estimate from the LLRM, we can use the sediment data paired with dissolved oxygen data and literature-based empirical formulas or assumptions to estimate the net and gross internal phosphorus load to Mascoma Lake. Using the loosely bound and iron bound phosphorus fractions to derive the release rate (milligrams per square meter per day) multiplied by the anoxic factor (days per year) or anoxic area (d per year) and total lake surface area (square meters) according to Nürnberg, we estimate a gross internal phosphorus load of **273 kg/yr** (net = 216 kg/yr) (Nürnberg, 1988). These results are an order of magnitude higher than the partial net estimate derived as part of the LLRM. There are a couple explanations for this discrepancy.

First, the water quality-derived partial net estimate may be too low given some limitations with sampling methods:

(1) Mascoma Lake is a deep (70 feet+, 21 meters+), stratified lake. This means that **thermocline** erosion and eventually fall turnover when the entire water column mixes, occurs later in the fall, which extends the duration of thermal stratification and thus the exposure of sediments to anoxia that can release phosphorus into the water column. Consequently, peak internal loading likely occurs in September-October, which has not typically been sampled in the past. Additionally, VLAP protocols collecting discrete grab samples for phosphorus analysis at three mid-layer depths misses the full variation in phosphorus concentrations throughout the water column. Mid-layer depth in the hypolimnion is around 12-18 meters, which is 6-10 meters above the lake bottom and represents an area with potentially the highest concentrations of phosphorus coming from sediment release.
(2) Discrete profiles taken only at the deep spots may miss spatial variations in anoxia that impact internal loading. Anoxia can differ throughout the lake based on the morphology/morphometry of different coves, bays, or basins (as is seen with the northwestern basin of Mascoma Lake). The northwestern basin has not been sampled since 2011, representing a data gap. Other shallower areas may have slightly more/less anoxia at depths which can worsen/lessen the risk of internal loading.

Second, the sediment-derived gross estimate may be too high given some natural controls on the net release of phosphorus from sediment in Mascoma Lake. The sediment-derived gross estimate is a modeled potential (not actual) release of phosphorus from sediment. Mascoma Lake sediments have a relatively high wet bulk density, which generates a high mass of potentially releasable phosphorus. There are many mechanisms that control phosphorus release and thus the effective internal phosphorus load to the lake. These mechanisms include groundwater inflows, rapid precipitation of released phosphorus with iron, aluminum, clay, or organic particles, low upward flux of phosphorus out of sediments due to higher bulk density, or high nitrate or manganese in bottom waters or sediments that are more readily used electron receptors than iron.

Regardless, internal load estimations ranging from 21 – 273 kg/yr of phosphorus are plausible for the system. Because Mascoma Lake has a high total phosphorus load from a large watershed (2,444 kg/yr of phosphorus), having a larger range for an internal load estimate does not impact the model calibration. The predicted in-lake total phosphorus concentration is still within 5 percent of observed data using the higher internal load estimate from the sediment data. With this full range in mind, the internal load may comprise between 1 percent to 10 percent of the total phosphorus load to Mascoma Lake, which is below the critical 20 percent threshold where in-lake treatment measures such as alum treatments are considered.

Table 8. Sediment sample results for Mascoma Lake ordered from shallowest to deepest water depth. Blue columns are part of the northwestern basin of Mascoma Lake. Samples were analyzed by the University of Wisconsin-Stout Center for Limnological Research and Rehabilitation. The reporting limit for loosely-bound P is 0.010 milligrams per gram, so values below the limit are approximate. All samples were collected on 8/19/2025.

Measurement	ML-14	ML-13	ML-1	ML-9	ML-10	ML-11	ML-2	ML-12	ML-5	ML-3	ML-8	ML-4	ML-7	ML-6
Water depth *(meters)*	4.7	7.0	7.3	7.9	8.5	9.1	9.1	10.8	12.2	13.4	15.8	18.3	18.3	21.6
Core length *(centimeters)*	10	10	10	4	10	10	10	10	10	10	10	10	10	10
Moisture content *(percent)*	72.5	79.7	74.9	55.9	59.7	73.5	79.1	80.2	80.9	80.4	77.1	83.0	79.3	82.1
Solids content *(percent)*	27.5	20.3	25.1	44.1	40.3	26.5	20.9	19.8	19.1	19.6	22.9	17.0	20.7	17.9
Loss on ignition (organic content) *(percent)*	8.9	10.4	13.8	7.3	7.7	11.0	13.2	12.6	13.2	14.0	12.6	15.5	13.9	14.8
Wet bulk density *(grams per cubic meter)*	1.182	1.126	1.153	1.336	1.296	1.169	1.126	1.119	1.113	1.115	1.141	1.097	1.123	1.103
Dry bulk density *(grams per cubic meter)*	0.330	0.231	0.295	0.604	0.534	0.315	0.240	0.225	0.215	0.222	0.266	0.190	0.237	0.200
Loosely bound phosphorus *(milligrams per gram)*	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.010	0.004	0.004	0.004	0.004
Iron bound phosphorus *(milligrams per gram)*	0.125	0.145	0.121	0.056	0.081	0.134	0.168	0.240	0.225	0.253	0.187	0.252	0.324	0.487
Labile organic phosphorus *(milligrams per gram)*	0.193	0.133	0.293	0.090	0.132	0.227	0.240	0.188	0.207	0.391	0.154	0.289	0.194	0.350
Aluminum bound phosphorus *(milligrams per gram)*	0.359	0.396	0.333	0.082	0.148	0.340	0.716	0.569	0.714	0.753	0.429	0.830	0.652	0.877
Other refractory phosphorus *(milligrams per gram)*	0.316	0.479	0.406	0.206	0.321	0.360	0.109	0.372	0.155	0.000	0.223	0.333	0.426	0.000
Total phosphorus *(milligrams per gram)*	0.997	1.157	1.157	0.438	0.686	1.065	1.237	1.373	1.305	1.373	0.997	1.708	1.600	1.656

2.3.1.5 Lake Loading Response Model Results

Overall, model predictions for Crystal Lake and Mascoma Lake were in good agreement with observed data for total phosphorus (4 percent and 2 percent, respectively), moderate agreement for Secchi disk transparency (6 percent and 12 percent, respectively) and poor agreement for chlorophyll-*a* (15 percent and 37 percent, respectively). It is important to note that the LLRM does not explicitly account for all the biogeochemical processes occurring within a waterbody that contribute to overall water quality and is less accurate at predicting chlorophyll-*a* and Secchi disk transparency. For example, chlorophyll-*a* is estimated strictly from nutrient loading, but other factors strongly affect algae growth, including transport of phosphorus from the sediment-water interface to the water column by cyanobacteria, low light from suspended sediment, grazing by zooplankton, presence of heterotrophic algae, and flushing effects from high flows. There was insufficient data available to evaluate the influence of these other factors on observed chlorophyll-*a* concentrations and Secchi disk transparency readings. The model predicts zero cyanobacteria bloom days for Crystal Lake and one cyanobacteria bloom day for Mascoma Lake. Although both lakes have received bloom warnings for multiple days in recent summers, these blooms were generally shoreline accumulations and not representative of the epilimnion water column cell densities that the model predicts.

Watershed runoff combined with baseflow (i.e., watershed load) was the largest phosphorus loading contribution across all sources to Mascoma Lake, which is the final receiving waterbody in the watershed (Figure 12, Figure 13). The watershed load (94 percent) to Mascoma Lake includes the total phosphorus load from Crystal Lake (7 percent) (Figure 13). Atmospheric deposition (2 percent), internal loading (1 percent), waterfowl (1 percent), and septic systems (2 percent) were relatively minor sources to Mascoma Lake but may be seasonally important during low flow summer conditions. For Crystal Lake, the model predicted 73 percent of the total phosphorus load originates from watershed sources, with septic systems (9 percent), internal loading (9 percent), atmospheric deposition (6 percent), and waterfowl (3 percent) making up the remaining phosphorus load.

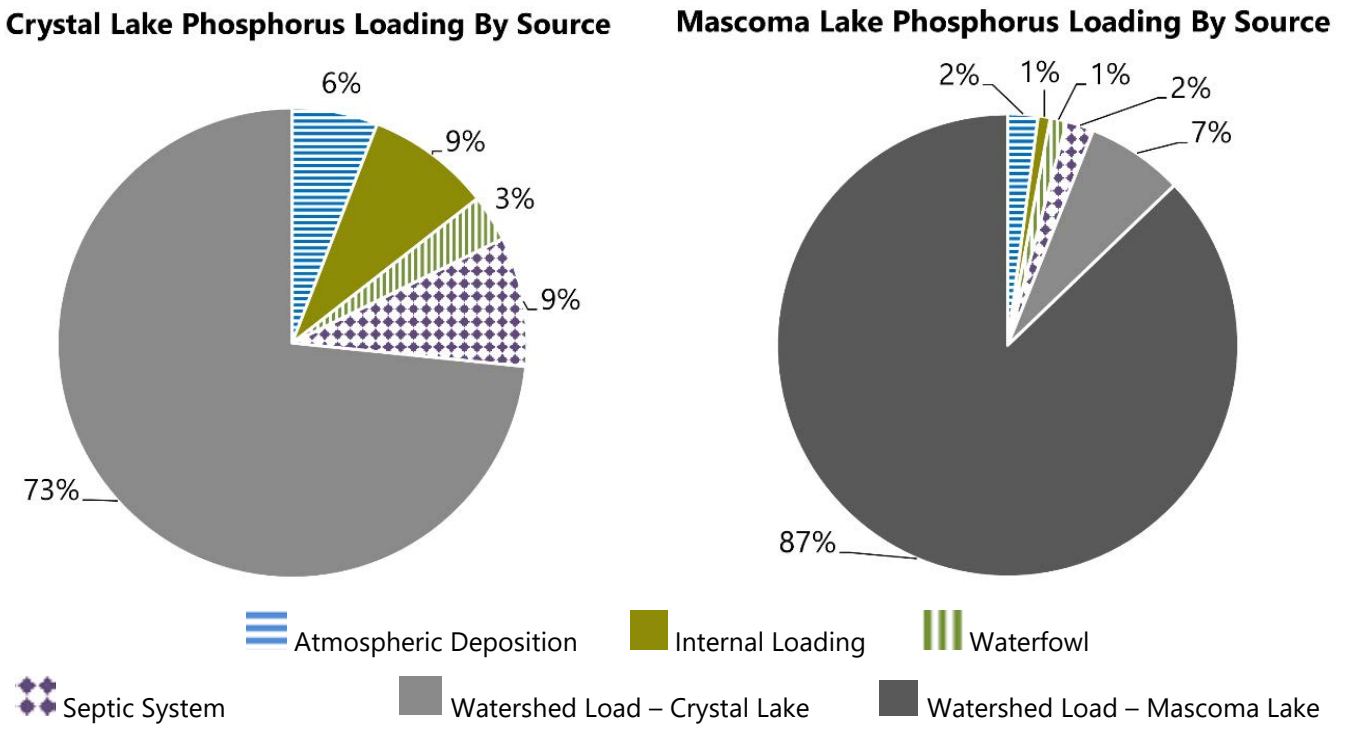


Figure 12. Summary of total phosphorus loading by major source for Mascoma Lake and Crystal Lake. Refer to Table 12 for a breakdown.

Development in the Mascoma Lake watershed is most concentrated along primary roadways through Enfield and Canaan and is particularly dense in the Canaan and Enfield town centers. Development is also dense around the shoreline where septic systems or holding tanks are located within a short distance of the water, leaving little horizontal (and sometimes vertical) space for proper filtration of wastewater effluent. Improper maintenance or siting of these systems can cause failures, which leach untreated, nutrient-rich wastewater effluent to the lake. Much of the southwestern shoreline of Mascoma Lake as well as Main Street in Enfield is sewered. The entirety of the Crystal Lake shoreline is serviced by septic systems. Sewer can also represent a potential vulnerability if the sewer systems are old or damaged and leaking wastewater into groundwater near waterbodies. Note that the septic system load estimate is only for those systems directly along the shoreline of Mascoma and Crystal Lakes and potentially short-circuiting minimally treated effluent to the lakes. The load from septic systems throughout the rest of the watershed is inherent to the coefficients used to generate the watershed load.

Normalizing for the size of a sub-watershed (i.e., accounting for its annual discharge and direct drainage area) better highlights sub-watersheds with elevated pollutant exports relative to their drainage area. Sub-watersheds with moderate to high phosphorus export rates (more than 0.2 kilograms per hectare per year) generally correspond to more developed areas, particularly dense urban development along Mascoma Lake's shoreline. Drainage areas directly adjacent to waterbodies have a direct hydrologic connection to the lake and are often targeted for development, increasing the potential for phosphorus export. Other high-loading areas with extensive developed land include sub-watersheds near the U.S. Route 4 corridor, encompassing downtown Enfield and Canaan, as well as development near Canaan Street Lake and Canaan Center.

Development in eastern Canaan and along New Hampshire Route 118 occurs within the largely undeveloped Lower Indian River sub-watershed, resulting in lower total phosphorus loads compared to other Route 4 and urban corridor sub-watersheds. Similarly, the Goose Pond sub-watershed shows relatively low loading despite shoreline development, due to extensive forest cover in its northern portion. Smaller sub-watersheds on Mascoma Lake's western shore, including the Lower and Upper Shaker Village and Smith Pond sub-watersheds, have lower phosphorus loading since a large portion of their land is conserved under the Lower Shaker Wildlife Management Area and the Smith Pond Shaker Forest. The areas with the lowest relative phosphorus load are concentrated in the northernmost part of the watershed, which is largely forested with low levels of development.

Once the model was calibrated for current in-lake phosphorus concentration, we manipulated land cover and other factor loadings to estimate pre-development loading scenarios (e.g., what in-lake phosphorus concentration was prior to human development or the best possible water quality for the lakes). Pre-development loading estimation showed that total phosphorus loading to Mascoma Lake (including the Crystal Lake model as an input source) increased by 174 percent, from 893 kg/yr prior to development to 2,444 kg/yr under current conditions (Table 9). These additional phosphorus sources are coming from development in the watershed (especially from the direct shoreline of Mascoma, Crystal, and Canaan Street Lakes, as well as U.S. Route 4 and downtown areas of Enfield and Canaan), septic systems, atmospheric dust, and internal loading (Table 10). Water quality prior to development was predicted to be excellent with extremely low phosphorus and chlorophyll-*a* concentrations and high water clarity (Table 10).

We also manipulated land cover and other factors to estimate future loading scenarios (e.g., what in-lake phosphorus concentration might be at full build-out under current zoning or the worst possible water quality for the lake). Refer to the 2025 *Mascoma Lake Watershed Build-out Report* (FBE, 2025b) for details on methodology. Though not accounted for in the future model, projected increases in the frequency and intensity of storms and runoff events, along with longer dry periods and warming trends, may exacerbate erosion of phosphorus-laden sediment to surface waters and increase in-lake phosphorus concentrations (despite dilution and flushing assumed by the model).

Future loading estimation showed that total phosphorus loading to Mascoma Lake (including the Crystal Lake model as an input source) may increase by approximately 276 percent from 2,444 kg/yr to 9,194 kg/yr at full build-out (2166) under current zoning (Table 10). Additional phosphorus will be generated from more development in the watershed (especially in undeveloped headwater areas), greater atmospheric dust, more septic systems, and enhanced internal loading (Table 9,Table 10). The Mascoma Lake model predicted higher (worse) phosphorus (28.0 ppb), higher (worse) chlorophyll-*a* (11.4 ppb) with 246 bloom days, and lower (worse) water clarity (1.8 meters) compared to current conditions for Mascoma Lake (Table 9). Predicted future water quality was similarly poor for Crystal Lake.

A substantial increase in phosphorus loading is predicted to occur due to the development of undeveloped headwater areas, particularly in Canaan. Of the potential new principal buildings that could be constructed under current zoning, 79% are located in the Town of Canaan, which lacks minimum lot size requirements and allows higher-density development, unlike other towns in the watershed. As a result, future phosphorus loading is expected to be greatest in sub-watersheds within Canaan, particularly the Little Goose Pond and Goose Pond Brook sub-watersheds.

Table 9. In-lake water quality predictions for Crystal Lake and Mascoma Lake. SDT = Secchi disk transparency. Bloom Days represent average annual probability of chlorophyll-*a* exceeding 8 parts per billion (ppb).

Lake	Model Scenario	Median Total Phosphorus *(ppb)*	Predicted Median Total Phosphorus *(ppb)*	Mean Chlorophyll-*a* *(ppb)*	Predicted Mean Chlorophyll-*a* *(ppb)*	Mean SDT *(meters)*	Predicted Mean SDT *(meters)*	Bloom Days
Crystal Lake	Pre-Development	--	2.7	--	0.4	--	10.9	0
	Current (2024)	6.8*	7.1	1.7	2.0	5.5	5.1	0
	Future (2166)	--	20.9	--	7.9	--	2.2	145
Mascoma Lake	Pre-Development	--	2.7	--	0.4	--	10.7	0
	Current (2024)	7.5*	7.4	3.1	2.1	4.4	5.0	1
	Future (2166)	--	28.0	--	11.4	--	1.8	246

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

Table 10. Total phosphorus and watershed load summary for Crystal Lake and Mascoma Lake, organized by model and source. Italicized source categories represent components that sum to the total watershed load. TP = total phosphorus. kg/yr = kilograms per year.

CRYSTAL LAKE

Development State	Measurement	Atmospheric	Internal	Waterfowl	Septic System	Watershed Load	Total Load To Lake
Pre-Development	TP (kg/yr)	11.6	0.0	10.0	0.0	94.4	**116.0**
	Percent	10	0	9	0	81	**100**
	Water (cubic meters per year)	2,041,112	0	0	0	22,285,796	**24,326,908**
Current (2024)	TP (kg/yr)	18.3	26.5	10.0	27.6	227.1	**309.5**
	Percent	6	9	3	9	73	**100**
	Water (cubic meters per year)	2,041,112	0	0	22,784	22,243,307	**24,307,202**
Future (2166)	TP (kg/yr)	41.6	77.7	10.0	27.6	751.9	**908.7**
	Percent	5	9	1	3	83	**100**

Development State	Measurement	Atmospheric	Internal	Waterfowl	Septic System	Watershed Load	Total Load To Lake
	Water (cubic meters per year)	2,041,112	0	0	22,784	22,039,078	**24,102,973**

MASCOMA LAKE

Development State	Measurement	Atmospheric	Internal	Waterfowl	Septic System	Watershed Load	*Load to Mascoma*	*Load from Crystal Lake*	Total Load To Lake
Pre-Development	TP (kg/yr)	33.0	0.0	28.3	0.0	832.0	*769.8*	*62.2*	**893.2**
	Percent	4	0	3	0	93	*86*	*7*	**100**
	Water (cubic meters per year)	5,594,647	0	0	0	247,185,611	*223,713,574*	*23,472,038*	**252,780,259**
Current (2024)	TP (kg/yr)	51.8	20.8	28.3	47.0	2,295.9	*2,129.9*	*166.0*	**2,443.7**
	Percent	2	1	1	2	94	*87*	*7*	**100**
	Water (cubic meters per year)	5,594,647	0	0	37,341	246,845,405	*223,393,073*	*23,452,332*	**252,477,394**
Future (2166)	TP (kg/yr)	117.7	76.9	28.3	56.4	8,915.1	*8,429.2*	*486.0*	**9,194.4**
	Percent	1	<1	<1	<1	97	*91*	*5*	**100**
	Water (cubic meters per year)	5,594,647	0	0	49,094	244,288,606	*221,040,503*	*23,248,103*	**249,932,348**

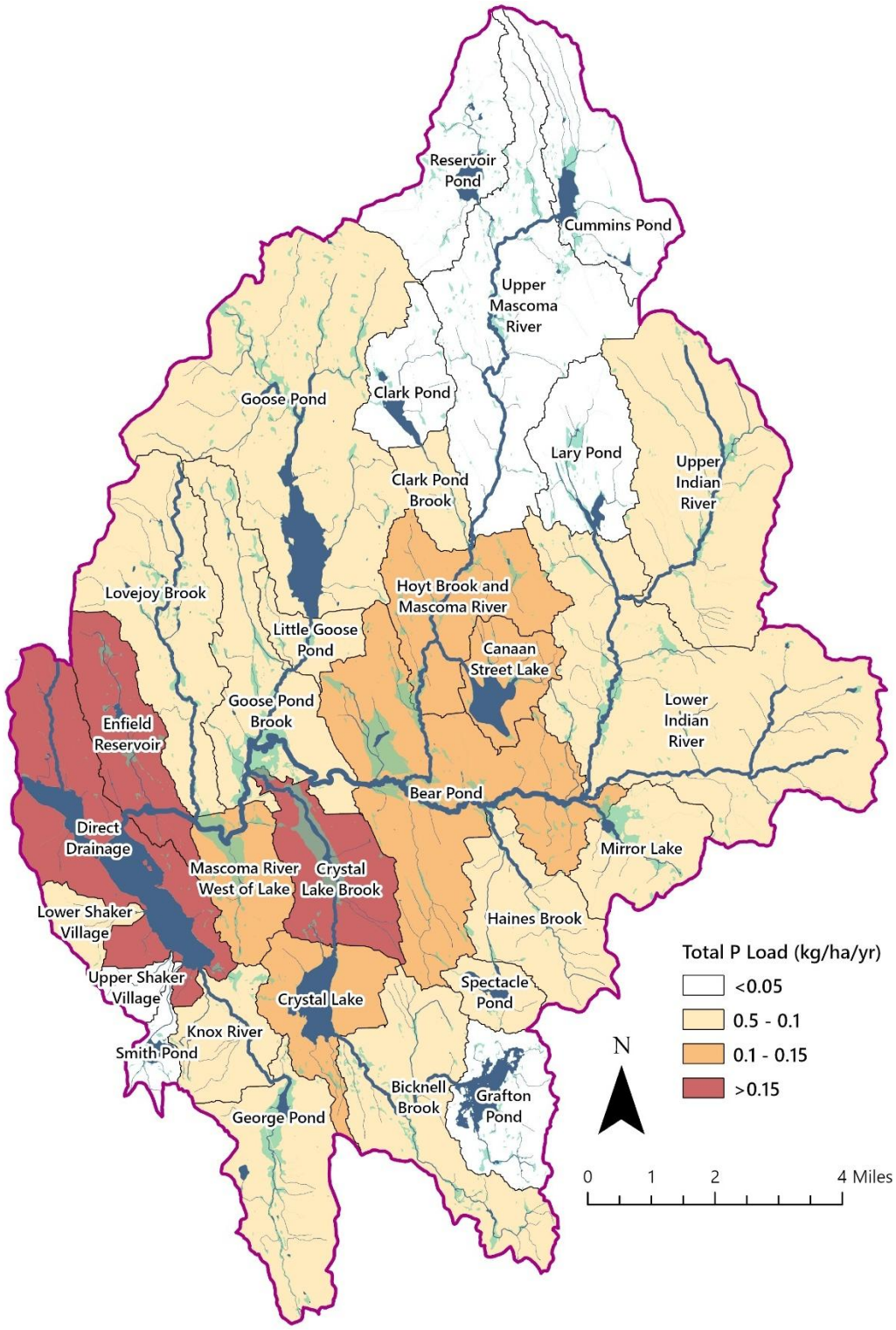


Figure 13. Map of current total phosphorus load per unit area (kilograms per hectare per year = kg/ha/yr) for each sub-watershed in the Mascoma Lake watershed. Sub-watersheds with higher phosphorus load per unit area are located along the highly developed shoreline of Mascoma Lake and along U.S. Route 4 which includes downtown Enfield and Canaan. The upper portion of the watershed, which is largely undeveloped, has the lowest phosphorus loading values. The phosphorus loads per unit area were calculated using the total baseflow phosphorus and runoff phosphorus for each sub-watershed directly and does not incorporate routing patterns or attenuation factors.

2.3.2 Build-out Analysis

A **full build-out** analysis was completed for the Mascoma Lake watershed for the municipalities of Lyme, Dorchester, Hanover, Lebanon, Enfield, Grantham, Springfield, Grafton, Orange, and Canaan (FBE, 2025b). A build-out analysis identifies areas with development potential and projects future development based on a set of conditions (e.g., zoning regulations, environmental constraints) and assumptions (e.g., population growth rate). A build-out analysis shows what land is available for development, how much development can occur, and at what densities. "Full build-out" is a theoretical condition representing the moment in time when all available land suitable for residential, commercial, and industrial uses has been developed to the maximum capacity permitted by local ordinances and zoning standards. Local ordinances and zoning standards are subject to change, and the analysis requires simplifying assumptions; therefore, the results of the build-out analysis should be viewed as planning-level estimates only for potential future outcomes from development trends.

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

To determine where development may occur within the study area, the build-out analysis first subtracts land unavailable for development due to physical constraints, including environmental restrictions (e.g., wetlands, conserved lands, hydric soils), zoning restrictions (e.g., shoreland zoning, street rights-of-way, and building setbacks), and practical design considerations (e.g., lot layout inefficiencies) (Appendix A, Map A-3). Existing buildings also reduce the capacity for new development.

The build-out analysis showed that 44 percent (43,918 acres) of the study area is buildable under current zoning regulations (Appendix A, Map A-4). The Town of Canaan, excluding the Historic District, has the most buildable area available with 23,979 acres available (Table 11). FBE identified 9,358 existing

buildings in the watershed, with build-out projections adding 33,633 more, for a total of 42,991 buildings at full build-out (Appendix A, Map A-5).

A TimeScope Analysis applies growth rates from multiple historical time periods to evaluate projections across different length trends. Three iterations of the TimeScope Analysis were run using compound annual growth rates (CAGRs) for 10-, 20-, and 50-years from 2010-2020 (0.45 percent), 2000-2020 (1.22 percent), and 1970-2020 (1.09 percent), respectively, to project the rate of new development into the future (Table 12). Full build-out is projected to occur in 2365 at the 10-year CAGR, 2151 at the 20-year CAGR, and 2166 for the 50-year CAGR (Figure 14).

Note that the growth rates used in the TimeScope Analysis are based on town-wide census statistics but have been applied here to only the portions of the municipalities within the watershed. If areas closer to town centers within each municipality develop faster than lands within the watershed (as applicable), watershed full build-out conditions may occur sooner and vice versa. Projecting population growth or development using census data comes with inherent limitations. For instance, building rates may not align with population growth due to factors such as differences between commercial and residential development or changes in household size. Many projected buildings would also require new road construction, which could slow the rate of development. As such, the TimeScope Analysis might overestimate or underestimate the time needed for the study area to reach full build-out. Population growth and development are influenced by a range of social and economic factors, including policies adopted by federal, state, and local governments. The relationships among the various factors may be complex and therefore difficult to model.

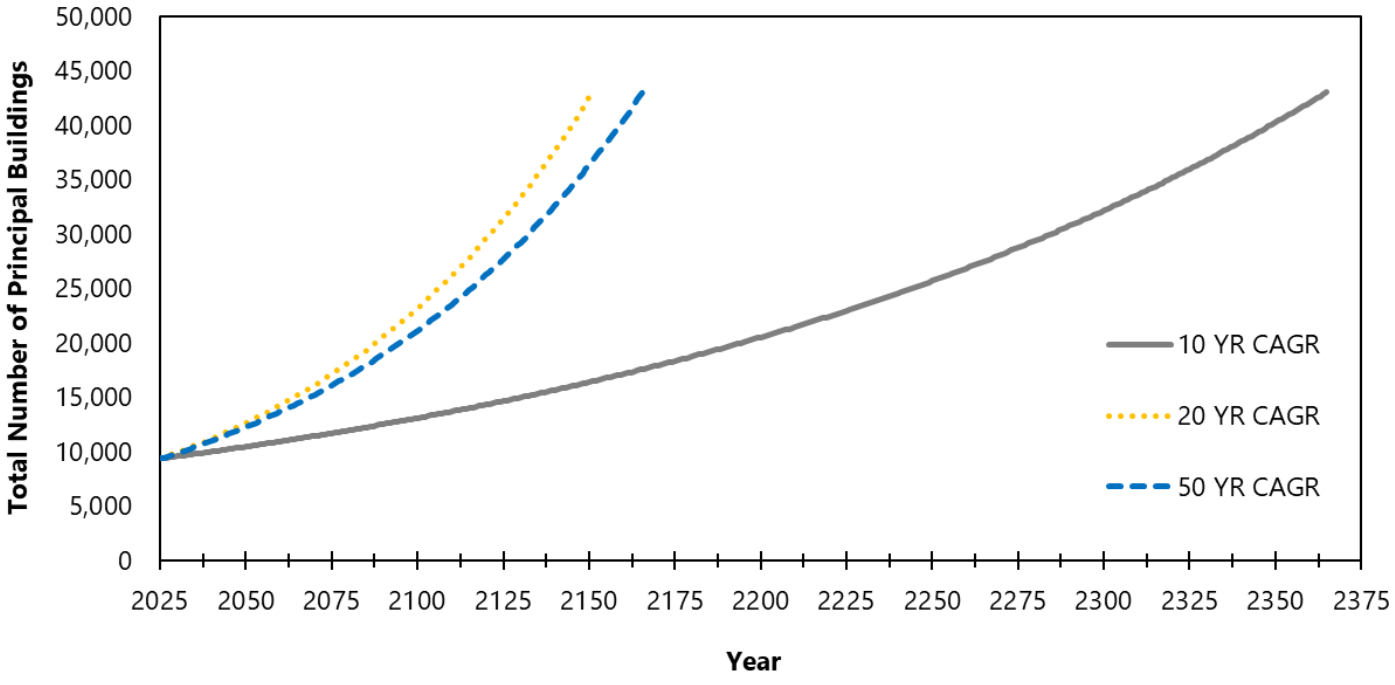


Figure 14. Full build-out projections of the Mascoma Lake watershed (based on CAGRs).

Table 11. Amount of buildable land and projected buildings by each municipality's zone in the Mascoma Lake watershed, including Canaan, Dorchester, Enfield, Grafton, Grantham, Hanover, Lebanon, Lyme, Orange, and Springfield, NH.

Town	Zone	Total Area *(acres)*	Buildable Area *(acres)*	Percent Buildable Area	Number Existing Buildings	Number Projected Buildings	Total Number Buildings	Percent Increase
Canaan	Historic District	270	122	45%	85	40	125	47%
	Rest of Town	33,668	23,979	71%	1,776	26,447	28,223	1489%
Dorchester	Rural	14,246	4,567	32%	45	1,463 (*2,926*)	1,508	3251%
Enfield	Conservation	654	85	13%	7	10	17	143%
	Community Business: on-lot water and sewer	189	142	75%	20	92	112	460%
	Community Business: municipal water and sewer	125	61	49%	110	65	175	59%
	Residential: on-lot water and sewer	7,809	1,546	20%	3455	899	4,354	26%
	Residential: with municipal water and sewer	1,224	93	8%	2528	197	2,725	8%
	Rural Residential	3,733	1,731	46%	430	350	780	81%
	Rural Residential: agricultural	8,787	3,578	41%	296	416	712	141%
	US Route 4: buildings directly along route	190	143	75%	55	228	283	415%
	Commercial/Industrial	78	62	80%	0	22	22	none
Grafton	Town of Grafton	7,513	2,685	36%	78	2,641 (*5,282*)	2,719	3386%
Grantham	Conservation District	44	0	0%	0	0	0	0%
	Rural Residential I	68	29	42%	17	22 (*44*)	39	129%
Hanover	Forestry & Recreation	7,435	2,104	28%	39	65	104	167%
	Goose Pond	47	10	20%	38	17	55	45%

Town	Zone	Total Area *(acres)*	Buildable Area *(acres)*	Percent Buildable Area	Number Existing Buildings	Number Projected Buildings	Total Number Buildings	Percent Increase
	Rural Residence	740	207	28%	6	44 (*88*)	50	733%
Lebanon	Rural Land 1	473	51	11%	110	31 (*62*)	141	28%
	Rural Land 2	264	91	34%	71	53 (*106*)	124	75%
	Rural Land 3	60	33	55%	0	3 (*6*)	3	none
Lyme	Mountain and Forest District	4,459	494	11%	0	6 (*12*)	6	none
	East Lyme District	1,266	325	26%	20	17 (*34*)	37	85%
	Rural District	55	33	60%	0	7 (*14*)	7	none
Orange	Rural Residential	6,873	1,681	24%	168	475 (*950*)	643	283%
Springfield	Rural Residential	71	66	93%	4	23 (*46*)	27	575%
	Forest Conservation	2	2	63%	0	0	0	0%
All Towns	**Total**	***100,343***	***43,918***	***44%***	**9,358**	**33,633**	**42,991**	**359%**

**Parcels on municipal sewer were modeled to have two dwelling units per acre. Numbers in parentheses and italicized represent number of buildings if each parcel built an additional dwelling unit on their lot.*

Table 12. Compound annual growth rates for the municipalities in the Mascoma Lake watershed. Data from the U.S. Census Bureau.

Town	Canaan	Dorchester	Enfield	Grafton	Grantham	Hanover	Lebanon	Lyme	Orange	Springfield	Combined
50-year average ***(1970-2020)***	1.37%	1.77%	1.30%	2.68%	4.56%	0.67%	0.77%	0.91%	2.00%	2.84%	**1.09%**
20-year average ***(2000-2020)***	0.67%	-0.20%	-0.17%	0.99%	2.28%	0.45%	0.64%	0.19%	-0.38%	1.44%	**1.22%**
10-year average ***(2010-2020)***	-0.30%	-0.46%	-0.26%	0.33%	1.32%	0.53%	0.83%	0.17%	-1.77%	-0.40%	**0.45%**

2.4 WATER QUALITY GOAL AND OBJECTIVES

The LLRM results revealed increases in total phosphorus loading and in-lake total phosphorus concentrations over time from pre-development through future conditions. Although Mascoma Lake is classified as oligotrophic, recent monitoring shows conditions that challenge this status, with the 2023 VLAP Report documenting elevated total phosphorus and chlorophyll-*a* levels during heavy rainfall events and long-term assessments identifying impairments for low pH, low dissolved oxygen, presence of Eurasian milfoil, and production of cyanotoxins during bloom events. Historical trophic surveys reveal recurring summer anoxia in the hypolimnion, indicating internal phosphorus loading that can fuel cyanobacteria despite low surface nutrient concentrations, particularly under increasing extreme weather stressors. Water quality is further influenced by upstream lakes, ponds, and tributaries, including Crystal Lake, which experienced cyanobacteria blooms in 2023 despite oligotrophic conditions, suggesting limited reserve capacity for Mascoma Lake to assimilate additional nutrients under "business as usual" conditions. Consequently, reducing watershed phosphorus inputs and strengthening long-term management actions are essential to protect Mascoma Lake's water quality and limit future cyanobacteria bloom risk.

Given the sheer size of the Mascoma Lake watershed, substantial, watershed-wide phosphorus load reductions would be needed to effectively reduce the phosphorus concentration in Mascoma Lake. It would be more practical to develop separate WBMPs for upstream waterbodies with more focused phosphorus load reduction targets led by local groups. Therefore, the phosphorus load reductions set for the Mascoma Lake WBMP focused on field-identified opportunities located near Mascoma Lake. It is important to note that meeting this goal for Mascoma Lake will likely not be enough to prevent cyanobacteria blooms caused by external factors such as a longer growing season and warming lake water, as well as the substantial phosphorus load coming from other areas in the watershed.

The goal of the Mascoma Lake WBMP is to improve the water quality of Mascoma Lake such that it meets state water quality standards for the designated uses of ALI and PCR for oligotrophic waterbodies and experiences substantially reduced likelihood of harmful cyanobacteria blooms. This goal will be achieved by accomplishing the following objectives . More detailed action items to achieve these objectives are provided in the Action Plan.

Objective 1: Reduce phosphorus load from current watershed activities nearest Mascoma Lake by 86 kg/yr (4 percent). This would result in a decrease in the average total phosphorus concentration in Mascoma Lake by 0.3 ppb.

Objective 2: Mitigate (prevent or offset) phosphorus loading from future development in the entire watershed by 475 kg/yr to maintain the average total phosphorus concentration in Mascoma Lake over the next 10 years (2035).

Reality Check for Meeting Objective 1: The watershed survey conducted by VHB identified 5 sites impacting the lake. Remediating these sites could prevent up to 1.5 kg/yr of phosphorus from entering Mascoma Lake. Treating vulnerable shoreline sites (scoring ≥5 from the shoreline evaluation) could reduce the phosphorus load to Mascoma Lake by 30.4 kg/yr. Upgrading the 222 known shorefront septic systems along Mascoma Lake (139) and Crystal Lake (83) that are older than 25 years, is estimated to reduce the phosphorus load to Mascoma Lake by 22.2 kg/yr. Mitigating the impacts of unpaved and

paved roads less than 50 feet from a surface water throughout the watershed could prevent about 30.6 kg/yr of phosphorus load to Mascoma Lake. Stabilizing the banks around culverts assessed as vulnerable in the watershed (n=4) could prevent about 1.4 kg/yr in phosphorus load to Mascoma Lake. **In sum, treating all existing pollutant sources identified as coming from the external watershed load could reduce the phosphorus load to Mascoma Lake by approximately 86 kg/yr, which meets 100 percent of Objective 1 for Mascoma Lake.**

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

Objective 2 can be met through zoning and ordinance revisions that implement **low impact development** strategies, encourage cluster development with open space protection, as well as conservation of key parcels of forested and open land, and targeted outreach and education.

The interim benchmarks for each water quality objective allow flexibility in reassessing objectives following more data collection and expected increases in phosphorus loading from future development in the watershed over the next 10 or more years (Table 13). Comparing observed water quality changes to predicted water quality changes with no action can help guide adaptive changes to interim benchmarks (e.g., actions are meeting objectives or actions are falling short of objectives). If the benchmarks are not met due to lack of funding or other resources for implementation projects rather than due to increases in phosphorus loading from new development outpacing reductions in phosphorus loading from improvements to existing development, then this creates much different conditions from which to adjust interim benchmarks. For each interim benchmark year, stakeholders should review water quality data, then assess if and why benchmarks are or are not being met. Stakeholders can then decide on how to adjust the next interim benchmarks to better reflect water quality conditions and any practical limitations to implementation.

Table 13. Summary of interim benchmarks for tracking progress towards achieving the water quality objectives for Mascoma Lake. Interim benchmarks are cumulative. kg/yr = kilograms per year. ppb = parts per billion.

Interim Benchmarks by Objective	2028	2030	2035
Objective 1 Reduce phosphorus load from current watershed activities nearest Mascoma Lake by 86 kg/yr (4%). This would result in a decrease in the average total phosphorus concentration in Mascoma Lake by 0.3 ppb.	Achieve 1% (21.5 kg/yr) reduction in total phosphorus loading to Mascoma Lake.	Achieve 2% (43 kg/yr) reduction in total phosphorus loading to Mascoma Lake; re-evaluate water quality and track progress.	Achieve 4% (86 kg/yr) reduction in total phosphorus loading to Mascoma Lake; re-evaluate water quality and track progress.
Objective 2 Mitigate (prevent or offset) phosphorus loading from future development in the entire watershed by 475 kg/yr to maintain the average total phosphorus concentration in Mascoma Lake over the next 10 years (2035).	Prevent or offset 186 kg/yr in total phosphorus loading from future development to Mascoma Lake.	Prevent or offset 373 kg/yr in total phosphorus loading from future development to Mascoma Lake; re-evaluate water quality and track progress.	Prevent or offset 475 kg/yr in total phosphorus loading from future development to Mascoma Lake; re-evaluate water quality and track progress.

3 POLLUTANT SOURCE IDENTIFICATION

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

3.1 WATERSHED DEVELOPMENT

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

3.1.1 Historical Development

Before the first settlers arrived in Enfield in 1761, Indigenous Abenaki communities, including the Penacook, Winnipesaukee, Pigwacket, Sokoki, Cowasuck, and Ossipee bands, lived and traveled along Mascoma Lake and the surrounding area (Enfield Heritage Commission, n.d.). The region's waterways linked the Connecticut River with the Atlantic coast and with southern villages and were corridors of travel and trade. Local Indigenous settlements were semi-permanent, seasonal, and clustered along flat areas of the shoreline. Material traces of Indigenous presence, such as stone flakes, pottery fragments, axes, and stone jugs, have been found along the flat, beachy shoreline of Mascoma Lake near the Knox and Mascoma River inlets, as well as on the shores of Canaan Street Lake and near the Goose Pond outlet (Enfield Heritage Commission, n.d.; Wallis & Wallace, 1910). During the period before European colonization, the land was cultivated for crops such as corn, beans, squash, sunflowers, Jerusalem artichokes, ground cherries, and tobacco. However, epidemics in 1615 and 1620 devastated Indigenous populations, a loss further compounded by conflicts with colonists and the Iroquois League (Enfield Heritage Commission, n.d.). These factors, along with migration north, further reduced the Indigenous presence in the region.

Early colonial settlers established villages along the Mascoma River in the mid-18th century, with Lebanon, Enfield, and Canaan all chartered in 1761 (Upper Valley Lake Sunapee Regional Planning Commission, 2010). In 1793, the Shakers established a community along the western shores of Mascoma Lake, constructing over 100 buildings and cultivating more than 3,000 acres of farmland (Enfield Shaker Museum, 2023). The Shakers relied on agriculture for subsistence while also regionally trading their seeds, produce, flour, woven goods, and flannels (Enfield Shaker Museum, 2023). In the surrounding towns, communities began to utilize the rivers and waterways for water-powered industries, beginning with sawmills and gristmills in the 1760s and later expanding to wool carding mills, textile mills, and tanneries (Child, 1886; Mascoma River Local Advisory Committee, 2012). Enfield alone had over twenty mills, driving the development of churches, hotels, shops, and a bustling downtown in North Enfield. The Town of Canaan became known as "Factory Village" for its production of lumber, leather, and grain (Town of Canaan, New Hampshire, n.d.).

The construction of the Fourth New Hampshire Turnpike in 1804 and the completion of the Northern Railroad in 1847 (spanning 143 miles from Boston to White River Junction, VT) transformed the region (Enfield Heritage Commission, n.d.; The Mascoma River Greenway, n.d.). By linking the towns to broader trade networks, the turnpike and railroad boosted local industries and population growth in Enfield and Canaan (Town of Canaan, New Hampshire, n.d.; Upper Valley Lake Sunapee Regional Planning Commission, 2010). In 1849, the Shaker Bridge was built across a narrow segment of the lake, connecting the Shaker Village to the railroad and expanding their trade network for selling seeds, herbs, and other goods (Upper Valley Lake Sunapee Regional Planning Commission, 2010). Though reconstructed, the bridge remains in place today and serves as a popular route for travel across the lake. With the success of the mills, the attraction of the lake, the easy access by train, and the development of hotels, taverns, and other amenities, Enfield and Mascoma Lake became a popular tourist destination by 1900 (Sanborn & Carr, 2006). The first cottage on Mascoma Lake was built in 1883 on the eastern shoreline at Point Comfort, quickly followed by serval other cottages and a cookhouse (Enfield Heritage Commission, n.d.; Mascoma Lake Association, n.d.). Located across from the Shaked Village, they primarily relied on boats for communication, particularly trade (Enfield Heritage Commission, n.d.).

During the peak of industrial activity, mills and factories used the Mascoma River both for energy and as a dumping ground for untreated waste, including textile dyes and chemical byproducts (Upper Valley Lake Sunapee Regional Planning Commission, 2010). The Baltic Mill in Enfield alone discharged 740,000 gallons of untreated textile waste and 5,000 gallons of raw sewage daily, resulting in discolored water and visible contamination, such as oily residues and gas bubbles along the riverbanks (Enfield Heritage Commission, n.d.). Additionally, the 1952 *Mascoma River Watershed Staff Report* documented that the Town of Enfield discharged approximately 30,000 gallons per day of raw sewage to the Mascoma River, and that untreated sewage from Enfield Village entered the river less than one mile upstream of its discharge to Mascoma Lake (Gotthardt, 2012). After years of severe pollution, sanitation issues, and algal blooms, the New Hampshire Water Supply and Pollution Control Commission ordered the municipalities of Enfield and Lebanon to cease polluting these waterways. This led to the construction of a combined sewage treatment plant, and in 1988, the development of a sewer system in Enfield which pumps waste to Lebanon for treatment (Enfield Heritage Commission, n.d.). The Clean Water Act of 1972 also played a pivotal role in establishing water quality standards and reducing industrial pollution, both regionally and nationwide (Upper Valley Lake Sunapee Regional Planning Commission, 2010). These efforts, in addition

to the closure of the mills in the 1960s and 1970s, marked a stark improvement in the water quality of Mascoma Lake (Upper Valley Lake Sunapee Regional Planning Commission, 2010).

By 1923, a decline of Shaker membership led to the closure of their community in Enfield, and the land was purchased by the Missionaries of Our Lady of La Salette (Enfield Shaker Museum, 2023). Today, the area is owned by the Enfield Shaker Museum, which was established in 1986 and operates as an educational center for Shaker history. Approximately 1,100 acres of this land is now under permanent conservation and managed by the NH Fish and Game Department (Enfield Heritage Commission, n.d.). Like its historical appeal for natural beauty and recreational opportunities, Mascoma Lake remains a popular destination today, as its shoreline becomes increasingly developed with summer cottages and year-round homes.

(Left) A photo of Shaker Bridge taken from the vicinity of the 4th New Hampshire Turnpike, just south of the bridge. Circa 1889. Credit: Enfield Shaker Museum. (Middle left) View of a Shaker agricultural field on the shore of Mascoma Lake. The people in the photo include both Shakers and non-Shakers. Circa 1881. Credit: Enfield Shaker Museum. (Middle right). Hiram Baker at the Shaker sawmill. Circa 1903. Credit: Enfield Shaker Museum. (Right) Postcard of the Enfield Depot Street train station looking west towards Mount Cardigan. Circa 1906-1915. Credit: Enfield Shaker Museum.

3.1.2 Watershed Survey

A desktop and field-based watershed survey of the Mascoma Lake direct watershed was completed by technical staff from VHB. The objective of the watershed survey was to identify and characterize sites contributing to nonpoint source pollution and/or providing opportunities to mitigate nonpoint source pollution in the watershed. Additional desktop analysis was performed by FBE staff for surrounding roads and stormwater infrastructure.

VHB performed a desktop review of public utilities, stormwater infrastructure, publicly-owned parcels, impervious areas, and select road-stream crossings within the Mascoma Lake watershed based on publicly-available geospatial data. Many sites identified during desktop review were close to the lake, largely due a higher proportion of impervious surface near existing stormwater infrastructure with a direct hydraulic connection to Mascoma Lake. These sites were documented in an online GIS web application with a geodatabase of identified candidate locations. On June 24, 2025, VHB presented initial results of the desktop analysis to the Steering Committee during a virtual meeting, and Steering Committee members provided comments on additional sites that may be considered, which VHB added to the inventory of sites to investigate in the field.

VHB performed field reconnaissance within the Mascoma Lake watershed on August 13, 2025, including sites identified by VHB, Steering Committee members, and other sites as identified in the field. During field reconnaissance, VHB met on site with Rick Brown, City of Lebanon Assistant Director of Public Works, and Jim Taylor, Town of Enfield Director of Public Works, at sites within each respective municipality. Field reconnaissance included visual observation of topography and drainage patterns, existing utilities or conflicts visible from the surface (i.e., stormwater outfalls, existing land uses), and discussion with municipal staff regarding construction feasibility. VHB did not perform professional land survey during this field reconnaissance effort. Elevations shown on concept plans are derived from publicly available digital elevation data and record plans available from the Town of Enfield.

Based on VHB's desktop analysis, results of field reconnaissance, and discussions with municipal staff, VHB identified five locations as candidate locations for structural stormwater SCMs. These sites were all located within the Town of Enfield, largely due to the potential for capturing and treating stormwater from relatively large impervious areas, publicly owned properties with proximity to Mascoma Lake, and existing stormwater infrastructure. These sites were reviewed with the Steering Committee during a virtual meeting on September 19, 2025. Upon Steering Committee review, VHB proceeded to develop concept-level plans, cost estimates, and pollutant load reduction estimates for each of the five locations. Concept plans were based, in part, on record plans available from the Town of Enfield Department of Public Works and GIS data of existing municipal- and state-owned utilities. Concept plans were intended only to assist discussions among the Steering Committee and project proponents regarding the feasibility of structural SCMs.

Implementing SCMs at the five priority sites could remove an estimated 1.5 kg/yr of phosphorus. The primary issues identified across the reviewed plans were uncontrolled stormwater flow causing erosion and inadequate or failing infiltration/retention features. Appendix B summarizes the recommendations, load reduction estimates, and estimated costs for each site. Each of the five priority sites are also described below (Figure 15, Figure 16, Figure 17, Figure 18, Figure 19, Figure 20).

Site C-1: Huse Park Subsurface

Location: 43.6441, -72.1438 ***Impact: High***

Observations: Stormwater from the paved parking areas concentrates along existing flow paths that direct runoff toward the open field and ultimately to the downgradient drainage feature. The current layout does not provide much treatment or dispersion before runoff infiltrates or leaves the site. Flow lines from multiple areas converge near the proposed SCM location, creating erosion issues during large storm events. Watershed delineation for Huse Park identified 37,870 square feet of impervious surface. This large impervious region highlights the need for a centralized treatment system that can reliably manage the water that comes through this area.

Recommendations: Install a subsurface infiltration SCM, as shown in Figure 15, sized to treat the required water quality volume. The system was designed based on the delineated watershed and pollutant load reduction calculations and would include two catch basins tied into the subsurface infiltration chambers. Grading should ensure that contributing drainage areas flow consistently toward the SCM without creating new points of concentrated flow. Incorporating the catch basins will reduce sediment loading and extend the life of the subsurface system.

Figure 15. Site C-1 Huse Park Subsurface site plans. Refer to Appendix C: SCM Conceptual Site Plans for enlarged images.

Site C-2: Huse Park Infiltration Trench

Location: 43.6441, -72.1438 ***Impact: High***

Observations: Runoff from the southeast corner of the parking lot and adjacent gravel areas currently drains downslope without defined pretreatment. The delineated drainage area includes 2,231 square feet of impervious surface contributing directly to this location. The proposed infiltration trench would intercept a large amount of the flow from the area. The surrounding ground shows signs of erosion and compaction that could deliver sediment to the trench and reduce its long-term infiltration capacity.

Recommendations: Implement the proposed infiltration trench as shown in Figure 16, sized using the pollutant load reduction calculations and watershed delineation. The trench would outlet to an existing catch basin and requires regrading and repaving of the southeast corner of the parking lot. The SCM footprint has been located to avoid conflict with the existing sanitary sewer line. Proposed SCMs include adding pretreatment to reduce sediment loading, stabilizing disturbed soils around the trench, and establishing a defined, stabilized overflow path connected to the existing catch basin. These combined measures will enhance stormwater treatment performance and extend the trench's functional lifespan.

Figure 16. Site C-2 Huse Park Infiltration Trench site plans by VHB. Refer to Appendix C: SCM Conceptual Site Plans for enlarged images.

Site C-3: Mascoma Bank Biofiltration

Location: 43.6434, -72.1433 ***Impact: Moderate***

Observations: Stormwater from the adjacent Mascoma Bank driveway and the upper slope currently becomes concentrated as it flows downhill toward the Mascoma River, which ultimately drains into Mascoma Lake. The steep grades and limited vegetation in this area increase its susceptibility to erosion. Flow disperses across the wooded slope without treatment, increasing the potential for sediment and nutrient delivery to the lake. Watershed delineation for the Mascoma Bank area identified 23,671 square feet of impervious surface. The proposed biofiltration basin is well positioned to intercept runoff; however, the steep terrain and existing informal flow paths may continue to convey water around the system unless intentionally directed to the SCM.

Recommendations: Implement the proposed biofiltration basin as shown in Figure 17. The SCM would receive flow from the existing outlet along the berm through a proposed inlet ditch. The selected basin footprint avoids impacts to the existing sanitary sewer line to the west and is in a relatively flat area between the Mascoma Bank and the Mascoma River. Establish clearly defined routes to ensure runoff enters the SCM for treatment. Stabilize disturbed soils and steep riverbank areas to reduce sediment transport and improve long-term stability. Incorporate an overflow outlet to safely convey high flows downslope without causing erosion. These improvements will enhance the SCM's ability to capture, filter, and slow runoff before it reaches the lake.

Figure 17. Site C-3 Mascoma Riverbank Biofiltration site plans by VHB. Refer to Appendix C: SCM Conceptual Site Plans for enlarged images.

Site C-4: Library Subsurface

Location: 43.6429, -72.1443 ***Impact: High***

Observations: The Town of Enfield constructed an addition to the Enfield Public Library building in 2024-2025. The addition included regrading the parking lot and installation of closed stormwater drainage. The asphalt parking lot is now graded to direct stormwater to a single catch basin in the center of the parking lot, which collects stormwater from the paved parking area and roof runoff from the building. Stormwater is discharged to the Mascoma River via a single outfall along the bank of the river to the east of the parking lot. Watershed delineation for this site identified 20,856 square feet of impervious surface contributing to this drainage area. The proposed subsurface SCM is located to capture most of the parking lot runoff.

Recommendations: Install the proposed subsurface infiltration system as shown in Figure 18. The SCM includes two catch basins and the building roof and foundation drains tied into the infiltration system to maximize the contributing drainage area. The system would outlet to a proposed storm drain connected to an existing outfall. Important pieces of the SCM's success are to establish clear inlet controls, stabilize adjacent slopes, and incorporate an overflow route to safely convey excess stormwater downslope without causing erosion. Together, these measures will improve stormwater capture and enhance water quality treatment.

Figure 18. Site C-4 Library Subsurface site plans by VHB. Refer to Appendix C: SCM Conceptual Site Plans for enlarged images.

Site C-5: Shakoma Beach

Location: 43.6311, -72.1578 ***Impact: Moderate***

Observations: The Shakoma Beach area exhibits clear signs of erosion, including steep unvegetated slopes, exposed soils, and concentrated runoff pathways that deliver sediment directly to Mascoma Lake. Stormwater from the adjacent roadway and upper slopes flows across the beach without treatment, particularly during spring runoff when snowbanks redirect flow downslope. These conditions accelerate shoreline degradation and reduce water quality in the nearshore area. Parameters such as gully width, length, depth, soil type, and unit weight indicate that ongoing erosion has contributed to phosphorus loading, estimated at 0.2 kilograms per year assuming a ten-year erosion period. Phosphorus loading may be higher if erosion gullies are formed more rapidly than a ten-year period.

Recommendations: Construct the proposed retaining wall and associated regrading shown in Figure 19 to substantially reduce the slope and stabilize the eroding Shakoma Beach area. The wall will allow a break in slope and create a more stable terrace that limits soil movement. Regrade the beach to soften slope angles and reduce runoff velocities. Install the proposed swale near the sidewalk edge to capture stormwater from the roadway and upper slopes, reducing untreated flow that contributes to shoreline erosion. Stabilize soils above and behind the retaining wall with native vegetation to enhance long-term erosion resistance. Establish a defined drainage path to safely convey runoff during large storms or spring melt events. Collectively, these measures will reduce sediment and phosphorus loading to Mascoma Lake and provide long-term stabilization of the Shakoma Beach area.

Figure 19. Site C-5 at the Shakoma Beach on Mascoma Lake site plans by VHB. Refer to Appendix C: SCM Conceptual Site Plans for enlarged images.

As part of FBE's desktop watershed survey, culverts and road segments located near surface waters were evaluated to identify vulnerable problem sites within the Mascoma Lake watershed (Figure 20).

Using the New Hampshire Stream Crossing Initiative Data Viewer, a GIS-based screening tool, FBE identified four culverts adjacent to Mascoma Lake that may be vulnerable based on storm capacity and structural condition (Table 14). The New Hampshire Stream Crossing Initiative is a multi-agency group that collaboratively works to align resources and improve management of stream crossing infrastructure across the state. These culverts are generally undersized and overtop during moderate to large storm events, with several exhibiting sediment blockage, inlet and outlet scour, reduced hydraulic capacity, and limited aquatic passage despite some being in fair to good structural condition.

FBE also conducted a desktop analysis of roads located near waterbodies, as roads near surface waters can contribute to elevated nutrients, contaminants, and sediment in waterbodies. Runoff from road surfaces and roadside ditches, particularly along unpaved or poorly maintained sections, can rapidly transport sediment and pollutants into adjacent waterways, especially where culverts are undersized or drainage is inadequate. Within the Mascoma Lake watershed, approximately 16 miles of roadway lie within 50 feet of a waterbody, of which 46 percent are paved and 54 percent are unpaved. Most of these near-shore roads are in the towns of Canaan (41 percent) and Enfield (37 percent). See Appendix D for a more detailed map of threatened roads by municipality.

To address the identified vulnerabilities at culverts and along near-shore road segments, a range of SCMs may be appropriate depending on site conditions, drainage area, and roadway use. For culverts, SCMs include upsizing or replacing undersized crossings to improve hydraulic capacity and reduce overtopping during storm events, or stabilizing inlet and outlet areas to address scour and sediment mobilization. Stabilizing the banks around culverts assessed as vulnerable by the New Hampshire Stream Crossing Initiative in the watershed (n=4) could prevent about 1.4 kg/yr of phosphorus load to Mascoma Lake (calculated using the PLET model). For road segments located close to surface waters, SCMs may include improved ditch stabilization, installation of check dams or level spreaders, paving roads, regrading or armoring concentrated flow paths, and conversion of eroding roadside ditches to vegetated swales. Mitigating the impacts of threatened roads which include unpaved and paved roads less than 50 feet from a surface water throughout the watershed could prevent about 30.6 kg/yr of phosphorus load to Mascoma Lake.

Additional outreach and discussions with municipal public works staff identified several priority stormwater drainage issues in Enfield (Table 15) and Lebanon (Table 16). The Steering Committee identified road washouts and other stormwater runoff issues along the Mascoma and Knox Rivers as a concern for water quality. Residents have observed plumes of sediment entering the lake from these rivers.

Table 14. High priority culverts identified for upgrades. Refer to Figure 20 for locations.

Location	Vulnerability / Key Issues	NHDES Statewide Asset Data Exchange System ID	Coordinates *(latitude, longitude)*
Graceville Rd., Canaan, NH	Overtops during storms ≥10-year; undersized corrugated steel culvert with poor structural integrity, scour at inlet and outlet, and reduced aquatic passage.	16,349	43.644, -72.013
Shaker Blvd., Enfield, NH	Vulnerable at 2-year storm and overtops during larger events; three buried round steel culverts with sediment obstruction, poor inlet, and fair structure condition; reduced aquatic passage, and geomorphic incompatibility.	26,201	43.627, -72.148
Route 4A, Lebanon, NH (Site 1)	Vulnerable at 2-year storm and overtops during larger events; undersized plastic corrugated culvert in good condition but with limited hydraulic capacity and reduced aquatic passage.	3,739	43.640, -72.180
Route 4A, Lebanon, NH (Site 2)	Passes 2-year storm but vulnerable at 10-year and overtops during larger events; good overall condition but undersized plastic corrugated culvert with minor scour and limited capacity.	3,738	43.645, -72.196

Table 15. High priority stormwater drainage issues identified for remediation in the Town of Enfield.

Site / Area	Observed Issues	Recommended Actions
Oak Grove Street	• Chronic drainage issues during heavy rain events leading to surface runoff and localized flooding.	• Evaluate storm drain capacity and upsizing needs. • Inspect and maintain culverts to ensure clear flow paths before major storm events. • • Install additional riprap or vegetated swales to slow and filter runoff on steep slopes.
Main Street Area (below downtown, near Frog Pond)	• Frequent flooding. • Water from Frog Pond drains into this low-lying section. • Roadway flooding occurs during intense rainfall events.	• Coordinate with NHDOT to evaluate and upsize undersized culverts. • Assess potential daylighting or wetland expansion near Frog Pond to increase storage. • Explore installation of flow restrictors or detention basins upstream to manage peak flow.

Site / Area	Observed Issues	Recommended Actions
Shaker Mountain (west side of Mascoma Lake)	• Very steep slopes create flash flooding risk. • Beaver dam failures have caused sudden downstream flooding, damaging infrastructure (including historic town hall basement). • Heavy rain (e.g., 4 inches in 2 hours) caused major hillside erosion and sediment transport.	• Conduct slope stability assessment and identify erosion-prone gullies. • Install check dams, woody debris structures, or armored drainage channels.
Town-wide (Street Sweeping and Catch Basins)	• State sweeps state roads (Main St., Shaker Hill Rd.) every other year. • Enfield lacks its own sweeping equipment. • Town staff clear clogged catch basins reactively when issues arise.	• Explore regional equipment-sharing agreement or contract sweeping services annually. • Increase frequency of catch basin cleaning, prioritizing steep areas and flood-prone zones. • Incorporate sweeping and catch basin cleaning into road SCMs for stormwater compliance.

Table 16. High priority stormwater drainage issues identified for remediation in the City of Lebanon.

Site / Area	Observed Issues	Recommended Actions
Tracy Street (West Lebanon)	• Closed drainage system (not a culvert) that connects directly to Main Street. • Limited stormwater capacity during major rain events.	• Inspect and assess closed drainage system for blockages or capacity limitations. • Evaluate connection to Main Street storm drain for backflow or undersized segments. • Consider upgrading piping or adding relief outlets to reduce surcharge pressure during heavy storms.
Maple Street (West Lebanon)	• Chronic flooding during heavy rain events. • Standing water and poor drainage observed along curb line and intersections.	• Conduct drainage analysis to determine stormwater flow paths and system constraints. • Improve inlet spacing and slope to promote faster drainage. • Add or upsize catch basins and replace degraded storm lines as needed.

Site / Area	Observed Issues	Recommended Actions
Developed Area (West Lebanon)	• Area drains perpendicular to the watershed, requiring stormwater to pass through development and a headwall before reaching the lower watershed. • Heavy runoff and potential for channel erosion or ponding upstream of the headwall.	• Evaluate stormwater conveyance through developed area for capacity and slope adequacy. • Stabilize headwall and downstream outlet with riprap or vegetated buffers. • Consider retention or detention measures within development to reduce peak flow rates.
Esterbrook Circle	• Frequent flooding during storm events. • Catch basins overtop and manhole covers blow off under hydraulic pressure.	• Inspect and clean storm drains and catch basins before major storm seasons. • Retrofit manhole covers with bolted or vented designs to prevent blow-off. • Investigate hydraulic bottlenecks in storm drain network contributing to surcharging. • Explore storm drain upsizing or additional inlet installation to distribute flow.

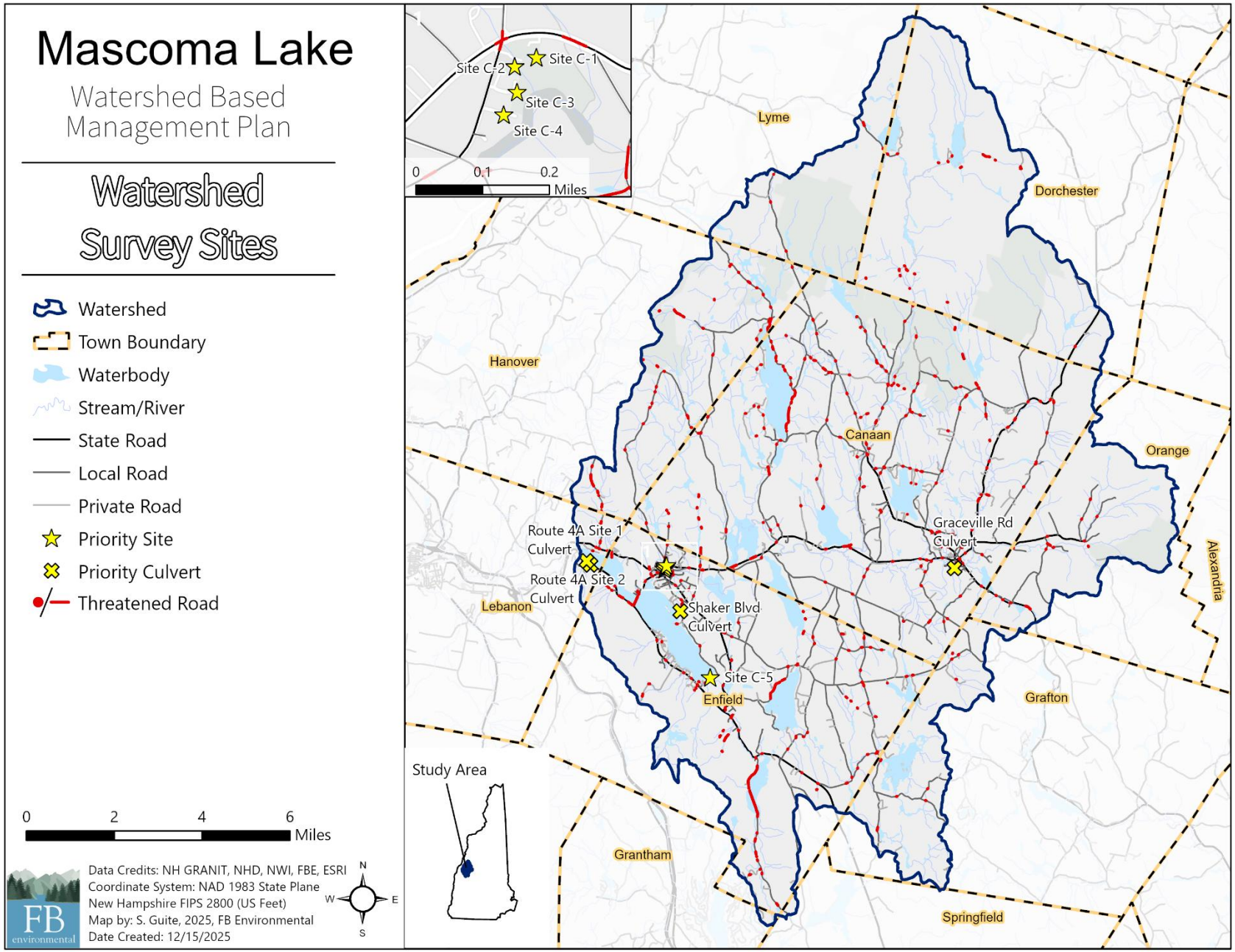


Figure 20. Location of identified nonpoint source sites in the Mascoma Lake direct watershed.

3.1.3 Shoreline Evaluation

FBE technical staff conducted a desktop shoreline evaluation of Mascoma Lake. The shoreline evaluation used a simple scoring method to highlight shoreline properties around the lake that exhibit significant erosion. This method of shoreline evaluation is a technique used to assess the overall condition of properties within the shoreland zone and prioritize properties for technical assistance or outreach. To evaluate the relative likelihood of a parcel may be negatively affecting water quality, FBE conducted a spatial overlay analysis of multiple attributes in ArcGIS Pro. First, the New Hampshire parcel data layer was clipped to the state Shoreland Zone (i.e., all land within 250 feet of the shoreline). The total likelihood score for each parcel's Shoreland Zone was calculated based on three factors: slope of the land, density of development within the Shoreland Zone, and building distance to the shoreline. These three metrics were summed together as the Shoreline Vulnerability Score.

1. The slope of the land was calculated using the U.S. Geological Survey elevation 1/3 arc-second Digital Elevation Model downloaded from the National Map Data Download Application. Using the "add surface information tool", the mean slope was calculated for each parcel based on the Digital Elevation Model raster. Likelihood scores for the average percent slope of each parcel were given as follows: slope 0-5 percent = score 0; slope 5-10 percent = score 1; slope 10-15 percent = score 2; slope 15-20 percent = score 3; slope greater than 20 percent = score 4. The average slope per parcel for the Mascoma Lake shoreline fell between 0.25 percent and 18.65 percent.
2. To determine the relative density of development within the Shoreland Zone, the "kernel tool" was run using a building point file developed by FBE to identify high density areas. To calculate the density risk for each parcel, the "add surface information tool" was run with the kernel density layer as the input file. The likelihood scores for urban density (houses per acre) were as follows: less than 0.2 = score 0; 0.2-1 = score 1; 1-2 = score 2; more than 2 = score 3. This gave a higher score to parcels clustered in a more developed area, as higher levels of impervious surface and human activity contribute more pollutants to the lake.
3. To calculate the building distance to the shoreline, the following risk scores were assigned: no building = score 0; more than 150 feet = score 1; 75-150 feet = score 2; less than 75 feet = score 3.

A total of 512 parcels were evaluated along the shoreline of Mascoma Lake in Enfield and Lebanon. Most of the parcels have a relatively low slope grade, though 156 parcels are moderately sloped and 30 parcels are more severely sloped. However, it is important to note that the slope values used in this analysis represent parcel-wide averages. As a result, steep, erosion-prone areas may be ranked lower if the parcel's topography is highly variable or if the parcel is particularly large. House distances to the lake were well distributed among 75 feet, 150 feet, and more than 250 feet from the shoreline, though more houses are located closer to the water. Most parcels received a moderate housing density score of 1, with 147 parcels scoring 2 and 24 scoring 3, reflecting areas of concentrated shoreline development.

The average shoreline vulnerability score for the Mascoma Lake shoreline is 3.1 (Table 17). A disturbance score of **5 or above** indicates shoreline conditions may be detrimental to lake water quality, and should be the target of outreach, education, and mitigation efforts. One hundred parcels received a total risk score of 5 or higher, indicating they may be more susceptible to erosion or contribute greater amounts

of runoff from more densely developed areas or homes built closer to the shoreline. These parcels (scoring 5 or higher) contribute approximately 30.4 kg per year of phosphorus to Mascoma Lake. This estimate is based on the EPA Region 5 bank stabilization model using silt loam soils, a 3-foot bank height, and a moderate lateral recession rate of 0.1 feet per year to represent all sites. Scores between 3 and 4 may also indicate at-risk parcels, though these are less of a priority than the higher scoring parcels (Appendix A; Map A-6).

Scores can be used to prioritize areas of the shoreline for remediation. Recommendations largely include improving shoreline vegetated buffers. Encouraging landowners to plant and/or maintain vegetated buffers as a SCM along their shoreline, particularly in areas of bare soil, will help mitigate erosion and reduce sediment and nutrient loading to the lake.

Table 17. Average scores for each evaluated condition criterion and the average Total Shoreline Vulnerability Score for the Shoreland Zone of Mascoma Lake. Note: the numbers in parentheses are the range of possible scores for that variable.

Evaluated Condition	Average Score
Slope (0-4)	0.4
House Distance to Shore (0-3)	1.3
House Density (0-3)	1.3
Average Shoreline Vulnerability Score (0-10)	**3.1**

3.1.4 Soil and Shoreline Erosion

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

3.1.4.1 Surficial Geology

The composition of soils in the area reflects the dynamic geological processes that have shaped the landscape of New Hampshire over millions of years. Some 300 to 400 million years ago, much of the northeastern United States was covered by a shallow sea; layers of mineral deposition compressed to form sedimentary layers of shale, sandstone, and limestone (Goldthwait, Goldthwait, & Goldthwait, 1951). Over time, the Earth's crust then folded under high heat and pressure to change the sedimentary rocks

into metamorphic rocks (quartzite, schist, and gneiss parent material). This metamorphic parent material has since been modified by bursts of molten material intrusions to form igneous rock, including the granite for which New Hampshire is famous (Goldthwait, Goldthwait, & Goldthwait, 1951). Erosion has further modified and shaped this parent material over the last 200 million years.

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

Mascoma Lake is located within the Connecticut River Valley, which was shaped most recently by the Wisconsin Glaciation. As the climate warmed and glaciers retreated, ice sheets blocked north-draining rivers and Lake Hitchcock was formed. This large glacial lake persisted for several thousand years, from approximately 16,000–15,000 years ago to around 12,000–11,000 years ago. Upon this lake formation from the glacial melt, sediments were deposited, including boulders, gravel, sand, silt, and clay, leaving behind extensive deposits throughout the valley. This glacial legacy is evident not only in the region's soil but also in the presence of aquifers.

There are several aquifers in the watershed (7 percent, 6,701 acres of the watershed), as shown by the New Hampshire Geographically Referenced Analysis and Information Transfer System statewide aquifer transmissivity data layer. This includes aquifers underneath Mascoma Lake, and within the watershed beneath the Mascoma River. Most of these aquifers have a maximum transmissivity between 2,000 and 4,000 square feet per day, while a couple have a maximum transmissivity of 4,000 square feet per day or higher. Any contamination that enters these aquifers via groundwater will move quickly due to the high transmissivity of the material and enter Mascoma Lake and other surface waters. Therefore, protection of the aquifer is vital to the protection of the lake and private and public drinking water wells.

3.1.4.2 Soils and Erosion Hazard

The soils in the Mascoma Lake watershed (Appendix A, Map A-7) are a direct result of geologic processes. Of the 78 soil series present within the Mascoma Lake watershed (excluding soils beneath waterbodies), the most prevalent soil group in the watershed is the Tunbridge-Lyman-Rock outcrop complex (17,731 acres, 10.2 percent), followed by Marlow fine sandy loam (9,295 acres, 5.4 percent), Marlow-Tunbridge association (8,539 acres, 4.9 percent), Becket fine sandy loam (8,025 acres, 4.6 percent) and Monadnock-Hermon association (8,002 acres, 4.6 percent). These five soils are well-drained, with the Monadnock Hermon Association and Tunbridge Lyman Rock Outcrop Complex also classified as excessively drained. The presence of rock outcrops in the Tunbridge Rock Outcrop Complex may further influence its drainage characteristics. The remaining 70.3 percent of the watershed (soils under waterbodies) is a combination of 73 additional soil series ranging from 4.3 percent to 0.005 percent of the watershed.

Soil erosion hazard is dependent on a combination of factors, including land contours, climate conditions, soil texture, soil composition, permeability, and soil structure (O'Geen, Elkins, & Lewis, 2006). Soil erosion hazard should be a primary factor in determining the rate and placement of development within a watershed. Soils with negligible soil erosion hazard are primarily low-lying wetland areas near abutting streams. The soil erosion hazard for the Mascoma Lake watershed was determined from the associated slope and soil erosion factor K_w[2] used in the Universal Soil Loss Equation. The Universal Soil Loss Equation predicts the rate of soil loss by sheet or rill erosion in units of tons per acre per year. A rating of "slight" specifies erosion is unlikely to occur under standard conditions. A rating of "moderate" specifies some erosion is likely and erosion control measures may be required. A rating of "severe" specifies erosion is very likely and erosion control measures and revegetation efforts are crucial. A rating of "very severe" specifies significant erosion is likely and control measures may be costly. Excluding soils under waterbodies, "very severe" and "severe" erosion hazard areas account for 8 percent (7,544 acres) and 15 percent (14,707 acres) of the Mascoma Lake watershed, respectively, and are most concentrated along the western watershed boundary and west of Mascoma Lake (Appendix A, Map A-8). Moderate erosion hazard areas account for 53 percent (51,707 acres) of the watershed land area. Slight erosion hazard areas account for 20 percent (19,475 acres), while 5 percent (4,528 acres) are not rated. Development should be restricted in areas with severe erosion hazards due to their inherent tendency to erode at a greater rate than what is considered tolerable soil loss. Since a highly erodible soil can have greater negative impact on water quality, more effort and investment are required to maintain its stability and function within the landscape, particularly from SCMs that protect steep slopes from development and/or prevent stormwater runoff from reaching water resources. Other areas prone to erosion include steeply sloped areas and areas with roadways within 50 feet of the waterbody (Appendix A; Map A-9).

3.1.4.3 Shoreline Erosion

Water level fluctuations in lakes and ponds can occur on long- and short-term timescales due to naturally changing environmental conditions or as a response to human activity. The effect of lake level fluctuation on physical and environmental conditions depends on several factors including the degree of change in water level, the rate of change, seasonality, and the size and depth of the waterbody (Leira & Cantonati, 2008; Zohary & Ostrovsky, 2011). Changes in lake level can impact flora and fauna mainly by altering available habitat, impacting nesting locations, and altering available food sources. In addition to impacts on biological communities, lakes can experience physical impacts on water quality from changes in lake level. Frequent lake level fluctuations can lead to erosion and increased sedimentation in near-shore habitats, inhibiting light penetration and altering water clarity. Exposed shoreline sediment that is inundated at high water levels can release phosphorus, leading to alterations in nutrient accumulation and algae populations. High and low water levels can have detrimental effects on water systems. Finding a balance in managing water level at appropriate times throughout the year is critical to maintaining a healthy waterbody for both recreational enjoyment and aquatic life use. Management strategies become even more challenging when considering the impact of increased wake boating and extreme weather events (droughts and storms) on water level.

[2] K_w = the whole soil k factor. This factor includes both fine-earth soil fraction and large rock fragments.

3.1.5 Wastewater

3.1.5.1 Septic Systems

Untreated discharges of sewage (domestic wastewater) are prohibited regardless of source. An example of a nonpoint source discharge of untreated wastewater is from insufficient or malfunctioning subsurface sewage treatment and disposal systems, commonly referred to as septic systems, but which also include holding tanks and cesspools. When properly designed, installed, operated, and maintained, septic systems can reduce phosphorus concentrations in sewage within a zone close to the system, but the effectiveness of nutrient binding depends on the presence of an effective biomat, the adsorption capacity of the underlying native soils, and proximity to a restrictive layer or groundwater. Conventional septic systems are not designed to remove nutrients but rather only solids and pathogens. Age, overloading, or poor maintenance can result in system failure and the release of nutrients and other pollutants into surface waters. Nutrients from insufficient septic systems can enter surface waters through surface overflow or breakout, stormwater runoff, or groundwater. Cesspools are buried concrete structures that allow solid sludge to sink to the bottom and surface scum to rise to the top and eventually leak out into surrounding soils through holes at the top of the structure. Holding tanks are completely enclosed structures that must be pumped regularly to prevent effluent back-up into the home.

FBE completed an initial review of available data on septic systems within 250 feet of the Mascoma Lake shoreline in 2025. The objective of this survey was to determine the number of septic systems along the shoreline of Mascoma Lake and the proportion of older septic systems. FBE queried the NHDES OneStop online database for subsurface permits and reviewed Lebanon and Enfield tax parcel records. There were 224 shoreline properties with buildings identified within 250 feet of the shoreline. One hundred thirty-nine (139) of the 224 properties (62 percent) had septic systems older than 25 years. As part of this review, FBE identified 124 parcels that are likely connected to the sanitary sewer, with most of the western shoreline of Mascoma Lake being sewered. These parcels were excluded from the shoreline septic system pollutant loading analysis.

FBE estimated the pollutant loading from shoreline septic systems using default literature values for daily water usage, phosphorus concentration output per person, and system phosphorus attenuation factors. The number of people using shoreline septic systems was determined by reviewing individual tax records per parcel. As detailed in the *Mascoma Lake Loading Response Model Report* (FBE, 2025a), shoreline septic systems contribute 47 kg/yr of total phosphorus loading to Mascoma Lake, comprising 2 percent of the total phosphorus load from all sources to the lake. Septic systems, cesspools, or holding tanks are located within a short distance to the water, leaving little horizontal (and sometimes vertical) space for proper filtration of wastewater effluent. Improper maintenance or siting of these systems can cause failures, which leach untreated, nutrient-rich wastewater effluent directly to the lake. This effluent contains not only nutrients and bacteria but also microplastics, pharmaceuticals, and other pollutants harmful to public health. A known or suspected septic system failure has been reported in the area of Bicknell Brook in Enfield. Enfield Center also has several homes with septic systems in proximity to the Knox River, which discharges into Mascoma Lake. The Steering Committee indicated that failing septic systems in this area may be the reason for elevated *E. coli* concentrations in the river.

3.1.5.2 Sewer Systems

The City of Lebanon maintains sewer along the northern portion of Route 4A in the watershed, which includes both gravity and force sewer mains. The Town of Enfield also has sewer lines along parts of Route 4A, including Lower Shaker Village and areas just south of it. A large portion of downtown Enfield is sewered with forced lines, and in total, the Town of Enfield services a total of 610 connections, which pipe the wastewater to the Lebanon Wastewater Treatment Facility. None of the properties surrounding Crystal Lake are sewered.

Canaan hosts a central treatment facility for its wastewater with a pump station on Depot Street that transfers liquids from the municipal sewer lines to the main wastewater treatment facility. Sludge beds at the facility are used to cure and dry decomposed solids before tilling into the soil.

A significant limitation of the phosphorus loading model is the assumption that sewered shoreline areas do not contribute additional phosphorus through groundwater to Mascoma Lake, when it is possible that some portion of the sewer system is leaking nutrient-rich effluent into surrounding soils. Sewer infrastructure failures can release nutrient-rich wastewater, including phosphorus, into surrounding soils and groundwater, and studies have identified elevated dissolved phosphorus downstream of urban areas consistent with inputs from leaking sanitary sewer systems (Sridhar & Parimalarenganayaki, 2024; Effler, Prestigiacomo, Matthews, Michalenko, & Hughes, 2009). There are planned sewer system upgrades for areas around Mascoma Lake in Enfield.

3.1.5.3 Boat Discharges

Boats can discharge nutrients in sewage from installed toilets and greywater such as drainage from sinks, showers, and laundry. Dumping even small amounts of raw sewage into surface waters can significantly affect local ecosystems, causing algal blooms and degraded water quality.

3.1.6 Fertilizers

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

Municipal properties, which are often used for recreation, are often fertilized. In the City of Lebanon, soils on town properties are sampled and analyzed each fall to determine the following year's fertilizer treatment plan. The recommended fertilizer is spread in the spring and again in the fall, with aeration and seeding in the spring. The City uses SeaBlend Organic fertilizer, which in 2024, the ratio of applied fertilizer was 12-0-12 (Nitrogen – Phosphorus – Potassium). Grass clippings and leaves are left in place until the volume of leaf litter is too substantial, at which time it is vacuumed and either disposed of on-site in passive areas or taken as organic waste at the City landfill.

3.1.7 Pets

In residential areas, fecal matter from pets can be a significant contributor of nutrients to surface waters. Each dog is estimated to produce 200 grams of feces per day, which contain concentrated amounts of phosphorus (Center for Watershed Protection, 1999). If pet feces are not properly disposed of, these nutrients can be washed off the land and transported to surface waters by stormwater runoff. Pet feces can also enter by direct deposition of fecal matter from pets standing or swimming in surface waters.

3.1.8 Agriculture

Agricultural activities, including dairy farming, raising livestock and poultry, growing crops, and keeping horses and other animals for pleasure or profit, involve managing nutrients. Agricultural activities are linked to water quality due to the potential for nutrient runoff and soil erosion from farmland. Practices such as plowing, fertilizer and manure application, livestock grazing, and poor storage of nutrients can result in significant pollution if not managed carefully. Studies have shown that excessive or poorly timed application of fertilizers can lead to the runoff of nutrients into nearby waterbodies, contributing to problems like algal blooms and eutrophication leading to low dissolved oxygen (EPA, 2004). The key to nutrient application is to apply the right amount of nutrients at the right time. When appropriately applied to soil, synthetic fertilizers or animal manure can fertilize crops. When improperly managed, pollutants in manure can enter surface waters through several pathways, including surface runoff and erosion, direct discharges to surface water, spills and other dry-weather discharges, and leaching into soil and groundwater. For agricultural land use management strategies and resources, please see Section 4.2.9.

Agriculture in the Mascoma Lake watershed primarily includes cropland, hayfields, and grazing areas. The LLRM results showed that agriculture covers 2% of the watershed but contributes 16% of the total phosphorus load to Mascoma Lake.

3.1.9 Flooding

Areas of concern for flooding include hilly areas, areas with large amounts of impervious cover, and areas located within a floodplain. Zoning ordinances within the watershed regulate development in flood hazard areas, which may include restrictions on development, requirements for flood-resistant construction practices, and proper water and sewer system designs to mitigate flood risks.

The water level in Mascoma Lake and other lakes in the watershed is managed by dams, which in the fall, are drawn down to mitigate the risk of ice damage and spring flooding. The dams help mitigate shoreline flooding and ensure a reliable drinking water supply for the City of Lebanon through the Mascoma River. Though the probability of dam failure is low in the watershed, the possible failure of multiple dams could have adverse effects on water quality, infrastructure, and/or public safety.

Thirty-four active dams within the watershed are registered with NHDES. Of these dams, three are classified as significant hazards, including the Canaan Sewage Lagoon Dam, the Crystal Lake Dam, and the Harris Brook Reservoir Dam. Significant hazard dams have the potential to cause significant damage to the environment and existing infrastructure but have no probable loss of human life. The remaining two dams are classified as high hazard: the George Pond Dam and the Goose Pond Dam. High hazard dams could result in probable loss of human life. In fall 2023, the NHDES Dam Bureau began repairing

the Goose Pond dam. Leakage was first detected in 2012, and the dam posed a significant threat to downstream communities and ecosystems. Officials warned that a failure could cause catastrophic flooding, sending water across Route 4 into Enfield, inundating Mascoma Lake and surging into the Mascoma River. Projections indicate the floodwaters could reach Lebanon, endangering infrastructure and potentially resulting in loss of life. The project was completed in June 2025.

3.1.10 Future Development

Understanding population growth, and ultimately development patterns, provides critical insight into watershed management, particularly as it pertains to lake water quality. According to the U.S. Census Bureau, Canaan, Dorchester, Enfield, Grafton, Grantham, Hanover, Lebanon, Lyme, Orange, and Springfield have experienced moderate population growth over the last fifty years, increasing from a total of 24,889 people in 1970 to 42,820 people in 2020 (see Section 2.3.2). The Mascoma Lake watershed area has long been treasured as a recreational haven for both summer vacationers and year-round residents. The lake and surrounding region offer fishing, hiking, boating, sailing, canoeing, kayaking, and swimming in the summer, and ice fishing, cross-country skiing, snowshoeing, and snowmobiling in the winter. The desirability of the Upper Valley area as a recreational destination will likely stimulate continued population growth in the future. Growth figures and estimates suggest that municipalities should continue to consider the effects of current municipal land-use regulations on local water resources. As the region's watersheds are developed, erosion from disturbed areas and runoff from impervious surfaces increase the potential for water quality decline.

3.2 POTENTIAL CONTAMINATION SOURCES

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

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

On November 21, 2024, FBE downloaded datasets for potential contamination sources in the Mascoma Lake watershed. In total, four aboveground storage tanks, 69 underground storage tanks, five solid waste facilities, 37 hazardous waste generators, 24 local potential contamination sources, three automobile salvage yards, and 99 remediation sites were identified in the study area (Appendix A, Map A-10). See the following sections for more information on these potential contamination sources.

3.2.1 Aboveground and Underground Storage Tanks

Aboveground and underground storage tanks include permitted containers with oil and hazardous substances such as motor fuels, heating oils, lubricating oils, and other petroleum and petroleum-contaminated liquids. There are four aboveground storage tanks within the Mascoma Lake watershed, two in Enfield and two in Canaan. There are 69 underground storage tanks within the Mascoma Lake watershed. Clusters of these tanks are primarily located in downtown Enfield, Canaan, and Canaan Center. Route 4 has some commercial businesses as it connects Enfield and Canaan, along which a couple of underground storage tanks are located. Route 118 and Route 4A have a few tanks as well. Ownership of these tanks includes commercial industries, gas stations, hospitals, marinas, schools, local government, residential properties, farms, and utilities.

3.2.2 Solid Waste Facilities

There are five solid waste facilities within the Mascoma Lake watershed. Two of these are no longer in operation. The three active solid waste facilities include Hammond Grinding and Recycling in Orange; the Enfield Transfer Station and Recycling Center; and the Canaan Transfer Station.

3.2.3 Hazardous Waste Sites

Hazardous waste generating facilities are identified through the EPA's Resource Conservation and Recovery Act and require federal or state regulation. Only seven of the 37 hazardous waste generating facilities within the Mascoma Lake watershed are listed as active; the remaining facilities are classified as either inactive (21) or declassified (9).

3.2.4 Local Potential Contamination Sources

Local potential contamination sources are sites that may represent a hazard to drinking water quality supplies due to the use, handling, or storage of hazardous substances. There may be overlap between local potential contamination sources and other potential contamination sources identified in this section. Of the 24 potential contamination sources within the Mascoma Lake watershed, most are concentrated around Enfield and West Canaan, primarily along Route 4.

3.2.5 National Pollutant Discharge Elimination System Outfalls

There are no National Pollutant Discharge Elimination System outfalls within the Mascoma Lake watershed.

3.2.6 Automobile Salvage Yards

There are three automobile salvage yards within the Mascoma Lake watershed—one each in Enfield, Canaan, and Orange--all of which are active.

3.2.7 Remediation Sites

The 99 remediation sites within the Mascoma Lake watershed include leaking storage facilities that contain fuel or oil; actual or potential discharges of hazardous materials; hazardous waste projects; non-hazardous and non-sanitary holding tanks; initial spill response sites; lined wastewater lagoons; non-

domestic wastewater; historical dump sites; on-premise use facilities containing fuel oil; rapid infiltration basins; septic lagoons; subsurface wastewater disposal systems; solid waste transfer stations; oil spills or releases; underground injection control; or submerged vehicles.

3.3 WILDLIFE

Fecal matter from wildlife such as geese, gulls, ducks, and beaver may be a significant source of nutrients in some watersheds. This is particularly true when human activities, including the direct and indirect feeding of wildlife and habitat modification, result in the congregation of wildlife (Center for Watershed Protection, 1999). Congregations of geese, gulls, and ducks are of concern because they often deposit their fecal matter next to or directly into surface waters. Examples include large, mowed fields adjacent to lakes and streams where geese and other waterfowl gather, as well as the underside of bridges with pipes or joists directly over the water that attract large numbers of pigeons or other birds. Studies show that geese inhabiting **riparian** areas increase soil nitrogen availability (Choi, et al., 2020). When submerged in water, the droppings from geese and gulls quickly release nitrogen and phosphorus into the water column, contributing to eutrophication in freshwater ecosystems (Mariash, Rautio, Mallory, & Smith, 2019). Additionally, other studies show greater concentrations of nitrogen, ammonia, and dissolved organic carbon downstream of beaver impoundments when compared to similar streams with no beaver activity in New England (Bledzki, Bubier, Moulton, & Kyker-Snowman, 2010). The model estimated that waterfowl are likely contributing 28 kg/yr (1 percent) of the total phosphorus load to Mascoma Lake and 10 kg/yr (3 percent) of the total phosphorus load to Crystal Lake.

3.4 REGIONAL TEMPERATURE AND PRECIPITATION TRENDS

In the last century, New England has experienced significant changes in stream flow and air temperature. Out of 28 rural stream flow stations throughout New England, 25 showed increased flows over the period of record. The rise in streamflow is likely due to the increase in total annual precipitation in the region that is in part driven by an increase in the frequency of extreme precipitation. In 79 years of recorded flooding in the Oyster River in Durham, NH, three of the four highest floods occurred within 10 years of the publication (Ballestero, Houle, Puls, & Barbu, 2017). Average annual air temperature in New England has risen by 1°C to 2.3°C since 1895 with greater increases in winter air temperature (IPCC, 2013). Lake ice-out dates are occurring earlier as warmer winter air temperature melts the snowpack and lake ice; earlier ice-out allows a longer growing season and increases the duration of anoxia in bottom waters. Increasing storm frequencies will flush more nutrients to surface waters for algae to feed on and flourish under warmer air temperatures. These trends will continue to impact both water quality and quantity. Future environmental condition models predict a 10-40 percent increase in stormwater runoff by 2050, particularly in winter and spring and an increase in both flood and drought periods as seasonal precipitation patterns shift. Adding to this stress is population growth and corresponding development in New Hampshire.

The build-out analysis for the watershed showed that about 43,918 acres are still developable and up to 33,633 new buildings could be added to the watershed at full build-out based on current zoning standards. Mascoma Lake is at serious risk of water quality degradation because of new development in the watershed unless resiliency and low impact development strategies are incorporated into existing zoning standards.

4 MANAGEMENT STRATEGIES

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

4.1 STRUCTURAL NONPOINT SOURCE RESTORATION

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

4.1.1 Watershed and Shoreline SCMs

Five (5) nonpoint source sites identified during the 2025 watershed survey and 512 high/medium/low impact rated shoreline properties from the 2025 desktop shoreline evaluation were documented to have some impact on water quality through the delivery of phosphorus-laden sediment (refer to Sections 3.1.2-3.1.3). Other significant external phosphorus sources include aging septic systems, roads, and culverts. As such, structural SCMs to reduce the external watershed phosphorus load are a necessary and important component for the protection of water quality in the watershed.

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

- Address the five sites identified during the watershed survey. The sites were ranked based on phosphorus load reduction and waterbody proximity. The full prioritization matrix with recommended improvements is provided in Appendix B.
- Provide technical assistance to the 100 high-risk shoreline properties identified during the desktop shoreline evaluation. Workshops and tours of demonstration sites can help encourage landowners to utilize SCMs on their own property. Conduct an in-person shoreline survey to better prioritize properties for technical follow-up.
- Mitigate erosion and runoff from unpaved and paved roads located within 50 feet of surface waters throughout the watershed by implementing SCMs such as improved ditching, cross-culverts, turnouts, crown restoration, and surface stabilization.
- Upgrade or replace aging shorefront septic systems (222 identified as older than 25 years) along Mascoma Lake and Crystal Lake, particularly systems older than 25 years, through inspection, repair, replacement, or conversion to advanced treatment systems where appropriate.
- Stabilize four vulnerable culverts and associated streambanks using erosion control, bank stabilization, and flow-dissipation measures to reduce sediment and nutrient transport.

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

4.1.2 In-Lake Treatment Options

Several in-lake management alternatives with varying levels of effectiveness, longevity, cost, risk, and effort exist to address cyanobacteria blooms. Management alternatives typically focus on controlling factors that influence cyanobacteria growth and abundance: namely, light and nutrients. Management techniques such as dyes, surface covers, and selective plantings seek to establish light limitation, while methods such as nutrient input reduction, circulation, hypolimnetic or sediment oxygenation, dilution and flushing, drawdown, dredging, phosphorus inactivation, selective plantings, and selective withdrawal are used to reduce nutrient availability, directly or indirectly. Other techniques aim to target cyanobacteria through food-web manipulation or disrupting cellular processes (e.g., stocking herbivorous fish, removing bottom-feeding fish, algaecides, or sonication).

For evaluating applicability to Mascoma Lake, strong preference should be given to techniques that reduce phosphorus loading as the primary source of nutrition supporting cyanobacteria growth. While many in-lake treatment options aim to address the internal phosphorus load, the internal phosphorus load was estimated to comprise only 1 to 10 percent of the total phosphorus load to Mascoma Lake (though this estimate may be refined with additional sampling). Given the relatively low contribution of internal phosphorus load in Mascoma Lake, many in-lake treatment options are not applicable and warranted no further consideration. For example, phosphorus inactivation using chemicals such as aluminum sulfate are commonly used for lakes in which internal phosphorus loading comprises more than 20 percent of the total phosphorus load; this type of treatment is expensive (especially for a relatively small internal phosphorus load) and can have less longevity in highly flushed systems such as Mascoma Lake. The relatively low internal phosphorus load also precludes other options such as dredging and hypolimnion or sediment oxygenation/aeration. Recommended management techniques with the greatest applicability for Mascoma Lake relate to external phosphorus load reduction through nonpoint source controls and pollutant trapping. No in-lake treatments are recommended due to the relatively low internal phosphorus load in Mascoma Lake.

4.2 NON-STRUCTURAL NONPOINT SOURCE RESTORATION

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

4.2.1 Pollutant Reduction Best Practices

Pollutant reduction best practices include recommendations and strategies for improving road management and municipal operations to protect water quality. Following standard best practices for road maintenance and drainage management protects both infrastructure and water quality through the reduction of sediment and other pollutant transport. Refer to the *New Hampshire Stormwater Manual* (NHDES, 2025) for standard road design and maintenance best practices.

Even though none of the watershed municipalities are required to comply with the six minimum control measures under the New Hampshire Small Municipal Separate Storm Sewer Systems (MS4) General Permit, each municipality could consider instituting the permit's key measures, such as street sweeping, catch basin cleaning, and road/ditch maintenance, if not already in place. A New Hampshire Small MS4 General Permit is a federal stormwater permit under the Clean Water Act that regulates how small MS4s in New Hampshire must manage and reduce polluted stormwater runoff to protect water quality. The MS4 permit also covers illicit discharge detection and elimination plans (and ordinance inclusion), source control and pollution/spill prevention protocols, and education/outreach and training for residents, municipal staff, and stormwater operators, all of which are aimed at minimizing polluted runoff to surface waters.

The City of Lebanon inspects and cleans stormwater outfalls and culverts at least once a year, as well as prior to forecasted heavy storms. A culvert inventory is currently being created. When culverts are installed, they are upsized in anticipation of higher capacities for future large storm events. Streets are swept following winter operations and periodically throughout the summer and fall months. If temperatures allow, the Department of Public Works treats the roadways with magnesium brine to help with the reduction of salt use throughout snowstorms. Salt is also treated with magnesium brine in the spinner during application to activate salt and reduce the quantity required. All trucks are equipped with calibrated application rates of up to 250 pounds per lane-mile and can be adjusted as the supervisor sees fit to conserve the amount of salt as needed. Salt is stored in a contained and covered salt shed on the Department of Public Works property. Lebanon maintains approximately five miles of unpaved, gravel roads, which are graded every spring and fall. The Department of Public Works efforts along gravel roads have focused on ditching roads throughout the summer months, inspecting and replacing failed culverts as needed, and following up on outfall areas prior to and following storms. Leaves, grass clippings, and organic debris are vacuumed and contained in vacuum trailers and hauled to the solid waste facility for composting.

The Town of Enfield does not have its own street sweeping equipment, making it difficult to perform regular sweeping, but streets are usually swept once in the spring. The State of New Hampshire sweeps state roads (Shaker Hill Road, Main Street, etc.) in Enfield approximately once every other year. The Enfield Department of Public Works responds as needed to clear clogged catch basins when issues are observed. Culverts are inspected annually and during/after large rain events. Culverts are replaced as needed; there is no formal culvert inventory with priority for replacement. Culverts along Shaker Boulevard in Enfield are prioritized for replacement. The Town of Enfield maintains about 33 miles of unpaved, gravel roads, which are graded in the spring and fall and treated with magnesium chloride for dust. Additional follow-up is needed to determine current municipal best practices in the other watershed towns.

4.2.2 Zoning and Ordinance Updates

Regulations through municipal zoning and ordinances such as low impact development strategies that prevent polluted runoff associated with new and re-development projects in the watershed are equally important as implementing structural SCMs on existing development. In fact, local land use planning and zoning ordinances can be the most critical components of watershed protection. FBE completed a preliminary ordinance review of natural resource protections for the municipalities of Lebanon, Enfield, and Canaan (Table 18). These three municipalities were prioritized because they directly surround Mascoma Lake and therefore play a critical role in influencing land use, shoreline development, and water quality conditions within the lake. These municipalities have incorporated several important regulations into their local ordinances, including wetlands protections, floodplain regulations, setback requirements, and SCMs, though the level of detail, consistency, and enforcement mechanisms vary between the communities. A more robust review of these ordinances is encouraged to develop more specific recommendations for improving regulations related to natural resource protection. A broader review of Grafton, Orange, Dorchester, Hanover, and Lyme is also recommended to provide a more comprehensive watershed-wide perspective. In addition, the municipalities should also consider the staffing capacity and administrative support necessary to effectively enforce both existing and proposed regulations.

Local land use planning and zoning ordinances should consider incorporating resiliency strategies for protecting water quality and improving infrastructure based on temperature, precipitation, water levels, wind loads, storm surges, soil moisture, and groundwater levels (Ballestero, Houle, Puls, & Barbu, 2017). There are nine strategies which can aid in minimizing the adverse effects associated with environmental stressors and include the following (McCormick & Dorworth, 2019), several of which are partially addressed within the current ordinances of Lebanon, Enfield, and Canaan but could be further strengthened and expanded. More details on ordinance recommendations and suggestions can be found in Table 18 and Table 19.

- **Installing green infrastructure and nature-based solutions:** Planning for greener infrastructure requires creating a network of interconnected natural areas and open spaces needed for groundwater recharge, pollution mitigation, reduced runoff and erosion, and improved air quality. Examples of green infrastructure include forest, wetlands, natural areas, riparian buffers, and floodplains; all of which already exist to some extent in the watershed and have minimized the damage created by intense storms. As future development occurs, these natural barriers must be maintained or even increased to reduce runoff of pollutants into freshwaters. See also Section 4.2.3: Land Conservation.
- **Using low impact development strategies:** Use of low impact development strategies requires replacing traditional approaches to stormwater management using curbs, pipes, storm drains, gutters, and retention ponds with innovative approaches such as bioretention, vegetated swales, and permeable paving.
- **Minimizing impervious surfaces:** Impervious surfaces such as roads, buildings, and parking lots should be minimized by creating new ordinances and building construction design requirements which reduce the imperviousness of new development. Property owners can increase the permeability for their lots by incorporating permeable driveways and walkways.
- **Encouraging riparian buffers and maintaining floodplains:** Municipal ordinances should forbid construction in floodplains, and in some instances, floodplains should be expanded to increase

the land area to accommodate larger rainfall events. Riparian buffers and filter strips along waterways should be preserved and potentially created to slow runoff and filter pollutants.

- **Protecting and re-establishing wetlands:** Wetlands are increasingly important for preservation because wetlands hold water, recharge groundwater, and mitigate water pollution.
- **Encouraging tree planting:** Trees help manage stormwater by reducing runoff and mitigating erosion when adjacent to surface waters. Trees also provide critical shading and cooling to streams, lake shorelines, and land surfaces.
- **Promoting landscaping using native vegetation:** Landowners should promote the use of native vegetation in landscaping, and landscapers should become familiar with techniques which minimize runoff and the discharge of nutrients into waterbodies (Chase-Rowell, Davis, Hartnett, & Wyzga, 2012).
- **Slowing down the flow of stormwater:** To slow and infiltrate stormwater runoff, roadside ditches can be armored or vegetated and equipped with turnouts, settling basins, check dams, or infiltration catch basins. Rain gardens can retain stormwater, while water bars can divert water into vegetated areas for infiltration. Water running off roofs can be channeled into infiltration fields and drainage trenches.
- **Coordinating infrastructure, housing, and transportation planning**: Coordinate planning for infrastructure, housing, and transportation to minimize the impacts on natural resources. Critical resources including groundwater must be conserved and remain free of pollutants especially as future droughts may deplete groundwater supplies.

Table 18. Ordinance review summary of regulatory and non-regulatory tools for natural resource protection in Lebanon, Enfield, and Canaan, which comprise the majority of the Mascoma Lake watershed and the entire lake shoreline.

REGULATORY TOOLS

Strategy	Lebanon	Enfield	Canaan
Zoning districts addressing environmental protection.	Overlay districts (e.g., Wetlands Conservation, Riverbank Protection) set additional restrictions to safeguard ecological areas. These include limited development, conservation buffers, and performance standards for activities like vegetation clearing and grading.	The Conservation District is specifically established to maintain natural resources and regulate activities to prevent environmental degradation. It includes limitations on structures, density, and activities to ensure resource protection.	Not by zoning district; subdivision process has some elements of environmental protection.
Shoreland zoning.	Structures must be set back at least 50 feet from designated shorelines. Clear-cutting and land disturbance are restricted to maintain riparian buffers. Only low-impact uses are permitted.	Structures must be set back at least 50 feet from seasonal high-water lines of rivers, lakes, and wetlands. For Prime Wetlands, the setback is 100 feet.	The Comprehensive Shoreland Protection Act governs activities within 250 feet of protected shorelands.
Waterfront parcel regulations.	Waterfront subdivisions require natural buffer zones and stormwater management measures to reduce runoff. The subdivision review process assesses environmental impacts before approval.	Includes specific setback and density requirements that regulate land use near waterbodies to minimize environmental impacts.	Waterfront lots must meet shoreland setback and frontage requirements. New subdivisions must address water quality impacts through nutrient loading analyses and SCMs to minimize runoff into adjacent waterbodies.
Cluster development and/or open space provisions for subdivisions.	Cluster subdivisions must dedicate at least 25% of the site to open space. This open space should be contiguous, accessible, and used for conservation, recreation, or natural habitat protection.	Cluster development is permitted in multiple districts to preserve open space. It is encouraged under Section 405 to consolidate development into smaller areas while retaining open lands.	Developers are encouraged to include open spaces in subdivisions. Open space areas must be designated for recreation or conservation and integrated into subdivision designs.

Strategy	Lebanon	Enfield	Canaan
Protection of wetlands.	A 100-foot no-build buffer is enforced around wetlands of significant ecological value. Wetland crossings and alterations are subject to strict permitting and mitigation requirements.	Wetlands are designated as sensitive areas with mandatory setbacks and activity restrictions to prevent degradation.	Wetland delineation is required as part of subdivision plans. Developments must include stormwater measures to avoid direct discharge into wetlands and maintain buffer zones.
Protection of groundwater.	Activities that risk contamination, such as fuel storage or heavy chemical use, are prohibited in designated groundwater protection zones. Development must not reduce groundwater recharge capacity.	No structures are allowed within 400 feet of wellheads associated with the town's drinking water supply.	Stormwater regulations mandate minimizing impervious surfaces to support groundwater recharge. Subdivisions must ensure drinking water safety by maintaining wellhead protection zones (75-foot radius).
Protection of steep slopes.	Construction on slopes over 25% is generally prohibited. Erosion control plans and vegetative stabilization are required for any permitted activity in such areas.	Development on steep slopes is regulated to mitigate erosion and maintain stability.	No steep slope percentage standard listed. Under Subdivision Regulations (2024) the Planning Board has authority to deny subdivision approval where excessive slope creates hazard.
Septic pump-out ordinance or regulation of septic and sewer systems.	Septic systems must be inspected regularly and are prohibited within 125 feet of sensitive water resources like Mascoma Lake. Sewer systems must adhere to setback and design standards to prevent leakage.	Sewage and gray water disposal must comply with state laws, especially for temporary accommodations like RVs. Passed a septic overlay district requiring pumping at least every three years and inspection at least every six years for properties in the protected shoreland for four major lakes, including Mascoma Lake.	In areas not currently served by public sewer systems, it shall be the responsibility of the subdivider or their agent to provide the necessary state approvals for the construction of an individual sewage disposal system. For new lots with on-site septic, the number of dwelling units per lot shall not exceed 1 unit per 150 feet of shoreland frontage, and for any lot that does not have direct frontage, one unit per 150 feet of lot width, as measured parallel to the shoreland frontage that lies between the lot and the reference line.

Strategy	Lebanon	Enfield	Canaan
Nutrient loading analysis required for fresh waterbodies.	Developments near fresh waterbodies must conduct nutrient analyses to evaluate potential impacts. Mitigation strategies, such as vegetative buffers or advanced septic technologies, may be required.	While specific nutrient analysis is not mentioned, setbacks and land-use regulations aim to reduce nutrient runoff into waterbodies.	Subdivisions impacting waterbodies are required to demonstrate compliance with water quality standards, including phosphorus and sediment reduction targets.
Low impact development requirements and standards.	Low impact development practices like bioretention, permeable pavements, and green roofs are required to manage stormwater naturally. New developments are assessed for compliance with low impact development requirements.	Low impact development approaches are encouraged for stormwater management in parking lots and other areas to reduce runoff.	Regulations promote practices such as preserving natural vegetation, using vegetative swales and buffers for stormwater treatment, and controlling post-development runoff to match pre-development conditions.
Environmental Ordinances (e.g. green building codes, green infrastructure, tree preservation, limits on impervious surface cover).	These include tree preservation rules, maximum impervious cover limits, and incentives for using renewable energy technologies or green building practices.	Limits on impervious surface coverage and landscaping requirements are specified, particularly in the Route 4 District.	Ordinances address green infrastructure, preservation of trees and other natural features, and limiting impervious surface coverage in subdivisions.
Fertilizer and/or pesticide ordinances.	Application near sensitive areas is heavily restricted. Fertilizers must be phosphorus-free unless soil tests demonstrate a need. Licensed professionals must apply pesticides under strict guidelines.	No specific ordinances are highlighted, but environmental protections in sensitive areas imply regulation of such substances.	Rules limit the use of fertilizers and pesticides near waterbodies to reduce runoff and protect water quality.

Strategy	Lebanon	Enfield	Canaan
Implement and enforce a Stormwater Management Plan.	Developers must submit detailed stormwater management plans. Requirements include capturing and treating runoff, minimizing peak flow rates, and integrating green infrastructure.	Landscaping and low impact development requirements incorporate stormwater management strategies to handle runoff sustainably.	Developers must include plans that control peak runoff during storms, use techniques like detention basins and infiltration systems, and prohibit snow plowing or storage within 25 feet of wetlands.

CONSERVATION FUNDING STRATEGIES

Strategy	Lebanon	Enfield	Canaan
Development transfer overlay district.	Not mentioned.	Not mentioned.	Not mentioned.
Conservation impact fees.	The City authorizes the assessment of impact fees on new developments under Section 213 of the Zoning Ordinance to finance public capital facilities, including conservation-related initiatives.	Conservation impact fees are outlined in Article IX of the Zoning Ordinance. These fees are charged to developers to offset the cost of public infrastructure or services necessitated by new development. The fees are calculated based on specific methodologies and are administered to support conservation and community growth without overburdening existing residents.	The Master Plan encourages the exploration of impact fees to offset municipal costs due to new development. These fees are proposed to reduce the financial burden on town infrastructure while supporting conservation goals.
Wetland mitigation funds.	Lebanon has a Wetlands Conservation District designed to protect wetlands, including high-value areas. This district mandates buffers and prioritizes on-site or nearby mitigation when wetland impacts are unavoidable.	Not mentioned.	Not mentioned.
Fee in lieu of land dedication.	Not mentioned.	Not mentioned.	Not mentioned.

Strategy	Lebanon	Enfield	Canaan
Stormwater utility district.	Not mentioned.	Not mentioned.	Not mentioned.
Open space or non-lapsing conservation fund.	Not mentioned.	The Master Plan emphasizes the importance of conserving open spaces to maintain the town's rural character, ecological health, and recreation opportunities. Approximately one-third of Enfield's land area is protected as public open space or private conservation land. These efforts ensure long-term preservation and are supported by ongoing conservation funding mechanisms.	The Master Plan emphasizes preserving open spaces as part of the town's rural character and promoting cluster development to maintain large undeveloped areas and continuing to deposit into Conservation Fund.
Has a Land Use Change Tax per RSA 79-A:25.	The Master Plan mentions that approximately 18,000 acres of open space in Lebanon are in current use under New Hampshire's Current Use Taxation Program, which aligns with RSA 79-A.	Not mentioned.	Master Plan (2019) recommends continuing to deposit Land Use Change Tax revenues in the Conservation Fund.
Participate or collaborate with a local watershed association.	Lebanon collaborates with watershed groups such as the Mascoma River Local Advisory Committee and Connecticut River Joint Commission for water resource management.	The Master Plan prioritizes protecting water resources, wildlife habitats, and forests. It identifies strategies to preserve ecological integrity through both regulatory and non-regulatory methods. Environmental protection is a guiding principle in Enfield's vision, which includes sustainable development and conservation of key natural areas.	The Master Plan discusses protecting shorelines and surface waters through collaboration with conservation organizations. Though watershed associations are not directly named, these efforts align with watershed conservation practices.
Participate or collaborate with a local land trust.	The City works with local organizations for conservation purposes, including preserving lands for ecological and recreational uses. The Master Plan highlights partnerships for land conservation initiatives.	Not mentioned.	Not mentioned.

NON-REGULATORY TOOLS

Strategy	Lebanon	Enfield	Canaan
Open space plan.	Lebanon's 2021 Open Space Plan is a foundational element of its conservation strategy, emphasizing the protection of open spaces, working lands, and natural areas to maintain rural character and ecological health. Approximately 70% of Lebanon's land is undeveloped, and the city dedicates 100% of Land Use Change Tax revenues to a conservation fund.	Not mentioned.	While there is no specific Open Space Plan mentioned, the Master Plan promotes open space conservation through cluster development and preserving undeveloped land for wildlife corridors and recreation.
Master Plan addresses natural resources and environmental protection.	The Master Plan highlights the importance of protecting natural resources such as wetlands, forests, and waterbodies. Key protections include the Wetlands Conservation District and the Riverbank Protection District. These measures align with efforts to balance growth while preserving biodiversity and ecological integrity.	The Master Plan focuses on protecting water resources, wildlife, and forests through both regulatory and non-regulatory strategies.	The Master Plan outlines strategies for protecting natural resources, including enforcing setbacks, limiting development in sensitive areas (e.g., wetlands, steep slopes), and conserving wildlife habitats. Specific measures include protecting Canaan Street Lake and aquifers as critical drinking water resources.
A town-wide natural resources inventory.	Lebanon completed the "Natural Lebanon" natural resource inventory in 2010. The natural resource inventory documents critical resources, including wetlands, farmland, and wildlife corridors, providing a data-driven foundation for conservation planning and decision-making.	Enfield's Conservation Commission developed a comprehensive natural resource inventory in 2005, documenting critical ecological features such as wetlands, wildlife corridors, and forests. This inventory is periodically updated and serves as a foundational tool for land use planning, zoning decisions, and environmental conservation.	The Master Plan refers to the use of natural resource inventories to guide land-use decisions and prioritize critical areas for protection. This inventory helps identify and map important ecological and hydrological features.

Strategy	Lebanon	Enfield	Canaan
Smart Growth Plan.	The City integrates Smart Growth principles into its planning, focusing on compact, mixed-use development near existing urban centers, reducing rural sprawl, and conserving farmland and natural areas.	Principles of smart growth, such as concentrating development in village centers, are integrated into the Master Plan, but not under this specific name.	The Master Plan incorporates smart growth principles by encouraging clustered development near village centers while preserving rural and undeveloped areas. These strategies are aimed at reducing sprawl and protecting natural resources.
Stormwater system mapping.	The Master Plan identifies challenges with stormwater infrastructure, including combined sewer overflows and EPA mandated upgrades. Lebanon has removed all combined sewer overflows as of 2024 and is working on mapping its stormwater infrastructure.	Not mentioned.	Not mentioned.
Consistent public outreach and engagement/public education programs.	The City emphasizes community engagement, including educational initiatives on water conservation and invasive species management. Public input and collaboration are highlighted as essential for effective planning and environmental stewardship.	Public outreach is a central theme in Enfield's Master Plan. The planning process included community surveys, focus groups, and visioning workshops to gather input from residents. Educational initiatives aim to raise awareness about conservation, sustainable development, and the town's environmental priorities.	The Master Plan highlights public involvement in the planning process, including surveys, forums, and workshops. It emphasizes ongoing community engagement to ensure conservation and land-use policies reflect public priorities.
Incentive-based programs for voluntary low impact development implementation.	None identified.	None identified.	None identified.

Strategy	Lebanon	Enfield	Canaan
Incentive-based programs for stormwater reduction efforts.	The City promotes stormwater reduction through infrastructure improvements and planning requirements. Incentives may include design flexibility for developments that incorporate effective stormwater management.	None identified.	None identified.
Conservation Commission	Lebanon has a Conservation Commission actively involved in land protection, natural resource management, and providing guidance on development impacts.	The Conservation Commission is a formal body responsible for overseeing the protection of natural resources in Enfield. Its duties include managing the natural resource inventory, advising on development projects, and collaborating with stakeholders to enhance conservation efforts. This body plays a vital role in implementing the town's environmental goals.	The Canaan Conservation Commission is active in guiding conservation efforts and advising on development impacts. The commission's role is critical in implementing the town's environmental protection goals.
Incentivize and/or encourage property owners to implement low impact development stormwater practices.	None identified.	None identified.	None identified.
Encourage property owners to put land into farmland/tree growth programs.	The City recognizes the importance of maintaining agricultural and forested lands. Incentives include the current use taxation program (RSA 79-A), which encourages landowners to preserve open space and working lands.	Not mentioned.	Not mentioned.

Table 19. Summary table of recommendations for natural resource protection based on the ordinance review for the municipalities of Lebanon, Enfield, and Canaan.

REGULATORY TOOLS

Strategy	Lebanon Recommendations	Enfield Recommendations	Canaan Recommendations
Zoning districts addressing environmental protection.	Expand overlay districts to include smaller tributaries and headwater areas. Increase buffer widths for higher-risk zones.	Expand Conservation Districts to include buffer zones around all significant waterbodies and wetlands, and incorporate mandatory riparian buffers to reduce runoff and protect aquatic habitats.	Create environmental overlay districts to protect wetlands, steep slopes, aquifer recharge areas, and the Canaan Street Lake watershed since protections currently occur only through the subdivision process.
Shoreland zoning.	Enforce a wider setback (e.g., 75-100 feet) and restrict impervious surfaces within the shoreland zone.	Increase the setback requirement from waterbodies to 75 feet for general areas and 150 feet for Prime Wetlands. Introduce vegetative buffer requirements for additional erosion and nutrient runoff control.	Adopt local shoreland standards that reinforce or exceed the Comprehensive Shoreland Protection Act by requiring stormwater treatment, larger natural buffers, and riparian vegetation restoration for redevelopment.
Waterfront parcels.	Require mandatory stormwater treatment systems and larger open-space requirements near waterbodies.	Implement stricter lot size and frontage requirements for waterfront subdivisions, and mandate open space preservation along shorelines to maintain water quality and ecosystem integrity.	Require enhanced SCMs, vegetated buffers, and limits on expansion of impervious surfaces on waterfront lots to reduce direct runoff into Canaan Street Lake and other waterbodies.
Cluster development and/or open space provisions for subdivisions.	Incorporate native vegetation restoration in open spaces and mandate green infrastructure for stormwater management.	Require a higher percentage of preserved open space for cluster developments near waterbodies and encourage integration of natural filtration features like rain gardens and wetlands.	Strengthen cluster development standards by requiring a minimum percentage of preserved open space and ensuring that conserved areas include riparian zones, wetlands, or steep slopes.

Strategy	Lebanon Recommendations	Enfield Recommendations	Canaan Recommendations
Protection of wetlands.	Strengthen protections with a no-disturb buffer and require compensatory wetland restoration for permitted impacts.	Increase setbacks from wetlands for all development and establish a no-disturbance buffer zone around all wetlands to better protect against habitat loss and water quality degradation.	Adopt a stand-alone wetland protection ordinance establishing setbacks, buffer widths, and performance standards, rather than relying on subdivision review alone.
Protection of groundwater.	Introduce stricter controls on industrial activities in groundwater recharge areas and encourage rainwater harvesting.	Expand protections for wellhead areas by enforcing stricter land-use controls within a larger radius and requiring regular monitoring of potential contamination sources.	Expand drinking water protection by establishing a mapped groundwater protection overlay with restricted land uses, increased setbacks, and stormwater infiltration requirements.
Protection of steep slopes.	Prohibit clear-cutting on steep slopes and require tiered erosion and sediment control measures during construction.	Prohibit development on steep slopes near waterbodies to prevent sedimentation and implement mandatory erosion control measures during construction.	Create a steep slope development ordinance that restricts clearing, grading, and new road cuts on slopes greater than 15 to 25 percent to prevent erosion and sedimentation to surface waters.
Septic pump-out ordinance or regulation of septic and sewer systems.	Identify and map areas where advanced septic treatment technologies are necessary to protect water quality and require them there.	Identify and map sensitive soils for septic systems. Mandate regular pump-outs and inspections within sensitive soil areas. Require that septic systems adequately prevent phosphorus pollution to lakes and streams, generally through adequate setback distances, vertical separation distances, avoiding highly porous soils, and ensuring adequate effluent flow paths through unsaturated soils.	Adopt a mandatory 3-to-5-year pump-out requirement for properties within the Canaan Street Lake watershed and require proof of system condition during property transfers.
Nutrient loading analysis required for fresh waterbodies.	Require detailed nutrient management plans for agricultural and residential areas near waterbodies.	Implement a requirement for nutrient loading assessments in site plans for developments near waterbodies. Develop a nutrient reduction plan for high-impact areas.	Require nutrient loading analyses for all subdivisions and large redevelopments within lake watersheds and tie approvals to demonstrated phosphorus load reductions.

Strategy	Lebanon Recommendations	Enfield Recommendations	Canaan Recommendations
Low impact development requirements and standards.	Provide incentives for developers to exceed low impact development requirements and require ongoing maintenance plans.	Make low impact development strategies mandatory in all developments, including rain gardens, permeable pavements, and green roofs, to reduce runoff and improve water infiltration.	Adopt low impact development design standards requiring infiltration, limits on effective impervious area, vegetated buffers, and use of practices like rain gardens and swales in all new development.
Environmental Ordinances (e.g. green building codes, green infrastructure, tree preservation, limits on impervious surface cover)	Incorporate stronger tree-preservation policies and increase restrictions on impervious surface limits near critical water resources.	Lower maximum impervious surface limits in all districts and require onsite stormwater infiltration features for developments exceeding certain thresholds.	Create an environmental protection ordinance that sets maximum allowable impervious cover for lake watershed parcels and protects mature trees and natural vegetation during site development.
Fertilizer and/or pesticide ordinances.	Prohibit fertilizer application within 25 feet of waterbodies and provide community education programs on reducing chemical usage.	Restrict fertilizer and pesticide application near waterbodies and promote the use of organic or low-impact alternatives. Educate landowners on safe application practices.	Adopt a fertilizer and pesticide use ordinance for lake watershed parcels that restricts phosphorus fertilizers and requires setbacks from shorelines and wetlands.
Implement and enforce a Stormwater Management Plan.	Mandate post-construction monitoring of stormwater systems to ensure they function as designed, reducing pollutants.	Develop a comprehensive stormwater management plan that includes regular maintenance of stormwater infrastructure, monitoring of runoff impacts, and incentives for retrofitting outdated systems.	Develop a town-wide stormwater management plan that includes erosion control standards, post-construction monitoring, and regular inspection requirements.

CONSERVATION FUNDING STRATEGIES

Strategy	Lebanon Recommendations	Enfield Recommendations	Canaan Recommendations
Development transfer overlay district.	Establish a transfer of development rights overlay district that shifts development pressure away from high priority water resources, wetlands, and steep slopes toward designated growth areas with existing infrastructure.	Implement development transfer overlay districts to direct growth away from sensitive lake and waterbody areas, concentrating development in less environmentally critical zones.	Establish overlay districts to redirect development away from sensitive lake and waterbody areas. Use transferred development rights to preserve riparian zones and critical watershed lands.
Conservation impact fees.	Expand conservation impact fees to explicitly support watershed protection projects, including stormwater retrofits, riparian buffer restoration, and land acquisition in high loading sub-watersheds.	Increase conservation impact fees to fund watershed protection programs, buffer zones around lakes, and public education on waterbody conservation.	Establish conservation impact fees and earmark them for projects protecting lakes and water quality, such as wetland restoration, stormwater infrastructure, and public education campaigns. Conservation Fund is mentioned, but no ordinance language establishing a conservation impact fee.
Wetland mitigation funds.	Create a dedicated wetland mitigation fund to support off site wetland restoration and enhancement projects when on site mitigation is not feasible, with priority given to projects that improve water quality and flood resilience.	Establish dedicated wetland mitigation funds to restore degraded wetlands that act as natural filters for lakes and waterbodies.	Create a wetland mitigation fund to finance restoration and protection of wetlands adjacent to lakes. Require developers to contribute to the fund for any permitted wetland disturbances.
Fee in lieu of land dedication.	Adopt an in-lieu fee program (ILFP) for land dedication option for subdivisions, with revenues directed to the open space conservation fund for land acquisition or restoration projects that protect surface waters and groundwater recharge areas.	Introduce a fee system where developers contribute to conservation funds instead of dedicating land, ensuring stable funding for lake protection initiatives.	Implement an ILFP where developers can contribute to conservation funds instead of dedicating land. Use these funds to acquire high-priority lands for lake and watershed protection.

Strategy	Lebanon Recommendations	Enfield Recommendations	Canaan Recommendations
Stormwater utility district.	Develop a stormwater utility district with an impervious area-based fee structure and credit program for property owners who reduce runoff through green infrastructure or low impact development practices.	Create a stormwater utility district to manage runoff and implement infrastructure that reduces pollutants entering lakes and waterbodies.	Establish a stormwater utility district to fund infrastructure improvements that reduce polluted runoff into lakes. Include stormwater fee incentives for property owners implementing SCMs.
Open space or non-lapsing conservation fund.	Formalize and expand the non-lapsing conservation fund to prioritize riparian corridors, wetlands, floodplains, and lake shoreline parcels that provide direct water quality benefits.	Formalize and allocate resources to an open space fund to preserve land surrounding lakes and waterbodies, ensuring natural filtration systems remain intact.	Formalize and allocate resources to an open space fund to focus on acquiring and conserving riparian buffers, lakefront properties, and areas critical to water filtration and wildlife habitats.
Has a Land Use Change Tax per RSA 79-A:25.	Continue implementing.	Establish land use change tax revenues to fund conservation easements and riparian buffer restoration around lakes and streams.	Allocate revenues from land use change taxes specifically to projects that protect water quality, such as riparian restoration and erosion control measures.
Participate or collaborate with a local watershed association.	Strengthen collaboration with MLA.	Strengthen collaboration with MLA.	Strengthen collaboration with MLA.
Participate or collaborate with a local land trust.	Work with local and regional land trusts to prioritize conservation easements along streams, lake shorelines, and headwater areas that contribute to nutrient and sediment loading.	Collaborate with local land trusts to protect critical lakefront properties through conservation easements or acquisitions.	Collaborate with land trusts to secure conservation easements or acquire critical lakefront properties to prevent development and protect water quality.
Open space plan.	Increase emphasis on riparian buffer preservation in open space priorities. Collaborate with land trusts to acquire conservation easements specifically protecting waterbodies.	Develop a detailed open space plan focusing on preserving riparian buffers, wetlands, and forests near lakes to enhance water quality and habitat.	Develop a comprehensive Open Space Plan that prioritizes the conservation of riparian areas, wetlands, and lake watersheds. Include strategies for maintaining public access while preserving ecological integrity.

NON-REGULATORY TOOLS

Strategy	Lebanon Recommendations	Enfield Recommendations	Canaan Recommendations
Master Plan addresses natural resources and environmental protection.	Expand buffer zone requirements for wetlands and watercourses. Implement stricter regulations on developments near sensitive habitats.	Include clear policies and action items in the Master Plan to regulate development, enforce buffer zones, and fund lake conservation projects.	Update the Master Plan to include explicit goals and action plans for reducing nutrient runoff, preventing erosion, and maintaining healthy riparian zones around lakes.
A town-wide natural resources inventory.	Update the inventory regularly to reflect changes in land use and climate impacts. Incorporate interactive GIS tools for better stakeholder access and decision-making.	Expand the Natural Resources Inventory to map and prioritize vulnerable lake ecosystems and their contributing watersheds.	Establish a natural resources inventory to include detailed data on lake watersheds, water quality trends, and critical habitat areas. Use this data to guide land-use decisions.
Smart Growth Plan.	Incentivize developments with minimal impervious surfaces. Promote green infrastructure in urban areas to improve water infiltration.	Adopt smart growth strategies that limit impervious surfaces near lakes, protect green spaces, and encourage compact, sustainable development.	Adopt a Smart Growth Plan that limits sprawl around lakes, directs growth to areas with existing infrastructure, and protects sensitive shorelands through zoning and conservation easements.
Stormwater system mapping.	Maintain detailed mapping of tributaries and stormwater pipes and outfalls. Post a success story regarding combined sewer overflows removal with a link from the City's homepage.	Conduct comprehensive stormwater system mapping to identify and mitigate sources of runoff pollution affecting lakes and waterbodies. Use this information to prioritize infrastructure upgrades.	Conduct a comprehensive stormwater system mapping project to identify and address sources of runoff pollution entering lakes. Use this information to prioritize infrastructure upgrades.
Consistent public outreach and engagement/ public education programs.	Develop specific campaigns on the importance of water conservation and best practices for stormwater management. Increase visibility of educational programs through community events and schools.	Enhance public education programs to promote responsible land use practices, such as reducing fertilizer use and maintaining septic systems near lakes.	Launch public education programs focused on preventing lake pollution, such as proper septic system maintenance, limiting fertilizer use, and adopting green infrastructure on private properties.

Strategy	Lebanon Recommendations	Enfield Recommendations	Canaan Recommendations
Incentive-based programs for voluntary low impact development implementation.	Provide tax rebates or grants for properties adopting low impact development technologies such as rain gardens or bioswales. Mandate low impact development implementation for large developments.	Provide tax rebates or grants for properties adopting low impact development technologies such as rain gardens or bioswales. Mandate low impact development implementation for large developments.	Provide tax rebates or grants for properties adopting low impact development technologies such as rain gardens or bioswales. Mandate low impact development implementation for large developments.
Incentive-based programs for stormwater reduction efforts.	Offer financial incentives to encourage stormwater reduction efforts, such as subsidies for installing rain barrels or implementing infiltration systems that prevent runoff into lakes.	Offer financial incentives to encourage stormwater reduction efforts, such as subsidies for installing rain barrels or implementing infiltration systems that prevent runoff into lakes.	Offer financial incentives to encourage stormwater reduction efforts, such as subsidies for installing rain barrels or implementing infiltration systems that prevent runoff into lakes.
Conservation Commission	Expand the commission's role in monitoring water quality and coordinating with state programs. Provide additional funding to support water-focused initiatives.	Empower the Conservation Commission to enforce stricter regulations and provide guidance for lakefront property management.	Empower the Conservation Commission to enforce stricter regulations and provide guidance for lakefront property management.
Incentivize and/or encourage property owners to implement low impact development stormwater practices.	Offer financial incentives like tax rebates or grants to property owners adopting low impact development measures such as permeable pavement or rain gardens.	Offer financial incentives like tax rebates or grants to property owners adopting low impact development measures such as permeable pavement or rain gardens.	Offer financial incentives like tax rebates or grants to property owners adopting low impact development measures such as permeable pavement or rain gardens.
Encourage property owners to put land into farmland/tree growth programs.	Promote state programs that encourage landowners to preserve tree growth or farmland, focusing on lands that contribute to healthy watersheds and prevent runoff into lakes.	Promote state programs that encourage landowners to preserve tree growth or farmland, focusing on lands that contribute to healthy watersheds and prevent runoff into lakes.	Promote state programs that encourage landowners to preserve tree growth or farmland, focusing on lands that contribute to healthy watersheds and prevent runoff into lakes.

4.2.3 Land Conservation

Land conservation is essential to the health of a region, particularly for the protection of water resources, enhancement of recreation opportunities, vitality of local economies, and preservation of wildlife habitat. Land conservation is one of many tools for protecting water quality for future generations. For Mascoma Lake, 20 percent (19,317 acres) of the watershed's land area (excluding Mascoma Lake and Crystal Lake) has been classified as conservation land (refer to Appendix A, Map A-11). Major conserved areas with over 1,000 acres of conserved land in the watershed include: the Mascoma Conservation Easement , Cardigan Mountain State Forest, Henry Laramy Wildlife Management Area, and Lower Shaker Wildlife Management Area. Many of the conservation areas border parts of lakes, ponds, streams, or riverways in the watershed.

Local groups should continue to pursue opportunities for land conservation in the Mascoma Lake watershed based on the highest valued habitat identified by the NH Fish and Game Department. The NH Fish and Game Department ranks habitat based on its value to the state, biological region (areas with similar climate, geology, and other factors that influence biology), and supporting landscape context. These habitat rankings are published in the State's 2025 Wildlife Action Plan, which serves as a blueprint for prioritizing conservation actions to protect Species of Greatest Conservation Need in New Hampshire (NHFG, 2025). The Mascoma Lake watershed is part of the Sunapee Uplands and White Mountain Foothills ecoregional subsection of the biological region (NHFG, 2025). Approximately 26,528 acres (27 percent) of the Mascoma Lake watershed are considered Highest Ranked Habitat in New Hampshire (including the waterbody of Mascoma Lake). Many of the conserved areas overlap with the Highest Ranked Habitat in New Hampshire and the Highest Ranked Habitat in the Biological Region. A map of priority habitats for conservation based on the 2025 New Hampshire Wildlife Action Plan can be found in Appendix A, Map A-11 and Map A-12.

4.2.4 Septic System Regulation

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

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

- Proper **operation** includes how the property owner uses the system. While most systems excel at treating normal domestic sewage, disposing of some materials, such as toxic chemicals, paints, personal hygiene products, and oils and grease in large volumes, can adversely affect the function and design life of the system, resulting in treatment failure and potential health threats. Proper operation also includes how the property owner protects the system. For example, allowing vegetation with extensive roots to grow above the system can result in clogs, and driving large vehicles over the system may crush or compact piping or leaching structures.
- Proper **maintenance** means having the septic tank pumped at regular intervals to eliminate accumulations of solids and grease in the tank. It may also mean regular cleaning of effluent filters, if installed. The frequency of septic pumping depends on the use and total volume entering the system. A typical three-bedroom, 1,000-gallon tank should be pumped every three to four years.
- Proper **replacement** of failed systems may include programs or regulations to encourage upgrades of conventional systems (or cesspools and holding tanks) to more innovative alternative technologies.

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

Management strategies for reducing water quality impacts from septic systems (as well as cesspools and holding tanks) start with education and outreach to property owners so that they are better informed and able to properly operate and maintain their systems. Other management strategies include setting local regulations to enforce proper maintenance and inspection of septic systems and establishing funding mechanisms to support replacement of failing systems (with priority for cesspools and holding tanks).

In an effort to regulate septic systems on shoreline properties within the Mascoma Lake watershed, the Town of Enfield drafted a septic ordinance which was unanimously approved by the selectboard on November 18, 2024, and the ordinance Enfield Shoreland Septic System Regulations went into effect on January 1, 2025. The ordinance applies to all private subsurface sanitary disposal systems located wholly or partially within Enfield's Protected Shoreland, defined as the 250-foot buffer around George Pond, Spectacle Pond, Crystal Lake, and Mascoma Lake. As defined by this ordinance, all systems must be inspected by a NH Licensed Septic Evaluator and pumped a minimum of once every three years, with the possibility of an exemption up to six years. Changes in the use or size of structures require approval from NHDES for the use applied for, and a new system must be installed to meet these standards as approved by NHDES. Sale of property requires a copy of the septic system evaluation reported to the Town within 30 days of the purchase.

4.2.5 Sanitary Sewer System Inspections

Because a portion of the watershed also relies on a municipal sewer system, it is important for municipalities with sewer to develop a program to inspect and evaluate their sanitary sewer system and reduce identified leaks and overflows, especially in areas near waterbodies. At the time of this report, there are no known municipal programs specific to routine inspection and condition assessment of the entire sewer system. The municipalities address sewer infrastructure issues as they arise.

4.2.6 Boats and Marinas

NHDES provides an interactive map of boat pump-out locations, including both public and private boat pump-outs, dump stations for portable toilets, and mobile pump-out vessels. There are no active pump-out facilities in the Mascoma Lake watershed, though best practices at public boat launches should be installed by the municipalities and followed by boat owners.

- Target outreach to marina owners, boat dealers, and their consumers regarding state and EPA requirements.
- Ensure boat launches provide clean and safe onshore restrooms and install runoff management practices.
- Provide an appropriate location for boat washing that minimizes runoff to surface waters.
- Consider alternatives to asphalt for parking lots and vessel storage areas such as permeable pavement.
- Install infiltration trenches at the leading edge of a boat ramp to catch pollutants in an oil absorbent barrier or crushed stone before discharge.
- Install vegetated buffers between surface waters and upland areas.
- Protect storm drains with filters or oil-grit separators. Stencil words (such as “Drains to the Lake”) on storm drains to alert customers and visitors that storm drains lead directly to waterbodies without treatment. Contact the appropriate municipal public works department before stenciling any drain.

4.2.7 Fertilizer Use Prohibition

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

4.2.8 Pet Waste Management

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

4.2.9 Agricultural Practices

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

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

These programs offered by the NRCS can serve as an essential resource for farmers, particularly in addressing environmental concerns in agricultural watersheds (USDA NRCS, 2024). Through continued collaboration with the NRCS and other stakeholders, farmers in the Mascoma Lake watershed can play a

pivotal role in enhancing water quality while maintaining agricultural productivity, thus supporting two essential natural resources for community well-being in the region.

NRCS
Orford Field Office
Serving Grafton County
19 Archertown Rd, Ste A
Orford, NH 03777
(603) 353-4651

To access the technical and financial support offered through these programs, it is recommended that farmers and landowners contact their local NRCS office. Information on agricultural best practices have been published in Section 1 of the NRCS Field Office Technical Guide for New Hampshire, under the "NH Ag BMPs" section. In this document, agricultural practices are sorted into three main sections: manure, agricultural compost, and chemical fertilizer (Figure 21). These classifications support the initial identification of appropriate practices for each farm, field, or site, depending on local needs. Once the relevant practices are identified, producers can better understand which NRCS practices will support best practices implementation. A full list of NRCS practices are available in Section 4 of the Field Office Technical Guide, with practices relevant to water quality highlighted in Table 20.

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

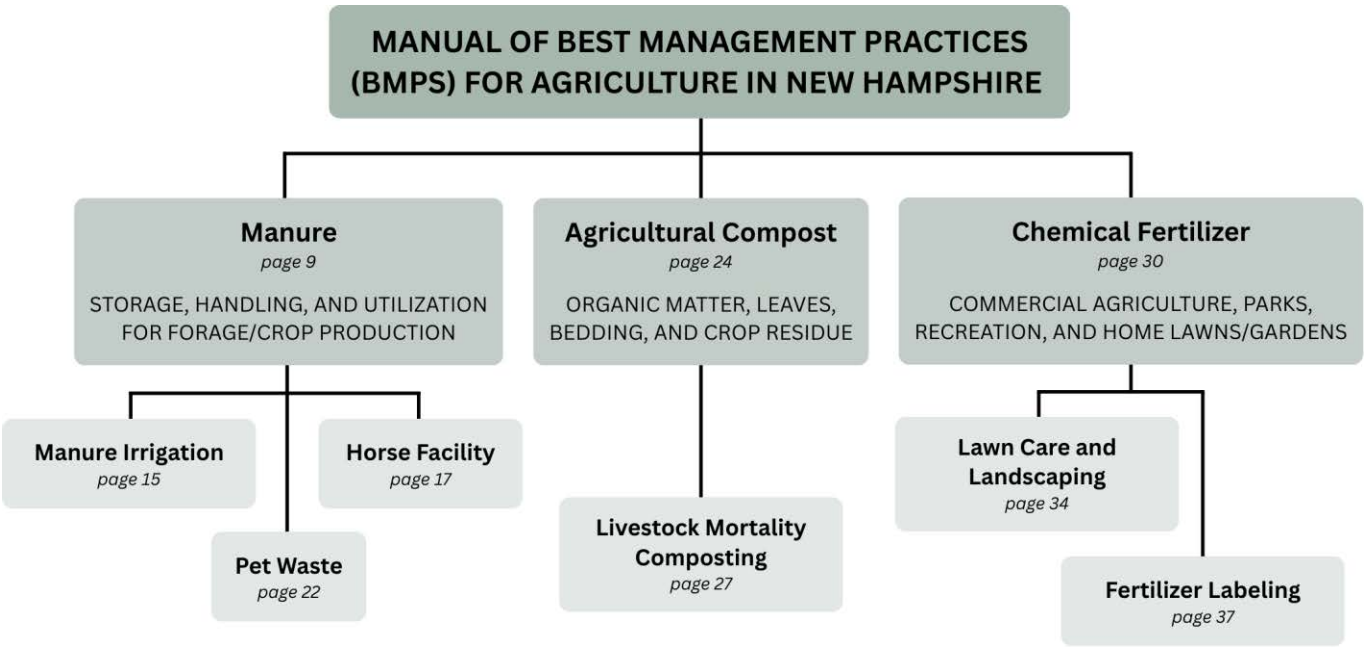


Figure 21. Overview of the major topics covered in the Manual of BMPs for Agriculture in New Hampshire, to orient producers to relevant sections. Relevant page numbers from the document are listed in each box.

Table 20. Conservation Practices covered by NRCS. Adapted from the *USDA Conservation Choices; Water Quality Practices*. The table is adjusted to meet current NH NRCS practices (USDA NRCS, 2022). "Y" indicates that the conservation practice is effective in addressing the pollutant or resource concern; "n" indicates that it is not. N = nitrogen. P = phosphorus. Sed = sediment.

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

4.2.10 Nuisance Wildlife Controls

Human development has altered the natural habitat of many wildlife species, restricting wildlife access to surface waters in some areas and promoting access in others. Minimizing the impact of wildlife on water quality generally requires either reducing the concentration of wildlife in an area or reducing their proximity to a waterbody. In areas where wildlife is observed to be a large source of nutrient contamination, such as large and regular congregations of waterfowl, a program of repelling wildlife from surface waters (also called harassment programs) may be implemented. These programs often involve the use of scarecrows, kites, a daily human presence, or habitat modification to reduce attractiveness of an at-risk area. Providing closed trash cans near waterbodies, as well as discouraging wildlife from entering surface waters by installing fences, pruning trees, or making other changes to landscaping, can reduce impacts on water quality. Public education and outreach that prohibit waterfowl or other wildlife feeding is an important step in reducing the impact of nuisance wildlife on the lake.

4.3 OUTREACH AND EDUCATION

Awareness through education and outreach is a critical and cost-effective tool for protecting and restoring water quality in the Mascoma Lake watershed. Although most residents and visitors want to be responsible stewards, many are unaware of how everyday actions such as septic system maintenance, fertilizer use, shoreline landscaping, and recreational practices influence lake health. A coordinated education strategy builds an informed community that understands the importance of watershed protection and actively supports implementation of the WBMP.

The MLA and the City of Lebanon, Enfield, and Canaan are the primary local entities responsible for advancing watershed education and supporting WBMP implementation. The overall goal is to increase awareness, promote SCMs, and foster long-term stewardship across all communities within the watershed. For example, the Committee discussed distributing educational packets to shoreline property owners each spring, ahead of the summer season, to provide guidance on lake-friendly practices such as septic maintenance, phosphorus-free fertilizer use, and shoreline buffer protection before peak recreational use begins (FBE, 2025c). Outreach efforts should also extend to upstream residents, seasonal visitors, recreational users, local businesses, youth, and municipal leaders, reinforcing that individual actions collectively influence water quality outcomes.

Educational messaging should highlight both the benefits of maintaining high water quality and the risks of inaction, including algae blooms, cyanobacteria outbreaks, and economic impacts. Priority topics include septic maintenance, responsible fertilizer and pesticide use, pet waste disposal, invasive species prevention, shoreline buffer restoration, gravel road erosion control, and stormwater management. MLA noted that previous events providing tangible resources, such as phosphorus-free fertilizer, were highly successful and drew strong community participation (FBE, 2025c). Building on this momentum, future workshops and events should be strategically scheduled during periods of high seasonal engagement and paired with clear calls to action. Success can be measured by tracking attendance, collecting participant feedback through surveys, and monitoring follow-up engagement such as newsletter sign-ups or participation in future programs. All outreach materials and event spaces should remain ADA-compliant and physically accessible, ensuring inclusive participation for individuals with hearing, visual, mobility, or cognitive impairments.

4.4 ADAPTIVE MANAGEMENT APPROACH

An adaptive management approach, to be employed by a dedicated committee, is highly recommended for protecting Mascoma Lake. Adaptive management enables stakeholders to conduct restoration actions in an iterative manner. Through this management process, restoration actions are taken based on the best available information. Assessment of the outcomes following restoration action, through continued watershed and water quality monitoring, allows stakeholders to evaluate the effectiveness of one set of restoration actions and either adopt or modify them before implementing effective measures in the next round of restoration actions. This process enables efficient utilization of available resources through the combination of SCM performance testing and watershed monitoring activities. Adaptive management features the establishment of an ongoing program that provides adequate funding, stakeholder guidance, and efficient coordination of restoration actions. Implementation of this approach ensures that

restoration actions are implemented and that surface waters are monitored to document restoration over an extended time. The adaptive management components for implementation efforts should include:

- **Maintaining an Organizational Structure for Implementation.** Communication and a centralized organizational structure are imperative to successfully implementing the actions outlined in this plan. A diverse group of stakeholders should be assembled to coordinate watershed management actions. This group can include representatives from state and federal agencies or organizations, municipalities, local businesses, non-profits, and other interested groups or private landowners. Refer to Section 6.1 Plan oversight.
- **Establishing a Funding Mechanism.** A long-term funding mechanism should be established to provide financial resources for management actions. In addition to initial implementation costs, consideration should also be given to the type and extent of technical assistance needed to inspect and maintain structural SCMs. Funding is a key element of sustaining the management process, and once it is established, the plan can be fully vetted and restoration actions can move forward. A combination of grant funding, private donations, and municipal funding should be used to ensure implementation of the plan. Refer to Section 6.3 for a list of potential funding sources.
- **Determining Management Actions.** This plan provides a unified watershed management strategy with prioritized recommendations for restoration using a variety of methods. The proposed actions in this plan should be used as a starting point for grant proposals. Once a funding mechanism is established, designs for priority restoration actions on a project-area basis can be completed and their implementation scheduled. Refer to Section 5: Action Plan.
- **Continuing and Expanding the Community Participation Process.** Plan development has included active involvement of a diversity of watershed stakeholders. Plan implementation will require continued and ongoing participation of stakeholders, as well as additional outreach efforts to expand the circle of participation. Long-term community support and engagement is vital to successfully implement this plan. Continued public awareness and outreach campaigns will aid in securing this engagement. Refer to Section 4.3: Outreach and Education.
- **Continuing the Long-Term Monitoring Program.** A water quality monitoring program is necessary to track the health of surface waters in the watershed. Information from the monitoring program will provide feedback on the effectiveness of management practices. Refer to Section 6.4: Monitoring Plan.
- **Establishing Measurable Milestones.** A restoration schedule that includes milestones for measuring restoration actions and monitoring activities in the watershed is critical to the success of the plan. In addition to monitoring, several environmental, social, and programmatic indicators have been identified to measure plan progress. Refer to Section 6.5: Indicators to Measure Progress and Section 2.4: Water Quality Goal for interim milestones.

5 ACTION PLAN

5.1 ACTION PLAN

The Action Plan (Table 21) outlines responsible parties, approximate costs, an implementation schedule, and potential funding sources for each recommendation within the following major categories: (1) Watershed and Shoreline SCMs; (2) Road and Driveway Management; (3) Municipal Operations; (4) Municipal Land Use Planning and Zoning; (5) Land Conservation; (6) Septic System Management; and (7) Education and Outreach. Cost estimates for each recommendation will need to be adjusted based on further research and site design considerations. The plan is designed to be implemented from 2026-2035 and is flexible to allow for new priorities throughout the 10-year implementation period as additional data are acquired. Priority actions in the Action Plan were identified using estimated implementation costs and projected phosphorus load reduction benefits. Following discussion with the Steering Committee, adjustments were made to incorporate committee feedback and community priorities into the final list.

Table 21. Action plan for the Mascoma Lake watershed. See Section 6.3 for funding source abbreviations.

Priority Level	Category	Action Item	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
1	**Municipal Land Use Planning & Zoning**	Present WBMP recommendations to Select Boards, City Council, Conservation Commissions, and Planning Boards in Lebanon, Canaan, and Enfield. Discuss the connection between municipal land use planning and water quality in the Mascoma Watershed.	City of Lebanon (Conservation Commission), Town of Canaan, Town of Enfield, MLA	$1,000 2027	Grants (319, CWSRF)
2	**Municipal Land Use Planning & Zoning**	Meet with municipal staff to review recommendations to improve or develop ordinances addressing setbacks, buffers, lot coverage, low impact development, and open space.	City of Lebanon (Planning Dept., Conservation Commission), Town of Canaan, Town of Enfield, MLA	$10,000 2027	Municipal funds, Grants (319, CWSRF)
3	**Municipal Land Use Planning & Zoning**	Enhance performance standards for roads (unpaved and paved) less than 50 feet from a surface water throughout the watershed to prevent erosion and protect lake water quality. This would achieve **36% (30.6 kg/yr of 86 kg/yr of phosphorus) of Objective 1.**	City of Lebanon, Town of Canaan, Town of Enfield	TBD 2027	Municipal funds

Priority Level	Category	Action Item	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
4	**Municipal Land Use Planning & Zoning**	Stabilize banks around four culverts assessed as vulnerable. **Achieves 2% (1.4 kg/yr of 86 kg/yr of phosphorus) of Objective 1.**	Town of Enfield	TBD 2027	Municipal funds
5	**Septic System Management**	Distribute educational materials to property owners about septic system function and maintenance. There are 222 known shorefront septic systems that are older than 25 years. If these are updated based on awareness and education, it could reduce phosphorus load to the lake which achieves **26% (22.2 kg/yr of 86 kg/yr of phosphorus) of Objective 1.**	City of Lebanon, Towns of Canaan and Enfield, MLA	$3,000 2026, 2030, 2035	Municipal funds, Grants (319, CWSRF)
6	**Watershed and Shoreline SCMs**	Treat vulnerable shoreline sites (scoring ≥5) to reduce phosphorus load, targeting 50% of this group achieves **18% (15.2 kg/yr of 86 kg/yr of phosphorus) of Objective 1.**	MLA, City of Lebanon, Towns of Canaan and Enfield	TBD 2029-2031	Private landowners
7	**Watershed and Shoreline SCMs**	Complete design and construction of SCMs of the top two highest-ranked watershed survey sites. **Achieves 1% (1.0 kg/yr of 86 kg/yr of phosphorus) of Objective 1.**	MLA, City of Lebanon, Towns of Canaan and Enfield , private landowners and associations	$517,000 2027-2029	CWSRF, Grants (319, Moose Plate, NFWF 5-Star, ILFP), Municipal funds, private landowners
8	**Watershed and Shoreline SCMs**	Treat remaining vulnerable shoreline sites (scoring ≥5) to reduce phosphorus load, addressing the other 50% of this group achieves **18% (15.2 kg/yr of 86 kg/yr of phosphorus) of Objective 1.**	MLA, City of Lebanon, Towns of Canaan and Enfield	TBD 2027-2028	Private landowners
9	**Watershed and Shoreline SCMs**	Complete a field shoreline survey. Use results to target technical assistance for high-impact sites. Cost assumes consultant support for survey and data analysis.	MLA, City of Lebanon, Towns of Canaan and Enfield	$7,000 2027, 2030	Municipal funds, Grants (Moose Plate, CWSRF)

Priority Level	Category	Action Item	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
10	**Education and Outreach**	Create accessible (ADA-compliant) homeowner packets and digital materials tailored to shorefront owners, upstream residents near tributaries, recreational users, and short-term renters. Include: septic care, fertilizer-free landscaping/native plants, dirt-road erosion tips, invasive species prevention, and cyanobacteria/ALS risk awareness with safe-use guidance. Mail to shoreline owners in April; push digital versions via town/MLA site, social media, and QR codes at kiosks/launches.	MLA, Towns of Lebanon, Canaan, Enfield	$20,000 - $60,000 2027-2035	Municipal funds, Grants (319, CWSRF)
11	**Education and Outreach**	Post predictable, scheduled updates (content calendar) on WBMP progress, lake conditions, bloom advisories, LakeSmart, and events. Use a 'Did You Know?' series; ensure all text, captions, screen-reader compatibility. Track engagement and adjust topics accordingly.	MLA	no cost estimate 2027- 2035	Grants and volunteer time
12	**Education and Outreach**	Coordinate MLA, Conservation Commissions, NH LAKES, UVLT, and Mascoma River Local Advisory Committee/Greenway to co-host workshops and co-publish materials. Leverage the Upper Valley Lake Sunapee Regional Planning Commission to host resources and expand reach. Include youth/schools and the sailing team for hands-on stewardship.	Lebanon, Canaan, Enfield Conservation Commissions, MLA	TBD 2027- 2035	Municipal funds
13	**Septic System Management**	Look into whether any septic pumping companies would give a quantity discount or a discount to members to incentivize septic system pumping.	City of Lebanon, Towns of Canaan and Enfield	no cost estimate 2027- 2028	Volunteer time

Priority Level	Category	Action Item	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
14	**Municipal Land Use Planning & Zoning**	Incorporate WBMP recommendations into municipal Master Plans (Lebanon, Canaan, Enfield) and encourage regular review of the WBMP action plan. Adopt/strengthen zoning ordinance provisions and enforcement mechanisms: 1. to promote conservation subdivisions to allow development but also set aside land for conservation. 2. to establish a lake protection overlay zoning ordinance that prohibits activities causing erosion from sites in sensitive areas (e.g., lake shorefront, along lake tributaries, steep slopes); 3. to promote low impact development practices and reduce impervious areas; 4. to encourage stormwater regulations that align with MS4 permit requirements regardless of MS4 status; 5. to promote or require vegetative buffers around lake shore and tributary streams; 6. to require that replacement shorefront homes maintain or reduce existing nonconformities; and 7. to require shorefront seasonal to year-round conversions of homes to demonstrate no additional negative impacts to lake water quality. Refer to Table 19 for specific recommendations.	City of Lebanon, Towns of Canaan and Enfield	no cost estimate 2027- 2028	Municipal funds
15	**Municipal Land Use Planning & Zoning**	Increase municipal staff capacity through code enforcement/building inspectors to ensure compliance with stormwater and shoreland regulations.	City of Lebanon, Towns of Canaan and Enfield	TBD 2028 - 2035	Municipal funds

Priority Level	Category	Action Item	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
16	**Septic System Management**	Institute a minimum pump-out/inspection ordinance for shorefront septic systems (e.g., every 3–5 years). Pump-out cost (~$250) remains responsibility of owners. Enfield has a new ordinance that considers shorefront septic systems (2025). Their action item should focus on implementing and enforcing the rule.	City of Lebanon, Towns of Canaan and Enfield	no cost estimate 2028 -2031	Municipal funds, Grants (319)
17	**Septic System Management**	Enforce HB1113 requiring septic system inspections at time of property sale for waterfront properties within the protected shoreland zone.	Watershed municipalities	no cost estimate 2028 -2031	Municipal funds
18	**Watershed and Shoreline SCMs**	Complete design and construction of SCMs at the other three highest-ranked survey sites. Achieves **<1% (0.5 kg/yr of 86 kg/yr of phosphorus) of Objective 1.**	MLA, City of Lebanon, Towns of Canaan and Enfield, private landowners/associations	$584,000 2030 -2035	Grants (319, Moose Plate, NFWF 5-Star, ILFP, CWSRF), Town funds, private landowners
19	**Watershed and Shoreline SCMs**	Promote LakeSmart evaluations and certifications through NH Lakes to educate shoreline owners on lake-friendly practices (shoreline buffers, mowing height, avoiding lawns). Cost assumes coordination/materials for ~10 workshops.	MLA, NH Lakes, City of Lebanon, Towns of Canaan and Enfield	$5,000 2027 -2035	NH Lakes, NHDES, Grants (319, Moose Plate, CWSRF)
20	**Education and Outreach**	Provide checklists for homeowners to vet landscapers (no phosphorus fertilizer near water, buffer protection, native plants). Distribute to shoreline homeowner's associations, rental hosts (Airbnb/Vrbo), and lakefront businesses.	MLA	no cost estimate 2027- 2035	No applicable grants
21	**Watershed and Shoreline SCMs**	Work with NRCS to implement soil conservation practices such as stormwater control, manure storage, cover crops, no-till methods, timing of manure applications, and other agricultural SCMs which reduce erosion and nutrient pollution to surface waters from agricultural activities.	NRCS, Farm owners (Lebanon, Canaan, Enfield)	TBD 2026 - 2035	Grants, NRCS

Priority Level	Category	Action Item	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
22	**Land Conservation**	Inspect wetlands for Prime Wetland Designations and survey for vernal pools within the watershed. Provide support to Lebanon, Canaan, Enfield Conservation Commissions.	City of Lebanon, Towns of Canaan and Enfield, MLA, local land trusts	TBD 2028 -2030	Municipal funds
23	**Road and Driveway Management**	Review practices for road and drainage maintenance currently used by public and private entities/groups and determine areas for improvement. Enfield recently (2025) completed 50-60 manhole repairs and pipe lining. Refer to Table 15 and Table 16 for specific remediation areas of road drainage issues identified in Enfield and Lebanon.	City of Lebanon, Towns of Canaan and Enfield, MLA	TBD 2027	Town funds, Grants (Moose Plate, NFWF 5-Star, CWSRF)
24	**Education and Outreach**	Educate contractors and municipal staff about erosion and sediment control practices required in permits.	MLA, City of Lebanon, Towns of Canaan and Enfield	$6,000 2027 -2035	Municipal funds, Grants (319, CWSRF)
25	**Road and Driveway Management**	Work with Lebanon, Canaan, and Enfield Public Works to reduce salt usage on roads in sensitive watershed areas. Identify reduced-salt areas and promote low-salt strategies. Focus on municipal roads like Shaker Blvd and gravel roads (dust suppression with magnesium chloride). For Route 4A/Main St, recommend coordination with NHDOT.	City of Lebanon, Towns of Canaan and Enfield, NHDOT	no cost estimate 2027 -2030	Municipal funds
26	**Municipal Operations**	Review and update winter operations procedures to be consistent with Green SnowPro SCMs for winter road, parking lot, and sidewalk maintenance.	City of Lebanon, Towns of Canaan and Enfield (Public Works/Highway)	no cost estimate 2027 -2030	Municipal funds
27	**Road and Driveway Management**	Develop or update written protocols for municipal road maintenance. Incorporate water quality considerations into roadway evaluations and action plans.	City of Lebanon, Towns of Canaan and Enfield, MLA	$20,000 2028 -2030	Municipal funds, Grants (Moose Plate, NFWF 5-Star, CWSRF)

Priority Level	Category	Action Item	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
28	Road and Driveway Management	Hold informational workshops on proper road/driveway maintenance and winter practices. Provide homeowner education on salt/sand use for driveways/walkways. Cost assumes up to 5 workshops.	MLA, City of Lebanon, Towns of Canaan and Enfield, private landowners	$5,000-$10,000 2028, 2031	Municipal funds, Grants (Moose Plate, NFWF 5-Star, CWSRF), private landowners
29	Education and Outreach	Encourage private property and road owners to hire Green SnowPro certified commercial salt applicators.	MLA, City of Lebanon, Towns of Canaan and Enfield	no cost estimate 2028 -2035	Grants, Municipal funds
30	Road and Driveway Management	Continue training contractors and municipal staff on best practices for road maintenance. Host at least one workshop; consider joint workshops across Lebanon, Canaan, and Enfield for cost savings.	City of Lebanon, Towns of Canaan and Enfield, MLA	$15,000 2028 -2029	Municipal funds, Grants (Moose Plate, NFWF 5-Star, CWSRF)
31	Road and Driveway Management	Establish inspection and maintenance agreements for private unpaved roads. Assumes municipalities can support added oversight.	City of Lebanon, Towns of Canaan and Enfield, private landowners	no cost estimate 2030 -2035	Municipal funds, private landowners
32	Municipal Operations	Implement MS4 activities to improve stormwater management in watershed municipalities, regardless of MS4 designation. Include infrastructure mapping, erosion/sediment controls, illicit discharge programs, and good housekeeping practices (e.g., catch basin cleaning).	City of Lebanon, Towns of Canaan and Enfield (Public Works/Highway)	TBD 2030 -2035	Municipal funds
33	Municipal Operations	Develop best practice design standards for SCMs, including deep sump catch basins.	City of Lebanon, Towns of Canaan and Enfield (Public Works/Highway)	no cost estimate 2030 -2035	Municipal funds
34	Septic System Management	Evaluate locations of older and/or noncompliant septic systems (including cesspools or holding tanks) to identify clusters where conversion to community septic systems might be desirable.	MLA, City of Lebanon, Towns of Canaan and Enfield	TBD 2030 -2032	Grants (CWSRF), Municipal funds

Priority Level	Category	Action Item	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
35	**Land Conservation**	Update the existing natural resource inventories for Lebanon and Enfield and complete a natural resource inventory for Canaan.	City of Lebanon, Towns of Canaan and Enfield (Conservation Commissions), MLA	$25,000 2029 -2031	Municipal funds, Grants (NFWF NEFRG, CWSRF)
36	**Land Conservation**	Create a priority list of watershed areas that need protection once the natural resource inventories have been completed.	MLA, City of Lebanon, Towns of Canaan and Enfield Conservation Commissions, local land trusts (UVLT, etc.)	$10,000-$15,000 2031 -2035	Grants (NFWF NEFRG, NAWCA, CWSRF), Municipal funds
37	**Land Conservation**	Maximize conservation of intact forests and ecologically important properties through education, zoning, and private/public conservation programs.	MLA, City of Lebanon, Towns of Canaan and Enfield, UVLT, private landowners	TBD 2031 -2035	Grants (Moose Plate, LCHIP, RCPP, NAWCA, LWCF, ACEP, CSP, EQIP, NFWF NEFRG), Municipal funds, private landowners
38	**Land Conservation**	Enhance community education regarding private land conservation easements. Host workshops educating landowners on the benefits.	MLA, City of Lebanon, Towns of Canaan and Enfield Conservation Commissions, UVLT	TBD 2031 -2035	Grants (Moose Plate, LCHIP, RCPP, NAWCA, LWCF, ACEP, CSP, EQIP, NFWF NEFRG), Municipal funds, private landowners

Priority Level	Category	Action Item	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
39	**Land Conservation**	Identify potential conservation buyers and property owners interested in easements within the watershed. Use available funding mechanisms, such as the Regional Conservation Partnership Program (RCPP) and the Land and Community Heritage Investment Program (LCHIP), to provide conservation assistance to landowners.	MLA, City of Lebanon, Towns of Canaan and Enfield, UVLT, NRCS	no cost estimate 2031 -2035	Grants (Moose Plate, LCHIP, RCPP, NAWCA, LWCF, ACEP, CSP, EQIP)
40	**Education and Outreach**	Offer workshops for landowners with 10 acres or more for NRCS assistance with land conservation. Cost assumes up to two workshops.	MLA, NRCS	$5,000 2030 -2034	Grants (RCPP, ACEP, CSP, EQIP)
41	**Septic System Management**	Develop and maintain community-wide septic system inventory databases to facilitate enforcement of septic ordinances. Lebanon and Canaan should initiate new databases, while Enfield is already developing one (using NHDES records and town data through the Assessing and Health Offices).	City of Lebanon, Town of Canaan	$5,000 2031 -2035	Municipal funds, Grants (CWSRF)
42	**Septic System Management**	Conduct a septic system risk assessment to identify areas in the community which may be more susceptible to septic system malfunction due to high groundwaters, soil filtering capacity, risk of flooding, and age of infrastructure.	City of Lebanon, Towns of Canaan and Enfield	$15,000-$20,000 2031 -2035	Municipal funds
43	**Education and Outreach**	Add bloom signage and QR codes at boat launches/parks; train volunteers and Lake Hosts (from the Lake Host program) to communicate cyanobacteria precautions, clean-drain-dry, and pet safety.	MLA	$10,000 2027 -2035	Grants (NHDES AIPC)
44	**Education and Outreach**	Collaborate with NH Lakes on legislative or advocacy issues such as boat speed limits.	MLA, NH Lakes	no cost estimate 2027 -2035	Grants

Priority Level	Category	Action Item	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
45	**Road and Driveway Management**	Enhance the existing municipal street sweeping and catch basin maintenance program to further reduce salt and sediment entering local waterways. Lebanon has their own street sweepers and completes sweeping once a year. Enfield does not have street sweepers, NHDOT completes sweeping every other year. Consider increasing sweeping frequency on municipal paved roads, particularly during dry-weather periods between winter storms, when road salt and sand can be more easily collected.	City of Lebanon, Towns of Canaan and Enfield	TBD 2032 -2035	Municipal funds
46	**Education and Outreach**	Partner with the Mascoma River Greenway and Friends of the Northern Rail Trail to promote watershed-friendly recreation (bike/pedestrian trails, signage about stormwater impacts, pet waste, invasive species, cyanobacteria).	MLA, Mascoma River Greenway, local conservation commissions.	$10,000-$20,000 2027 -2030	Recreational Trails Program, Moose Plate, private donations.

5.2 POLLUTANT LOAD REDUCTIONS

To meet the water quality goal, Objective 1 set a target phosphorus load reduction of 86 kg/yr to achieve an average in-lake summer total phosphorus concentration 8.7 ppb and chlorophyll-*a* concentration of 2.5 ppb, which meets state water quality standards for oligotrophic waterbodies and is anticipated to reduce the risk of cyanobacteria blooms in Mascoma Lake. The following opportunities for phosphorus load reductions to achieve Objective 1 were identified in the watershed based on field and desktop analyses:

- The watershed survey conducted by VHB identified five sites impacting the lake. Remediating these sites could prevent up to 1.5 kg/yr of phosphorus from entering Mascoma Lake.
- Treating vulnerable shoreline sites (scoring ≥5) could reduce the phosphorus load to Mascoma Lake by 30.4 kg/yr [3] as identified through the shoreline vulnerability analysis.
- Upgrading the 222 known shorefront septic systems along Mascoma Lake (139) and Crystal Lake (83) that are older than 25 years is estimated to reduce the phosphorus load to Mascoma Lake by 22.2 kg/yr.
- Mitigating the impacts of unpaved and paved roads less than 50 feet from surface water throughout the watershed could prevent about 30.6 kg/yr [4] of phosphorus from entering to Mascoma Lake.
- Stabilizing the banks around culverts assessed as vulnerable in the watershed (n=4) could prevent about 1.4 kg/yr[5] of phosphorus from entering Mascoma Lake.

Addressing these field-identified phosphorus load reduction opportunities associated with the external watershed load (i.e., watershed and shoreline sites and septic systems) could reduce the phosphorus load to Mascoma Lake by 86 kg/yr, meeting 100 percent of the needed reductions to achieve Objective 1 (Table 22).

Objective 2 (preventing or offsetting additional phosphorus loading from anticipated new development) can be met through ordinance revisions that implement low impact development strategies, limit impervious cover, and encourage cluster development with open space protection and/or through conservation of key parcels of forested and/or open land.

It is important to note that, while the focus of the objectives for this plan is phosphorus, the treatment of stormwater and sediment erosion will result in the reduction of many other kinds of pollutants that may impact water quality. These pollutants would likely include other nutrients (e.g., nitrogen), petroleum products, bacteria, road salt/sand, excessive organic material (raking/blowing leaves and grass cuttings or

[3] Calculated from Region 5 Tool as bank stabilization. Fields selected include sandy loam, length of 100 feet, height of 3 feet, and moderate lateral recession rate of 0.1 foot per year.

[4] Calculated using the Region 5 Tool as gully stabilization. Fields selected include sandy loam, top width 1-foot, bottom width 0.5-foot, depth 0.25-foot, length = 50% of total length (45,643 feet), 5 years, 0.8 efficiency factor. Field verification of all the unpaved roads less than 50 feet from a surface water is needed to validate this load reduction value.

[5] Calculated using the Region 5 Tool as bank stabilization. Fields selected include sandy loam, two banks, each with a length of 10 feet, height 5 feet, Lateral recession rate 0.1 feet per year, and an efficiency factor of 0.8. Field verification of the four vulnerable culverts is needed to validate this load reduction value.

erosion from boat wakes), and heavy metals (cadmium, nickel, zinc, etc.). Without a monitoring program in place to measure these other pollutants, it will be difficult to track the success of efforts that reduce these other pollutants. However, there are various spreadsheet models available that can estimate reductions in these pollutants depending on the types of SCMs installed. These reductions can be tracked to help assess long-term response.

Table 22. Breakdown of phosphorus load sources and modeled water quality for current and target conditions that meet the water quality goal (Objective 1) for Mascoma Lake and that reflect all field identified reduction opportunities in the watershed. Reduction percentages are based on the current condition value for each parameter. kg/yr = kilograms per year. ppb = parts per billion.

Parameter	Unit	Current Condition	Target Condition	Reduction	Percent Change
Total phosphorus load (all sources) [3]	kg/yr	2,444	2,358	-86	-4%
(A) Background phosphorus load[1]	kg/yr	912	912	0	0%
(B) Disturbed (human) phosphorus load[2]	kg/yr	1,532	1,446	-86	-6%
(C) Developed land use phosphorus load	kg/yr	1,464	1,400	-64	-4%
(D) Septic system phosphorus load	kg/yr	47	25	22	-47%
(E) Internal phosphorus load	kg/yr	21	21	0	0%
In-lake total phosphorus*	ppb	9.0	8.7	-0.3	-4%
In-lake chlorophyll-*a**	ppb	2.6	2.5	-0.1	-5%
In-lake Secchi disk transparency*	meters	4.4	4.5	+0.1	2%
In-Lake Bloom Probability*	days	1	0	-1	-100%

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

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

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

** Water quality parameters were sourced from the model*

6 PLAN IMPLEMENTATION AND EVALUATION

The following section details the oversight and estimated costs (with funding strategy) needed to implement the action items recommended in the Action Plan (Section 5), as well as the monitoring plan and indicators to measure progress of plan implementation over time.

6.1 PLAN OVERSIGHT

The recommendations of this plan will be carried out by a diverse stakeholder group in the form of a dedicated committee, including representatives from MLA, municipalities (e.g., select boards, planning boards), conservation commissions, state and federal agencies or organizations, non-profits, land trusts, schools and community groups, local business leaders, and landowners. The committee will need to meet regularly and work collaboratively to coordinate resources across stakeholder groups to fund and implement the management actions. The Action Plan (Section 5) will need to be updated periodically (typically every 2, 5, and 10 years) to ensure progress and to incorporate any changes in watershed activities. Measurable milestones (e.g., number of SCM sites, volunteers, funding received, etc.) should be tracked by the committee.

The Action Plan (Section 5) identifies the stakeholder groups responsible for each action item. Generally, the following responsibilities are noted for each key stakeholder:

- MLA will conduct water quality monitoring, facilitate outreach activities and watershed stewardship, and raise funds for stewardship work.
- Municipalities will be responsible for establishing a dedicated committee and will work to address nonpoint source problems identified in the watershed, including conducting regular best practices maintenance on roads, adopting ordinances for water quality protection, and addressing other recommended actions specified in the Action Plan. Other stakeholder groups can work with each municipality to provide support in reviewing and tailoring the recommendations to fit the specific needs of each community.
- Conservation Commissions will work with municipal staff and boards to facilitate the implementation of the recommended actions specified in the Action Plan.
- NHDES can provide technical assistance, permit approval, and the opportunity for financial assistance through the EPA Section 319 of the Clean Water Act that supports the NHDES Watershed Assistance Grant Program and other funding programs.
- Private landowners will seek opportunities for increased awareness of water quality protection issues and initiatives and conduct activities in a manner that minimizes pollutant impacts to surface waters.

The success of this plan is dependent on the continued effort of volunteers and a strong and diverse committee that meets regularly to coordinate resources for implementation, review progress, and make any necessary adjustments to the plan to maintain relevant action items and interim milestones. A reduction in nutrient loading is challenging because there are many diffuse sources of phosphorus

reaching Mascoma Lake. Therefore, success requires an integrated and adaptive approach across many different parts of the watershed community.

6.2 ESTIMATED COSTS

The strategy for reducing pollutant loading to Mascoma Lake to meet the water quality goal and objectives set in Section 2.3 will be dependent on available funding and labor resources. It will include approaches that address sources of phosphorus loading, as well as water quality monitoring and education and outreach. Additional significant but difficult to quantify strategies for reducing phosphorus loading to the lake include revising local ordinances such as setting low impact development requirements on new construction, identifying and replacing malfunctioning septic systems, performing proper road maintenance, and improving agricultural practices (refer to Section 5: Action Plan for more details). With a dedicated stakeholder group in place and with the help of grants or local funding, it is possible to achieve the target phosphorus reductions and meet the established water quality goal for Mascoma Lake in the next 10 years. **The cost of successfully implementing the plan is estimated to be at least $1.3 to $1.5 million over the next 10 or more years** (Table 23). However, many costs are still unknown or were preliminarily estimated and should be updated as information becomes available. In addition, costs to private landowners (e.g., septic system upgrades, private road maintenance, etc.) are not fully reflected in the estimate.

Table 23. Estimated pollutant reduction for total phosphorus and estimated total and annual 10-year costs for implementation of the Action Plan to meet the water quality goal and objectives for Mascoma Lake. The light blue shaded planning actions are necessary to achieve the water quality goal. Other planning actions are important but difficult to quantify for total phosphorus reduction and costs. Costs are preliminarily estimates provided as general placeholders. kg/yr = kilograms per year.

Planning Action	Total Phosphorus Reduction *(kg/yr)*	Estimated Total Cost	Estimated Annual Cost
Watershed & Shoreline SCMs	**31.9**	$1,113,000	$111,300
Road Management	**30.6**	$40,000-$45,000	$4,000 - $4,500
Municipal Operations	**1.4** *(culvert stabilization)*	TBD	TBD
Municipal Land Use Planning & Zoning	(475)*	$11,000	$1,000
Land Conservation	*Included in land use planning & zoning*	$35,000 - $40,000	$3,500 - $4,000
Septic System Management	**22.2**	$23,000 - $28,000	$2,300 - $2,800
Education & Outreach	TBD	$41,000 - $81,000	$4,100 - $8,100
Monitoring	*NA*	$50,000 - $200,000	$5,000 - $20,000
Total	**86.1**	**$1,310,000 - $1,520,000**	**$131,000 - $152,000**

** Estimated increase in phosphorus load from new development in the next 10 years. Not included in total.*

6.3 FUNDING STRATEGY

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

Funding Options:

- EPA/NHDES 319 Grants (Watershed Assistance Grants**)** – Each year, EPA awards NHDES Section 319 Clean Water Act funding to support the New Hampshire Nonpoint Source Management Program. A portion of those funds are dedicated to Watershed Assistance Grants designed to support local initiatives to restore impaired waters (priorities identified in the Nonpoint Source Management Program Plan, updated 2025) and protect high quality waters. Watershed Assistance grants are only available for the implementation of watershed-based plans and provide partial funding in the range of $50,000 to $150,000 to support full project budgets and implementation efforts that typically last two years.
- NHDES Cyanobacteria Mitigation Fund – The Cyanobacteria Mitigation Fund was established by the New Hampshire legislature in 2023 to help defray the costs of implementing nutrient control practices aimed at reducing chronic and extended cyanobacteria blooms. Municipalities, community water systems, and non-profit lake and river watershed associations are eligible to apply for Cyanobacteria Mitigation Fund assistance. Funding supports projects that implement strategies outlined in watershed management or lake protection plans, with the goal of improving water quality and mitigating harmful algal blooms. Applicants should refer to Administrative Rule Env-Wq 2300 for eligibility requirements and application procedures.
- NH State Conservation Committee Grant Program (Moose Plate Grants) – County Conservation Districts, municipalities (including commissions engaged in conservation programs), and qualified non-profit organizations are eligible to apply for the State Conservation Committee grant program. Projects must qualify in one of the following categories: Water Quality and Quantity; Wildlife Habitat; Soil Conservation and Flooding; SCMs; Conservation Planning; and Land Conservation. The total State Conservation Committee grant request per application cannot exceed $40,000.
- Land and Community Heritage Investment Program (LCHIP) **–** This grant provides matching funds to help municipalities and non-profits protect the state's natural, historical, and cultural resources.
- Aquatic Resource Mitigation Fund **–** This grant provides funds for projects that protect, restore, or enhance wetlands and streams to compensate for impacted aquatic resources. The fund is managed by the NHDES Wetlands Bureau that oversees the state ILFP compensatory mitigation program. A permittee can make a payment to NHDES to mitigate or offset losses to natural resources because of a project's impact to the environment.

- National Fish and Wildlife Foundation Northeast Forest and River Fund (NFWF NEFRG) – This grant awards $50,000 to $200,000 to projects that restore and sustain healthy forests and rivers through habitat restoration, fish barrier removal, and stream connectivity such as culvert upgrades.
- Aquatic Invasive Plant Control, Prevention and Research Grants (NHDES AIPC) – Funds are available each year for projects that prevent new infestations of exotic plants, including outreach, education, Lake Host Programs, and other activities.
- Clean Water State Revolving Fund (NHDES CWSRF) – This fund provides low-interest loans to communities, non-profits, 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 pollution prevention, watershed protection and restoration, and estuary management projects that help improve and protect water quality in NH. The City of Lebanon secured a CWSRF Stormwater Planning Loan to develop this WBMP. While CWSRF implementation loans are available, they are more limited in scope; interested parties should consult with NHDES staff to explore potential opportunities.
- Regional Conservation Partnership Program (RCPP) – This NRCS grant provides conservation assistance to producers and landowners for projects carried out on agricultural land or non-industrial private forest land to achieve conservation benefits and address natural resource challenges. Eligible activities include land management restoration practices, entity-held easements, and public works/watershed conservation activities.
- Agricultural Conservation Easement Program (ACEP) – This NRCS grant protects the agricultural viability and related conservation values of eligible land by limiting nonagricultural uses which negatively affect agricultural uses and conservation values, protect grazing uses and related conservation values by restoring or conserving eligible grazing land, and protecting, restoring, and enhancing wetlands on eligible land. Eligible applicants include private landowners of agricultural land, cropland, rangeland, grassland, pastureland, and non-industrial private forestland.
- Conservation Stewardship Program (CSP) – This NRCS grant helps agricultural producers maintain and improve their existing conservation systems and adopt additional conservation activities to address priority resource concerns. Eligible lands include private agricultural lands, non-industrial private forestland, farmstead, and associated agricultural lands, and public land that is under control of the applicant.
- Environmental Quality Incentives Program (EQIP) – This NRCS grant provides financial and technical assistance to agricultural producers and non-industrial forest managers to address natural resource concerns and deliver environmental benefits. Eligible applicants include agricultural producers, owners of non-industrial private forestland, water management entities, etc.
- National Fish and Wildlife Federation Five Star and Urban Waters Restoration Grants (NFWF 5-Star) – Grants seek to address water quality issues in priority watersheds, such as erosion due to unstable streambanks, pollution from stormwater runoff, and degraded shorelines caused by development. Eligible projects include wetland, riparian, in-stream and/or coastal habitat restoration; design and construction of green infrastructure SCMs; water quality monitoring/assessment; outreach and education.

- North American Wetlands Conservation Act (NAWCA) Grants – The U.S. Standard Grants Program is a competitive, matching grants program that supports public-private partnerships carrying out projects in the United States that further the goals of the NAWCA. These projects involve long-term protection, restoration, and/or enhancement of wetlands and associated uplands habitats for the benefit of all wetlands-associated migratory birds.
- National Park Service - Land and Water Conservation Fund Grant Program (LWCF) – Eligible projects include acquisition of parkland or conservation land; creation of new parks; renovations to existing parks; and development of trails. Municipalities must have an up-to-date Open Space and Recreation Plan. Trails constructed using grant funds must be ADA-compliant.

6.4 MONITORING PLAN

A long-term water quality monitoring plan is critical for evaluating the effectiveness of implementation efforts over time. Building on the historic data summarized in this report, the following monitoring efforts are recommended to be conducted by MLA as feasible.

- Continue to monitor the two deep spots on Mascoma Lake (MASENF2D and MASENF1D) for all parameters included in the NHDES VLAP protocol. This includes sampling three to five times per summer (June-September or October) for at least total phosphorus (epilimnion, metalimnion, and hypolimnion), chlorophyll-*a* (composite or epilimnion), Secchi disk transparency, and dissolved oxygen-temperature profiles to the lake bottom.
    - Ensure that dissolved oxygen-temperature profiles are collected concurrently with sampling of lake deep spot stations and consider collecting profiles at a higher frequency (e.g., every two weeks from May-October).
    - Consider adding total nitrogen and nitrogen species (total dissolved nitrogen, nitrate-nitrite, and ammonium) to routine lake sampling. Given the NHDES-listed impairment for the cyanotoxin microcystin, epilimnetic total nitrogen could also be sampled, as a rigorous 50-lake survey by the University of New Hampshire found total nitrogen to be the single most closely correlated parameter to microcystin concentrations, more closely correlated than total phosphorus or chlorophyll-*a* (Haney & Ikawa, 2001).
    - Consider increasing the frequency of discrete depth samples for total phosphorus analysis during monthly sampling each year to better assess the internal phosphorus loading at the deep spots.
- Continue to monitor the lake for cyanobacteria blooms and alert NHDES immediately. Coordinate with NHDES to collect samples for analysis.
- Monitor total phosphorus and flow (as well as specific conductance, chloride, temperature, and/or turbidity, if able) at major tributary inflows to Mascoma Lake, at least two to five times per year each summer, specifically targeting wet and dry weather conditions.
- Consider collecting monthly samples for the speciation and enumeration of phytoplankton and zooplankton in the water column.

6.5 INDICATORS TO MEASURE PROGRESS

The following environmental, programmatic, and social indicators and associated numeric targets (milestones) will help to quantitatively measure the progress of this plan in meeting the established goal

and objectives for the Mascoma Lake watershed (Table 24). These benchmarks represent short-term (2028), mid-term (2030), and long-term (2035) targets derived directly from actions identified in the Action Plan (Section 5). Setting milestones allows for periodic updates to the plan, maintains and sustains the action items, and makes the plan relevant to ongoing activities. The committee should review the milestones for each indicator on an ongoing basis to determine if progress is being made and then determine if the plan needs to be updated to reach the water quality goal.

Environmental Indicators are a direct measure of environmental conditions. They are measurable quantities used to evaluate the relationship between pollutant sources and environmental conditions. They assume that recommendations outlined in the Action Plan (Section 5) will be implemented accordingly and will result in water quality improvement. Programmatic indicators are indirect measures of watershed protection and restoration activities that help to achieve the water quality goal. Social Indicators measure changes in social or cultural practices and behavior that lead to implementation of management measures and water quality improvement.

Table 24. Environmental, programmatic, and social indicators for the Mascoma Lake WBMP. Milestones are cumulative starting at year 1. * Indicators particularly relevant to assessing progress toward achieving the water quality goal and objectives. ppb = parts per billion.

ENVIRONMENTAL INDICATORS

Indicator	2028	2030	2035
Achieve an average summer deep spot epilimnion total phosphorus concentration of 8.7 ppb at the primary deep spot station in Mascoma Lake.	<8.9 ppb	<8.8 ppb	<8.7 ppb
Reduce the occurrence of cyanobacteria or algal blooms in Mascoma Lake (milestones based on observed data from 2024).*	6 days per year	3 days per year	0 days per year
Achieve an average summer water clarity of 4.6 meters or deeper at the primary deep spot station in Mascoma Lake.	4.5 meters+	4.5 meters+	4.6 meters+
Prevent and/or control the introduction and/or proliferation of invasive aquatic species across all watershed waterbodies.	Invasives Controlled	Invasives Controlled	Invasives Controlled

PROGRAMMATIC INDICATORS

Indicator	2028	2030	2035
Amount of funding secured from municipal/private work, fundraisers, donations, and grants.	$270,000	$900,000	$1,800,000
Number of nonpoint source pollution sites remediated (five identified). *	1	3	5
Percentage of shorefront properties with LakeSmart certification.*	25%	45%	65%

Indicator	2028	2030	2035
Number of watershed/shoreline properties receiving technical assistance visits**	25	50	100
Number of workshops and trainings for stormwater improvements to residential properties (e.g., NH LAKES program).	1	2	5
Number of updated or new ordinances that target water quality protection.	2	5	10
Number of new municipal staff for inspections and enforcement of regulations.	1	1	2
Number of voluntary or required septic system inspections (seasonal conversion and property transfer).	5	10	25
Number of septic system upgrades.*	10	50	100
Number of informational workshops and/or trainings for landowners, municipal staff, and/or developers/landscapers on local ordinances, watershed goals, and/or best practices for road management and winter maintenance.	2	5	10
Number of parcels with new conservation easements or number of parcels put into permanent conservation.	1	2	5
Number of copies of watershed-based educational materials distributed or articles published (including social media posts).	200	500	1,000
Number of new best practices for road management and winter maintenance implemented on public and private roads by the municipalities.	2	5	10
Number of municipalities fully implementing key aspects of the MS4 program regardless of MS4 status.	1	2	3
Number of meetings and/or presentations to municipal staff and/or boards related to the WBMP.	4	12	30
Number of Comprehensive Nutrient Management Plans completed or NRCS technical assistance provided for farms in the watershed.	1	2	3

SOCIAL INDICATORS

Indicators	2028	2030	2035
Number of new MLA members.	20	50	75
Number of volunteers participating in educational campaigns.	5	10	25
Number of people participating in informational meetings, workshops, trainings, SCM demonstrations, or group septic system pumping.	25	50	100

Number of watershed residents installing conservation practices on their property and/or participating in LakeSmart.	25	50	100
Number of Public Works staff receiving Green SnowPro training.	1	3	5
Number of groups or individuals contributing funds for plan implementation.	25	50	100
Number of newly trained water quality and invasive species monitors.	2	4	6
Percentage of residents making voluntary upgrades or maintenance to their septic systems (with or without free technical assistance), particularly those identified as needing upgrades or maintenance.	10%	25%	50%
Number of farmers working with NRCS or GCCD.	1	2	3
Number of daily visitors to the MLA website.	10	25	50

ADDITIONAL RESOURCES

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

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

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

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

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

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

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

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

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

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

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

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

NHDES Road Salt Reduction. New Hampshire Department of Environmental Services.

NRCS *Field Office Technical Guide* for NH to provide information regarding agricultural BMPs

Protecting water resources and managing stormwater. University of New Hampshire, Cooperative Extension & Stormwater Center. March 2010.

NHDES Fact Sheets

Cyanobacteria in New Hampshire Waters. *WD-WMB-10, 2023*.

Erosion Control for Construction within the Protected Shoreland. SP-1, 2020.

Lake Eutrophication. WD-BB-3, 2019.

Lawn Care within the Protected Shoreland. SP-2, 2020.

New Hampshire Fish Consumption Guidelines. ARD-EHP-25, 2021.

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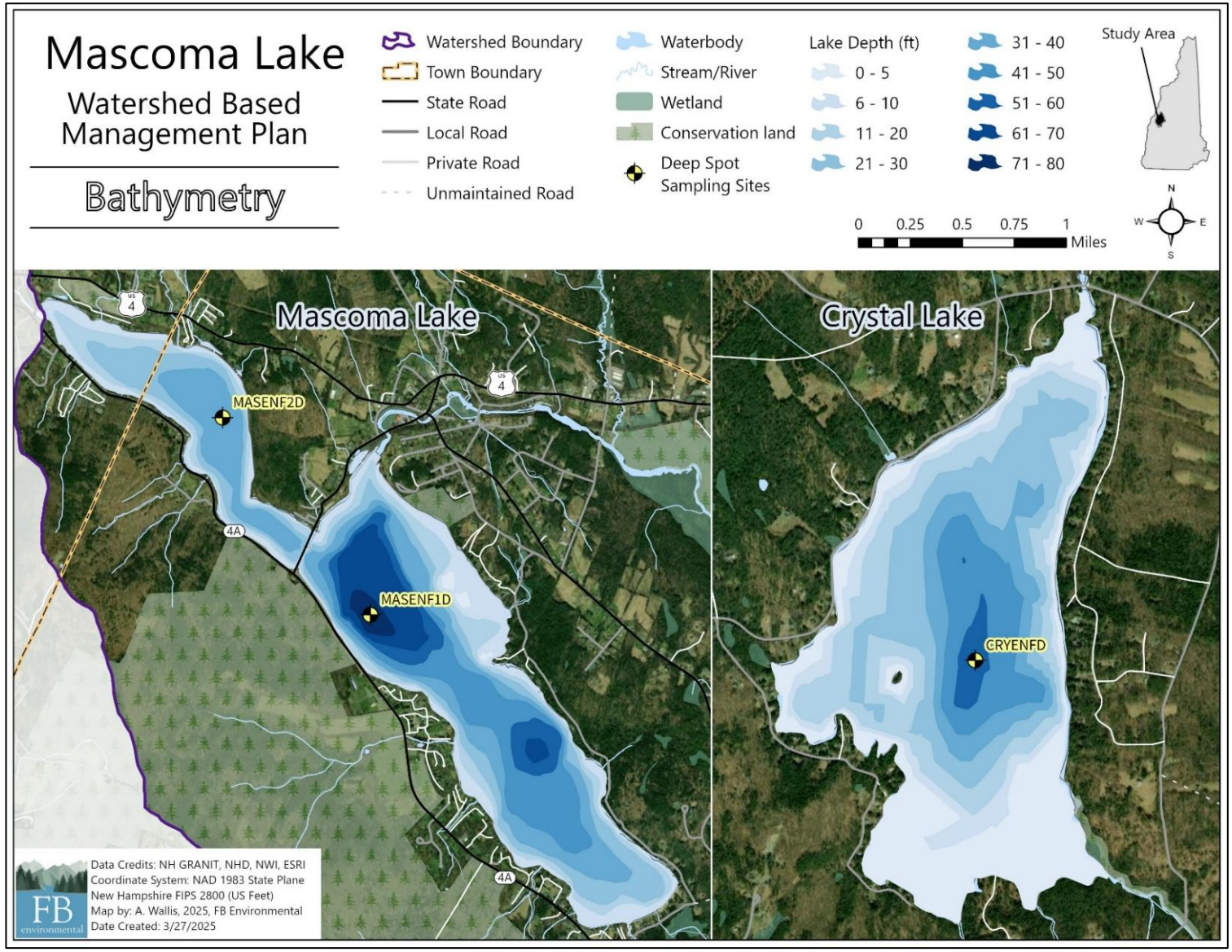
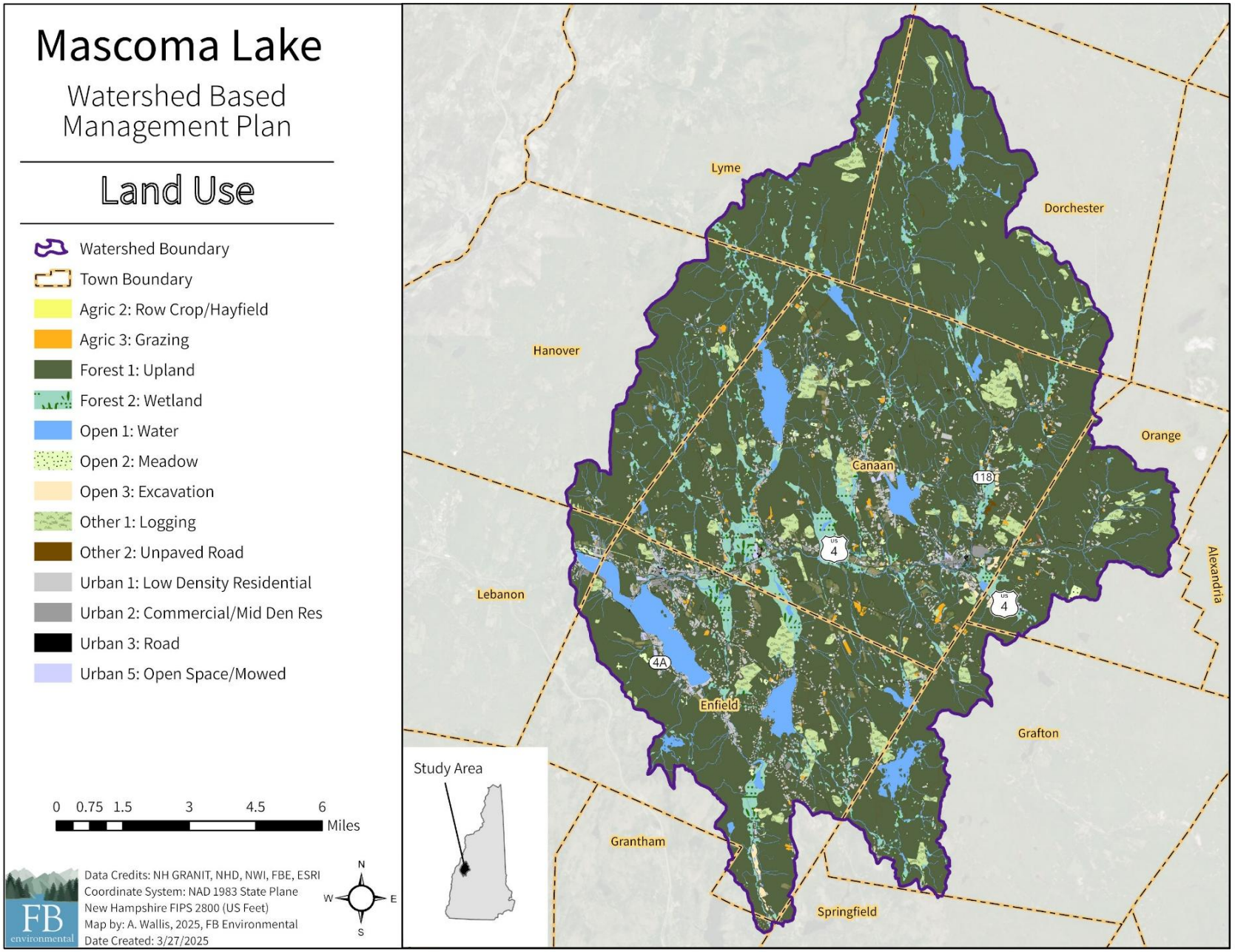
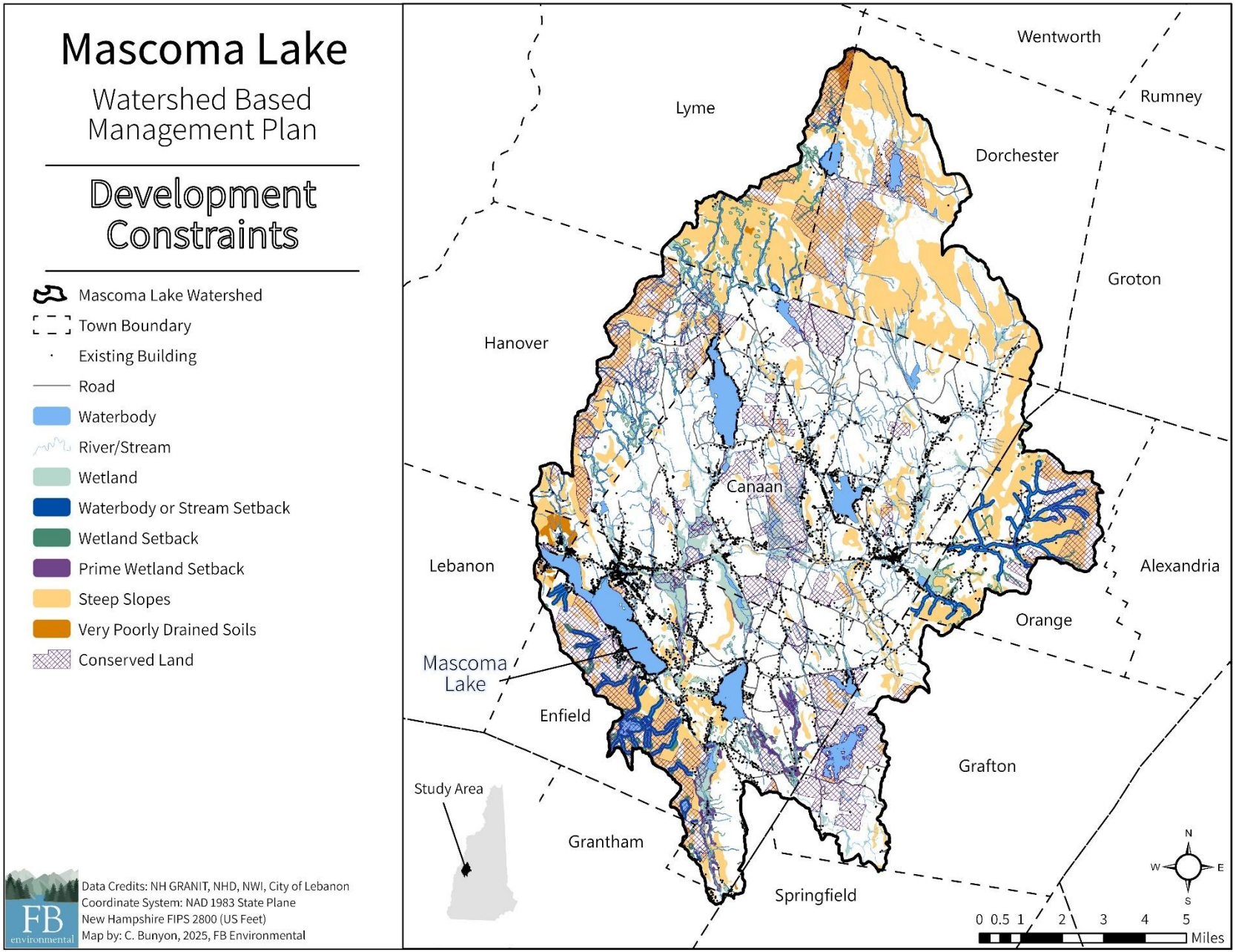
APPENDIX A: SUPPORTING MAPS



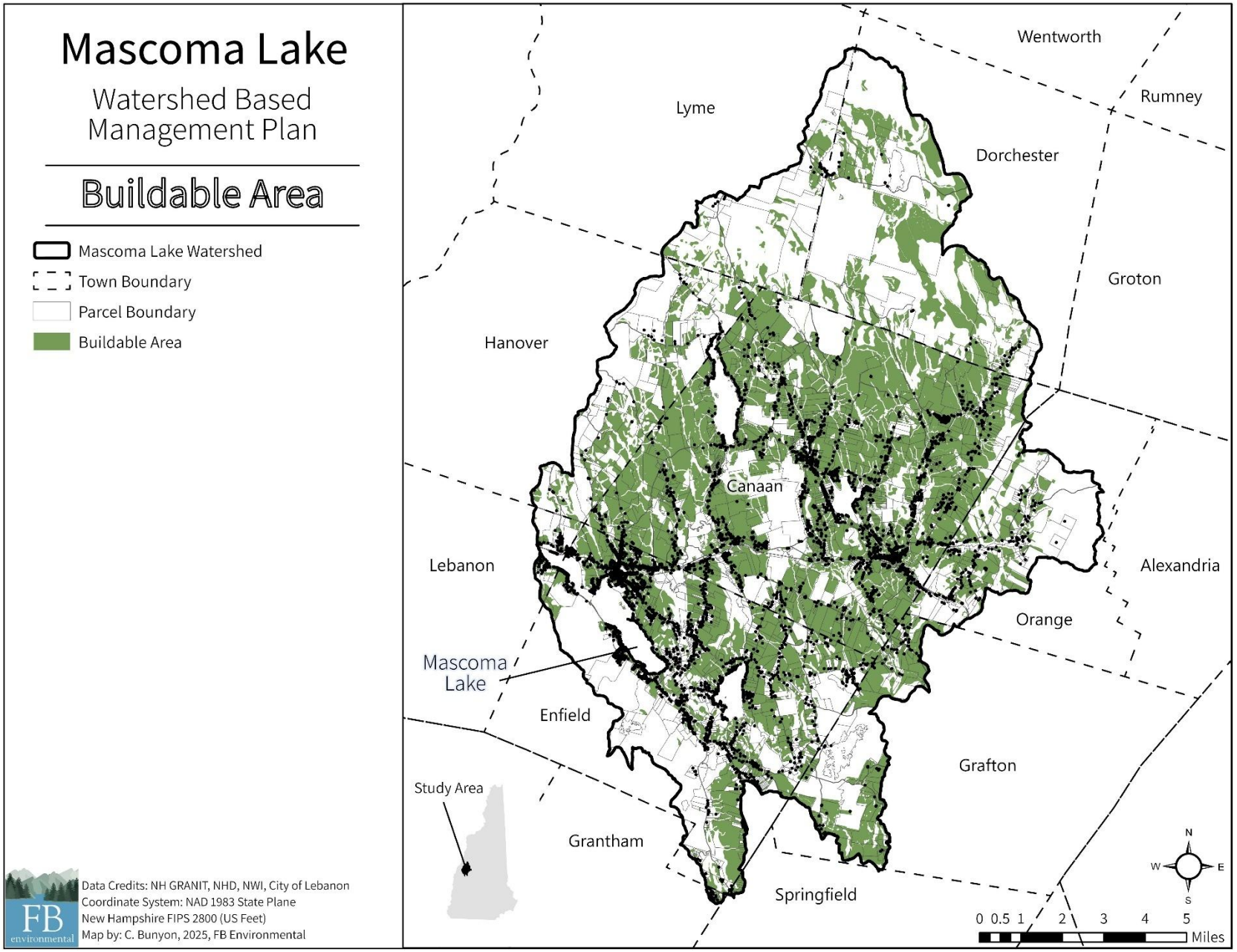
Map A-1. Bathymetry as 10-foot depth contours for Mascoma Lake and 5-foot depth contours for Crystal Lake.



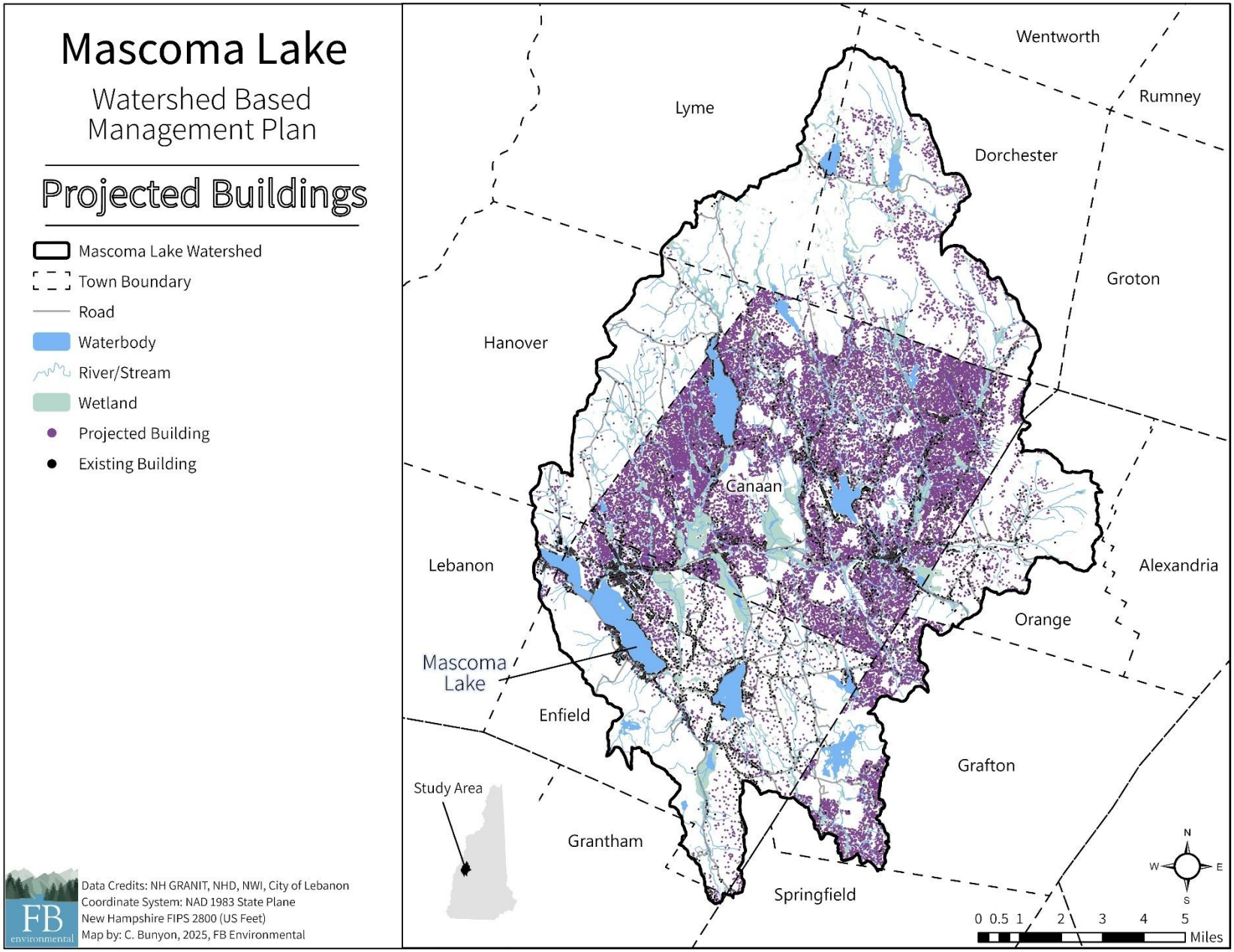
Map A-2. Land cover for the Mascoma Lake watershed.



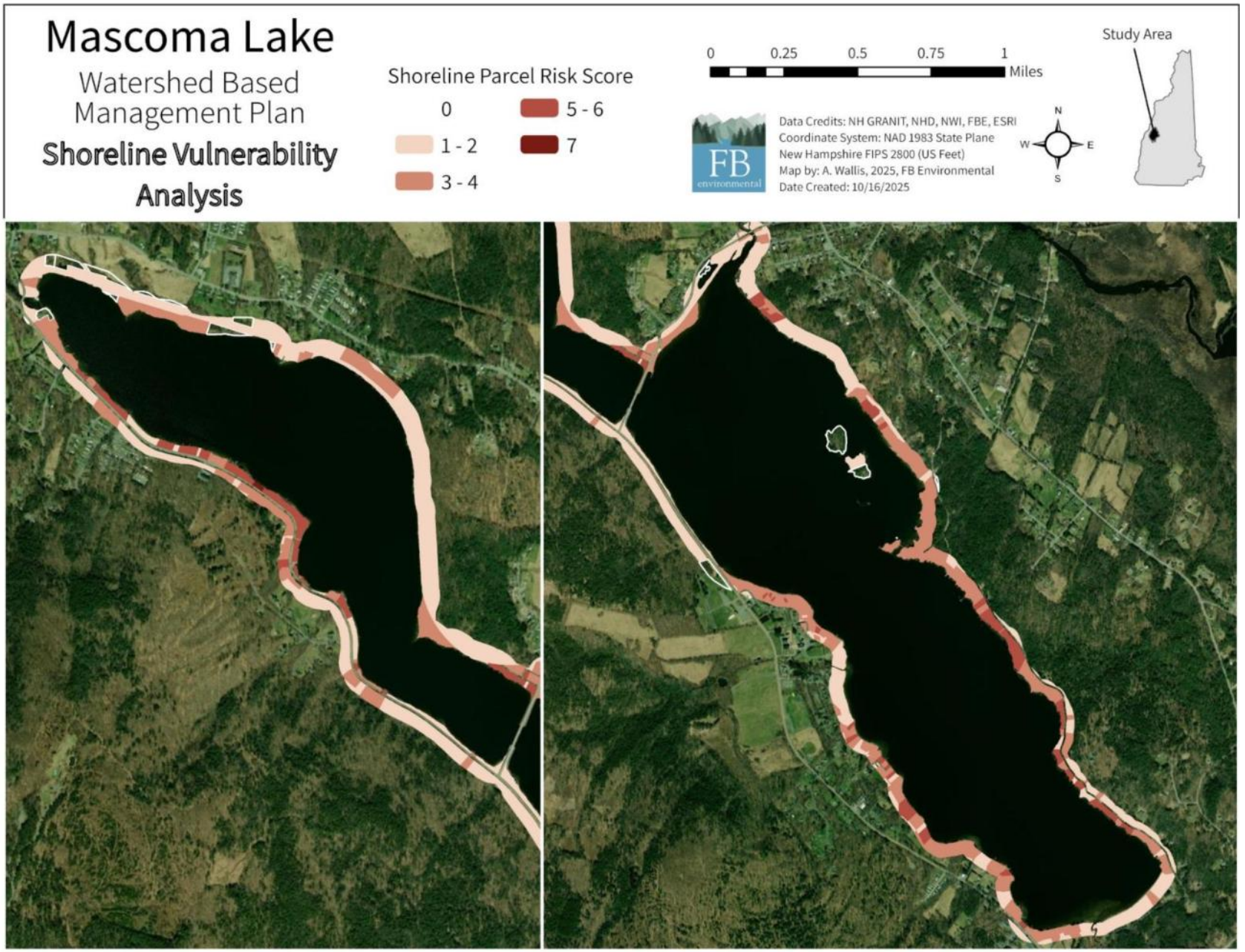
Map A-3. Development constraints in the Mascoma Lake watershed.



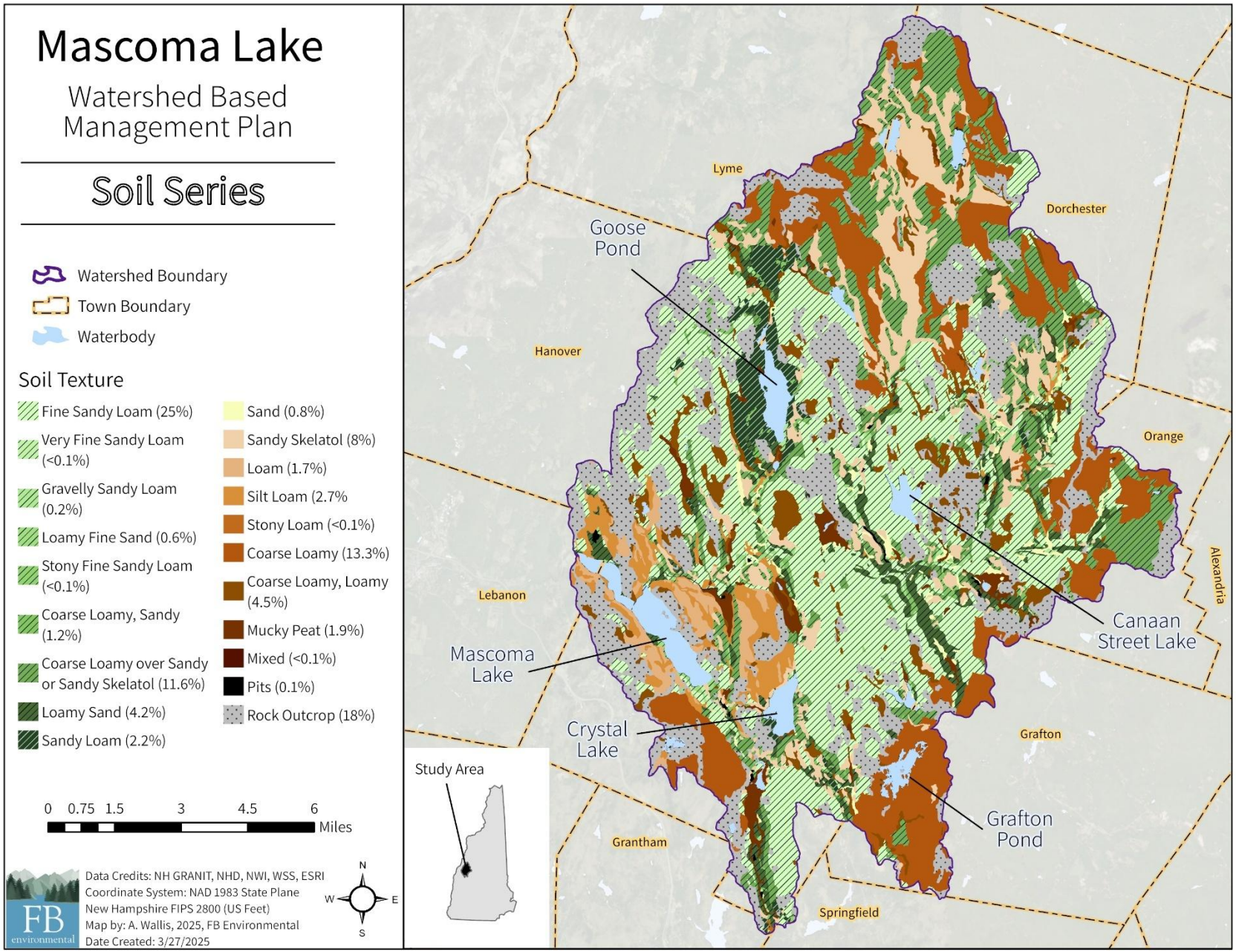
Map A-4. Buildable area in the Mascoma Lake watershed.



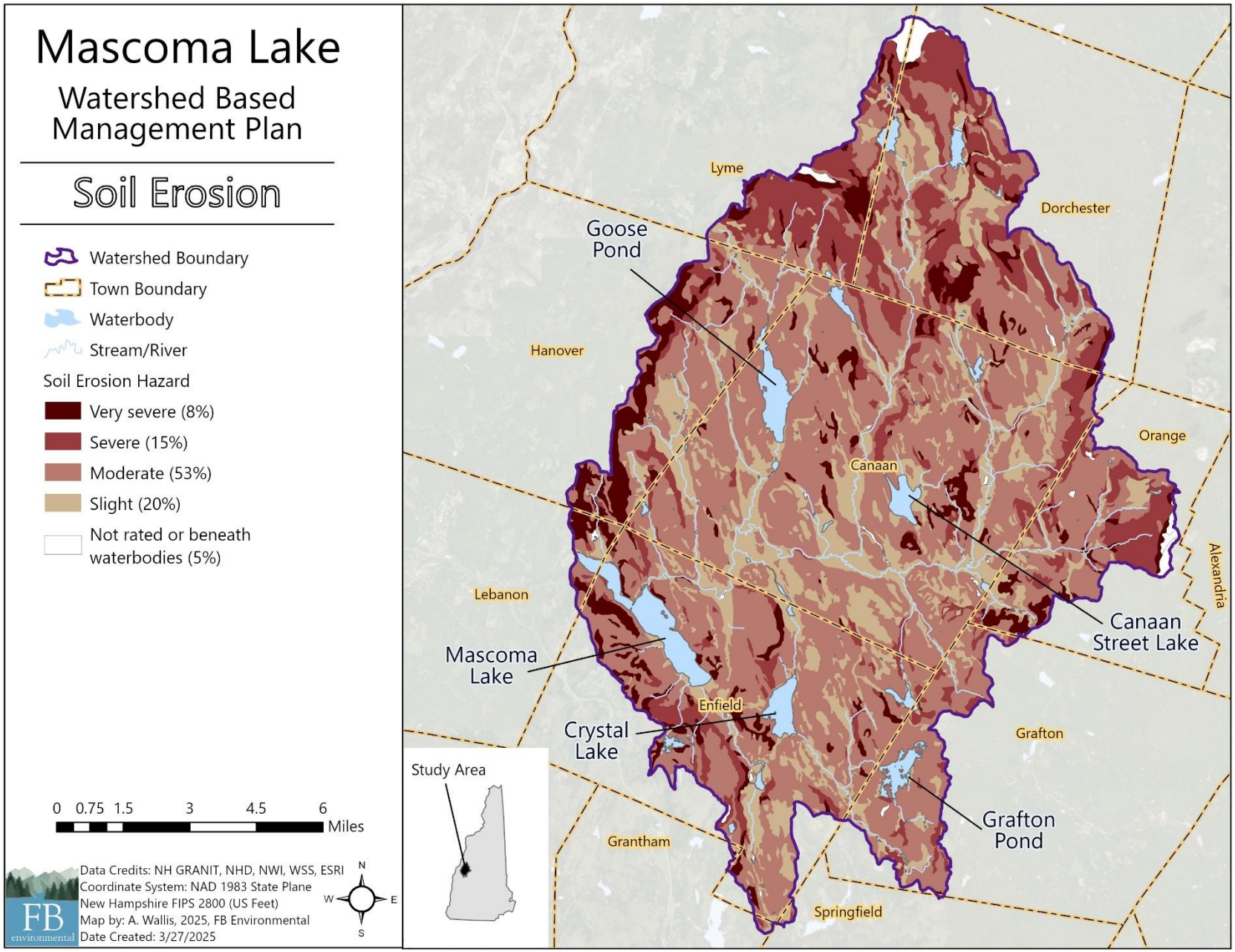
Map A-5. Projected buildings in the Mascoma Lake watershed.



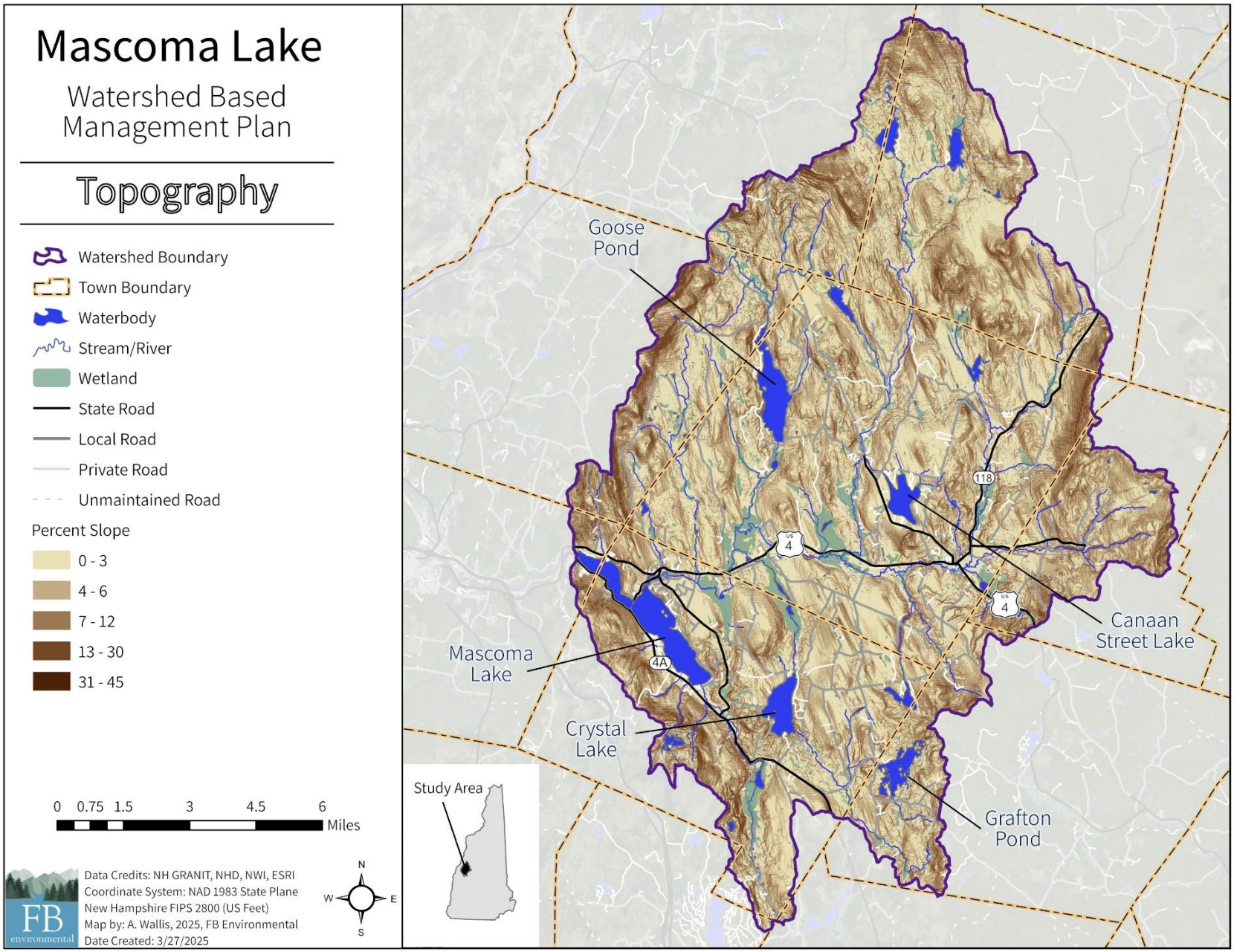
Map A-6. Map of the Shoreline Vulnerability Score for the shoreline zone (land within 250 feet of the shoreline) for Mascoma Lake.



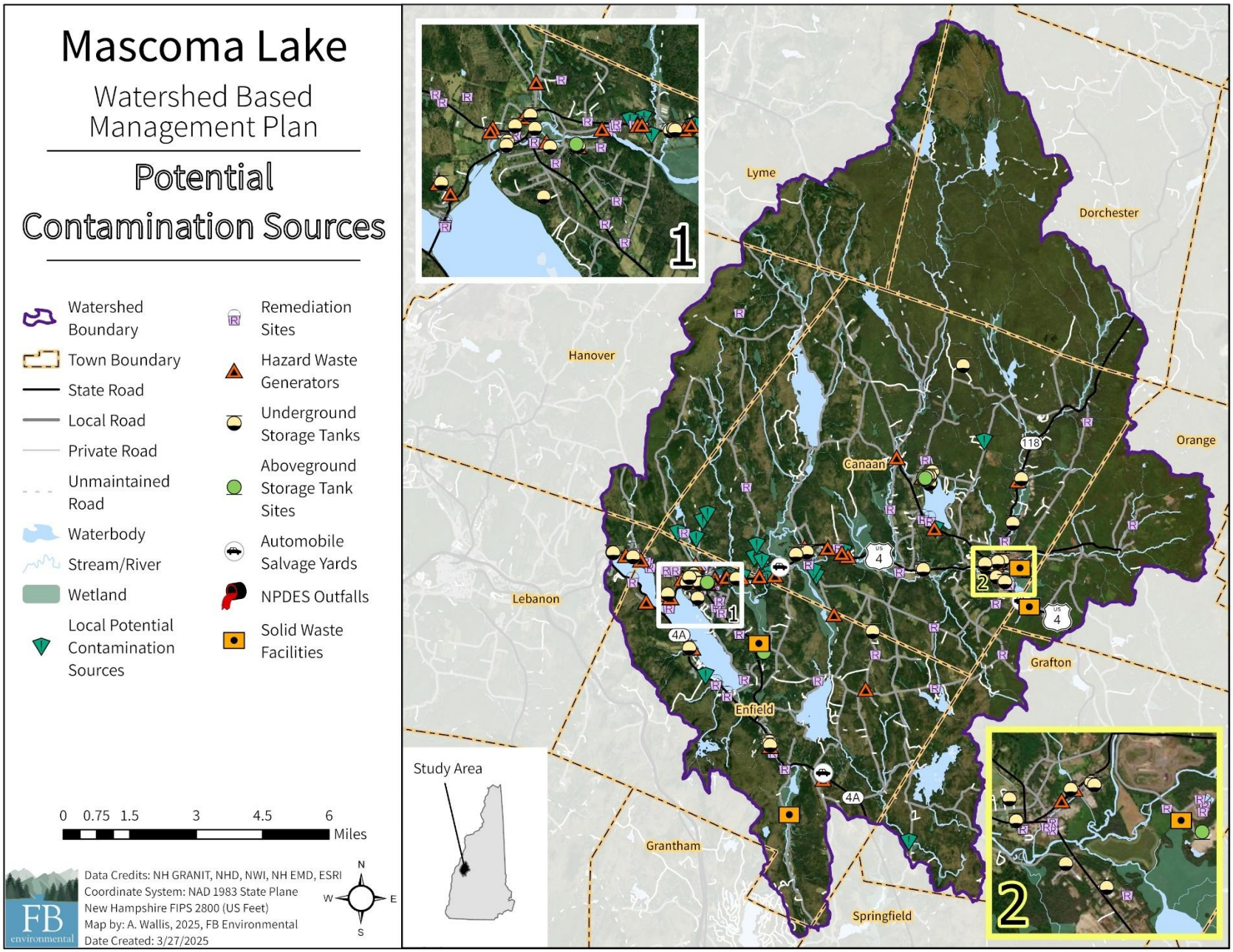
Map A-7. Soil series in the Mascoma Lake watershed.



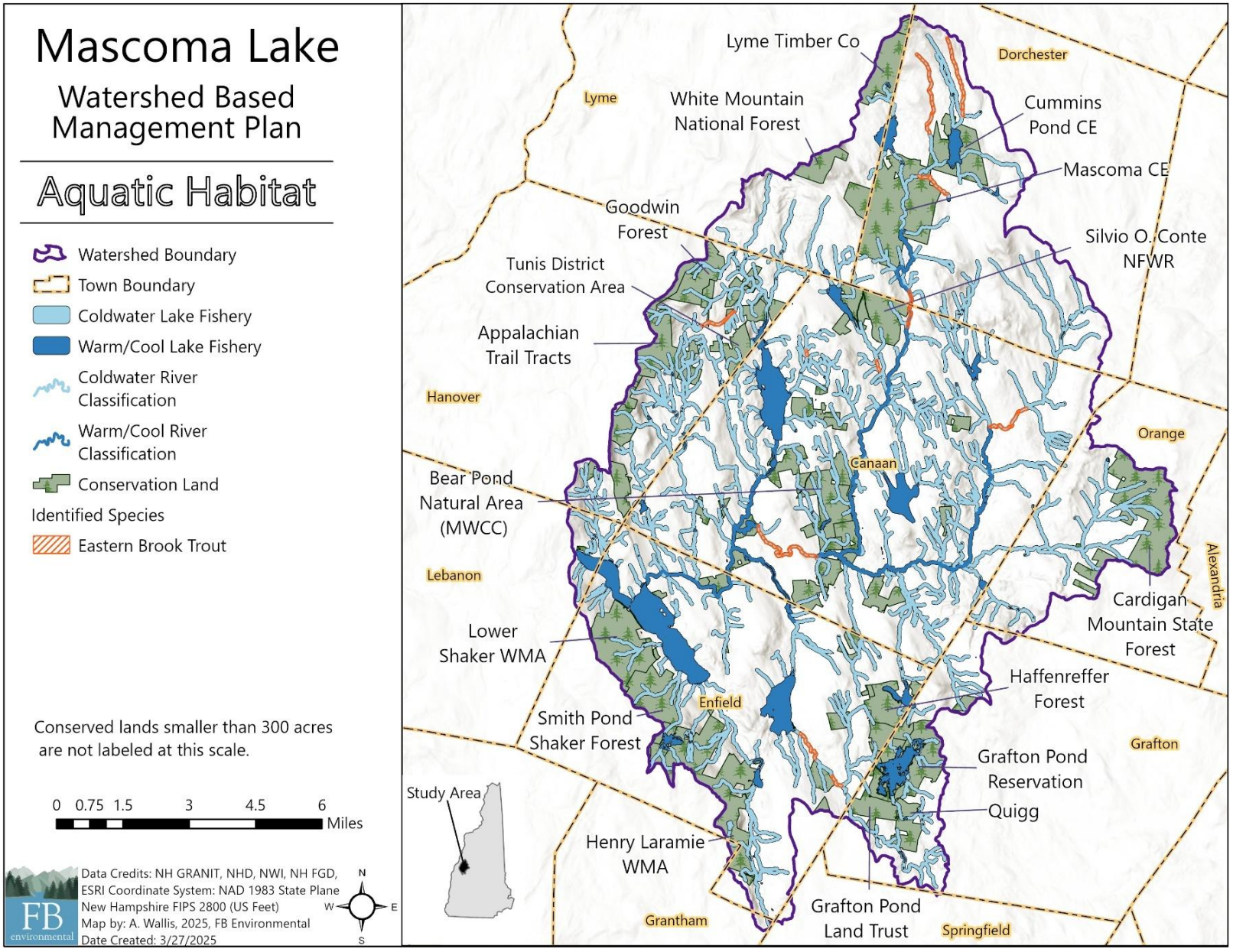
Map A-8. Soil erosion hazard in the Mascoma Lake watershed.



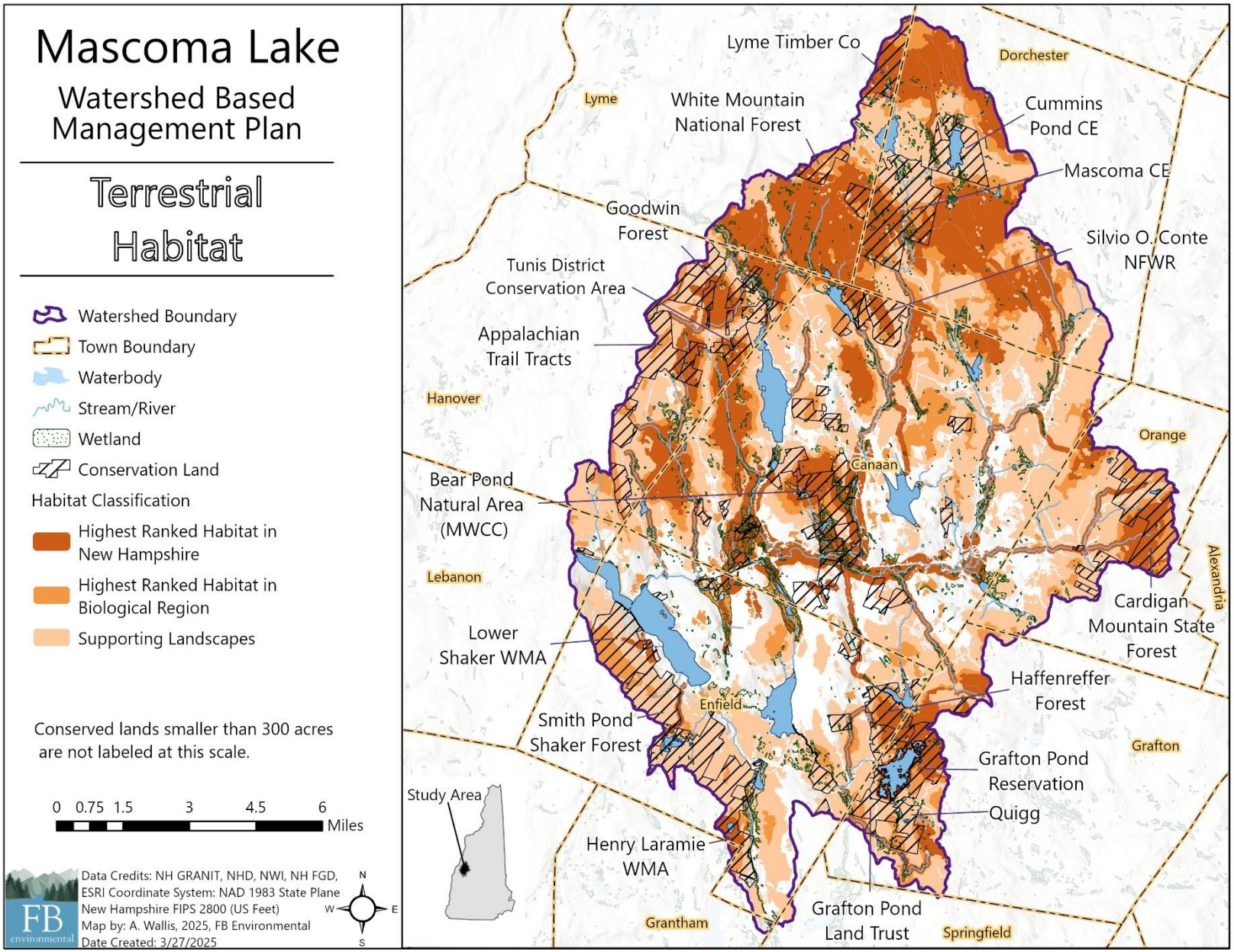
Map A-9. Topography of the Mascoma Lake watershed.



Map A-10. Potential sources of contamination in the Mascoma Lake watershed.



Map A-11. Conservation land and aquatic High Value Habitat according to the 2025 New Hampshire Wildlife Action Plan in the Mascoma Lake watershed.



Map A-12. Conservation land and terrestrial High Value Habitat according to the 2025 New Hampshire Wildlife Action Plan in the Mascoma Lake watershed.

APPENDIX B: ENGINEERING DESIGNS SCM MATRIX

Table B-1. Site name, sheet reference, ranking, impervious area draining to SCM, runoff depth assumption, impervious phosphorus (P) load to SCM, P removal efficiency of SCM, P load removed by SCM, EPA water quality curve used, and estimated implementation cost for the five sites identified in the direct Mascoma Lake watershed. Pollutant load reductions and cost estimates are preliminary and are for planning purposes only. There may be additional costs associated with engineering design and construction, and thus actual costs could be highly variable. These costs do not include pre-design, contingencies, or inflation. kg/yr = kilograms per year.

Site Name	Sheet Reference	Ranking	Impervious Area Draining to SCM *(square feet)*	Runoff Depth *(inches)*	Impervious P Load to SCM *(kg/yr)*	SCM P Removal Efficiency *(%)*	P Load Removed by SCM *(kg/yr)*	EPA Water Quality Curve	Cost
Huse Park Subsurface	C-1	1	37,870	1	0.68	98%	0.68	Infiltration Trench	$314,000
Huse Park Infiltration	C-2	5	2,231	0.9	0.045	100%	0.045	Infiltration Trench	$60,000
Bank Bio-filtration	C-3	3	23,671	1	0.545	52%	0.227	Bio-filtration	$295,000
Library Subsurface	C-4	2	20,856	1	0.41	98%	0.363	Infiltration Trench	$203,000
Shakoma Beach	C-5	4	Not applicable	Not applicable	Not applicable	Not applicable	0.186	EPA Region 5: Gully Erosion	$229,000

Total phosphorus load removed by SCM: 1.501 kg/yr

Total cost: $1,101,000

APPENDIX C: SCM CONCEPTUAL SITE PLANS

General Notes and Limitations

1. THE PURPOSE OF THESE PLANS IS TO PROVIDE CONCEPTUAL SIZING AND LOCATION INFORMATION FOR THE PROPOSED DESIGN OF STRUCTURAL STORMWATER TREATMENT PRACTICES AND ASSOCIATED POTENTIAL POLLUTANT REDUCTIONS IN SUPPORT OF THE MASCOMA LAKE WATERSHED MANAGMENT PLAN. ALL INFORMATION CONTAINED HEREIN SHALL BE CONSIDERED DRAFT FOR PLANNING PURPOSES ONLY.
2. TOPOGRAPHIC AND UTILITY INFORMATION SHOWN ON THIS PLAN IS BASED ON PUBLICLY AVAILABLE LIDAR AND GIS DATA. THIS INFORMATION IS APPROXIMATE AND MAY NOT REFLECT ACTUAL FIELD CONDITIONS. VHB HAS NOT PERFORMED A FIELD SURVEY TO VERIFY ACTUAL CONDITIONS.
3. A LOCAL DATUM WAS UTILIZED IN REFERENCED PLANS AND ADJUSTED TO NAVD88 BY VHB.

Reference Plans

1. "HUSE PARK ENFIELD NH 03748 EXISTING CONDITIONS PLAN" DATED JULY 2010, PREPARED BY CLD CONSULTING ENGINEERS, ON FILE WITH THE TOWN OF ENFIELD PUBLIC WORKS DEPARTMENT.
2. "STORM DRAIN PLAN" DATED JULY 2010, PREPARED BY CLD CONSULTING ENGINEERS, ON FILE WITH THE TOWN OF ENFIELD PUBLIC WORKS DEPARTMENT.
3. "STORM DRAIN PROFILE" DATED JULY 2010, PREPARED BY CLD CONSULTING ENGINEERS, ON FILE WITH THE TOWN OF ENFIELD PUBLIC WORKS DEPARTMENT.
4. "WHITNEY HALL MUNICIPAL BUILDING ADDITION" DATED NOVEMBER 2023, PREPARED BY BREADLOAF CORPORATION & KV PARTNERS, LLC, ON FILE WITH THE TOWN OF ENFIELD PUBLIC WORKS DEPARTMENT.
5. "ENFIELD SEWER SYSTEM ENFIELD, NEW HAMPSHIRE" DATED 1985, PREPARED BY DCPB, INC., ON FILE WITH THE TOWN OF ENFIELD PUBLIC WORKS DEPARTMENT.

PROPOSED SUBSURFACE INFILTRATION SYSTEM #1
ADS STORMTECH SC-310
WIDTH: 25' LENGTH: 103'
7 ROWS X 14 CHAMBERS
3,070 CF WQV REQ.

REGRADE SOUTHEAST CORNER OF PARKING LOT TO ALLOW DRAINAGE FOR INFILTRATION TRENCH

REGRADE PARKING LOT TO PROPOSED CATCH BASIN

PROPOSED DRAIN INLET

PROPOSED INFILTRATION TRENCH OUTLET DRAIN

106 CB
RIM=779.12
INV=773.39 OUT

PROPOSED INFILTRATION TRENCH
WIDTH: 4' LENGTH: 55'
173 CF WQV REQ.

42" CMP

18" CMPE

PROPOSED SUBSURFACE INFILTRATION SYSTEM OUTLET DRAIN

PROPOSED DRAIN INLET

PROPOSED DRAIN MANHOLE

CONVERT EXISTING CATCH BASIN TO DRAIN MANHOLE

104 CB
RIM=777.80
INV=772.03 105
INV=771.83 OUT

REGRADE PARKING LOT TO PROPOSED CATCH BASIN

780 779 778 777 776

Legend

- W — DOMESTIC WATER
- EXIST. SEWER
- EXIST. DRAIN
- PROP. DRAIN
- PROP. GRANITE CURB
- PROP. RETAINING WALL
- PROP. SWALE
- 45.0 TW / 38.5 BW — PROP. TOP & BOTTOM OF WALL ELEVATION

0 5 10 20 Feet

vhb.com

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2 Bedford Farms Drive
Suite 200
Bedford, NH 03110
603.391.3900

Mascoma Lake Watershed Managment Plan

Mascoma Lake
Enfield, NH

No.	Revision	Date	Appvd.

Designed by L.D. | Checked by B.M.

Issued for: Concept | Date: November 21, 2025

Not Issued for Construction

Drawing Title: Huse Park Subsurface BMP

Drawing Number: C-1

Sheet 1 of 5

Project Number: 53157.00

Progress Print
For Review Only
November 21, 2025

General Notes and Limitations

1. THE PURPOSE OF THESE PLANS IS TO PROVIDE CONCEPTUAL SIZING AND LOCATION INFORMATION FOR THE PROPOSED DESIGN OF STRUCTURAL STORMWATER TREATMENT PRACTICES AND ASSOCIATED POTENTIAL POLLUTANT REDUCTIONS IN SUPPORT OF THE MASCOMA LAKE WATERSHED MANAGMENT PLAN. ALL INFORMATION CONTAINED HEREIN SHALL BE CONSIDERED DRAFT FOR PLANNING PURPOSES ONLY.
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3. A LOCAL DATUM WAS UTILIZED IN REFERENCED PLANS AND ADJUSTED TO NAVD88 BY VHB.

Reference Plans

1. "HUSE PARK ENFIELD NH 03748 EXISTING CONDITIONS PLAN" DATED JULY 2010, PREPARED BY CLD CONSULTING ENGINEERS, ON FILE WITH THE TOWN OF ENFIELD PUBLIC WORKS DEPARTMENT.
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3. "STORM DRAIN PROFILE" DATED JULY 2010, PREPARED BY CLD CONSULTING ENGINEERS, ON FILE WITH THE TOWN OF ENFIELD PUBLIC WORKS DEPARTMENT.
4. "WHITNEY HALL MUNICIPAL BUILDING ADDITION" DATED NOVEMBER 2023, PREPARED BY BREADLOAF CORPORATION & KV PARTNERS, LLC, ON FILE WITH THE TOWN OF ENFIELD PUBLIC WORKS DEPARTMENT.
5. "ENFIELD SEWER SYSTEM ENFIELD, NEW HAMPSHIRE" DATED 1985, PREPARED BY DCPB, INC., ON FILE WITH THE TOWN OF ENFIELD PUBLIC WORKS DEPARTMENT.

Legend

- W — DOMESTIC WATER
- EXIST. SEWER
- EXIST. DRAIN
- PROP. DRAIN
- PROP. GRANITE CURB
- PROP. RETAINING WALL
- PROP. SWALE
- 45.0 TW / 38.5 BW — PROP. TOP & BOTTOM OF WALL ELEVATION

0 5 10 20 Feet

vhb.com

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2 Bedford Farms Drive
Suite 200
Bedford, NH 03110
603.391.3900

Mascoma Lake Watershed Managment Plan

Mascoma Lake
Enfield, NH

No.	Revision	Date	Appvd.

Designed by L.D. | Checked by B.M.

Issued for: Concept | Date: November 21, 2025

Not Issued for Construction

Drawing Title: Huse Park Infiltration Trench

Drawing Number: C-2

Sheet 2 of 5

Project Number: 53157.00

Progress Print
For Review Only
November 21, 2025

General Notes and Limitations

1. THE PURPOSE OF THESE PLANS IS TO PROVIDE CONCEPTUAL SIZING AND LOCATION INFORMATION FOR THE PROPOSED DESIGN OF STRUCTURAL STORMWATER TREATMENT PRACTICES AND ASSOCIATED POTENTIAL POLLUTANT REDUCTIONS IN SUPPORT OF THE MASCOMA LAKE WATERSHED MANAGMENT PLAN. ALL INFORMATION CONTAINED HEREIN SHALL BE CONSIDERED DRAFT FOR PLANNING PURPOSES ONLY.
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- PROP. SWALE
- 45.0 TW / 38.5 BW — PROP. TOP & BOTTOM OF WALL ELEVATION

0 5 10 20 Feet

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Suite 200
Bedford, NH 03110
603.391.3900

Mascoma Lake Watershed Managment Plan

Mascoma Lake
Enfield, NH

No.	Revision	Date	Appvd.

Designed by L.D. Checked by B.M.

Issued for: Concept — Date: November 21, 2025

Not Issued for Construction

Drawing Title: Bank Bio-Filtration

Drawing Number: C-3

Sheet 3 of 5

Project Number: 53157.00

Progress Print
For Review Only
November 21, 2025

General Notes and Limitations

1. THE PURPOSE OF THESE PLANS IS TO PROVIDE CONCEPTUAL SIZING AND LOCATION INFORMATION FOR THE PROPOSED DESIGN OF STRUCTURAL STORMWATER TREATMENT PRACTICES AND ASSOCIATED POTENTIAL POLLUTANT REDUCTIONS IN SUPPORT OF THE MASCOMA LAKE WATERSHED MANAGMENT PLAN. ALL INFORMATION CONTAINED HEREIN SHALL BE CONSIDERED DRAFT FOR PLANNING PURPOSES ONLY.
2. TOPOGRAPHIC AND UTILITY INFORMATION SHOWN ON THIS PLAN IS BASED ON PUBLICLY AVAILABLE LIDAR AND GIS DATA. THIS INFORMATION IS APPROXIMATE AND MAY NOT REFLECT ACTUAL FIELD CONDITIONS. VHB HAS NOT PERFORMED A FIELD SURVEY TO VERIFY ACTUAL CONDITIONS.
3. A LOCAL DATUM WAS UTILIZED IN REFERENCED PLANS AND ADJUSTED TO NAVD88 BY VHB.

Reference Plans

1. "HUSE PARK ENFIELD NH 03748 EXISTING CONDITIONS PLAN" DATED JULY 2010, PREPARED BY CLD CONSULTING ENGINEERS, ON FILE WITH THE TOWN OF ENFIELD PUBLIC WORKS DEPARTMENT.
2. "STORM DRAIN PLAN" DATED JULY 2010, PREPARED BY CLD CONSULTING ENGINEERS, ON FILE WITH THE TOWN OF ENFIELD PUBLIC WORKS DEPARTMENT.
3. "STORM DRAIN PROFILE" DATED JULY 2010, PREPARED BY CLD CONSULTING ENGINEERS, ON FILE WITH THE TOWN OF ENFIELD PUBLIC WORKS DEPARTMENT.
4. "WHITNEY HALL MUNICIPAL BUILDING ADDITION" DATED NOVEMBER 2023, PREPARED BY BREADLOAF CORPORATION & KV PARTNERS, LLC, ON FILE WITH THE TOWN OF ENFIELD PUBLIC WORKS DEPARTMENT.
5. "ENFIELD SEWER SYSTEM ENFIELD, NEW HAMPSHIRE" DATED 1985, PREPARED BY DCPB, INC., ON FILE WITH THE TOWN OF ENFIELD PUBLIC WORKS DEPARTMENT.

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Legend

- W — DOMESTIC WATER
- EXIST. SEWER
- EXIST. DRAIN
- PROP. DRAIN
- PROP. GRANITE CURB
- PROP. RETAINING WALL
- PROP. SWALE
- 45.0 TW / 38.5 BW — PROP. TOP & BOTTOM OF WALL ELEVATION

0 5 10 20 Feet

Mascoma Lake Watershed Managment Plan

Mascoma Lake
Enfield, NH

No.	Revision	Date	Appvd.

Designed by L.D. | Checked by B.M.

Issued for: Concept — Date: November 21, 2025

Not Issued for Construction

Drawing Title: Library Subsurface BMP

Drawing Number: C-4

Sheet 4 of 5

Project Number: 53157.00

Progress Print
For Review Only
November 21, 2025

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Legend

- W — DOMESTIC WATER
- EXIST. SEWER
- EXIST. DRAIN
- PROP. DRAIN
- PROP. GRANITE CURB
- PROP. RETAINING WALL
- PROP. SWALE
- 45.0 TW / 38.5 BW — PROP. TOP & BOTTOM OF WALL ELEVATION

0 5 10 20 Feet

Mascoma Lake Watershed Managment Plan

Mascoma Lake
Enfield, NH

No.	Revision	Date	Appvd.

Designed by L.D. | Checked by B.M.

Issued for: Concept | Date: November 21, 2025

Not Issued for Construction

Drawing Title: Beach Retaining Wall

Drawing Number: C-5

Sheet 5 of 5

Project Number: 53157.00

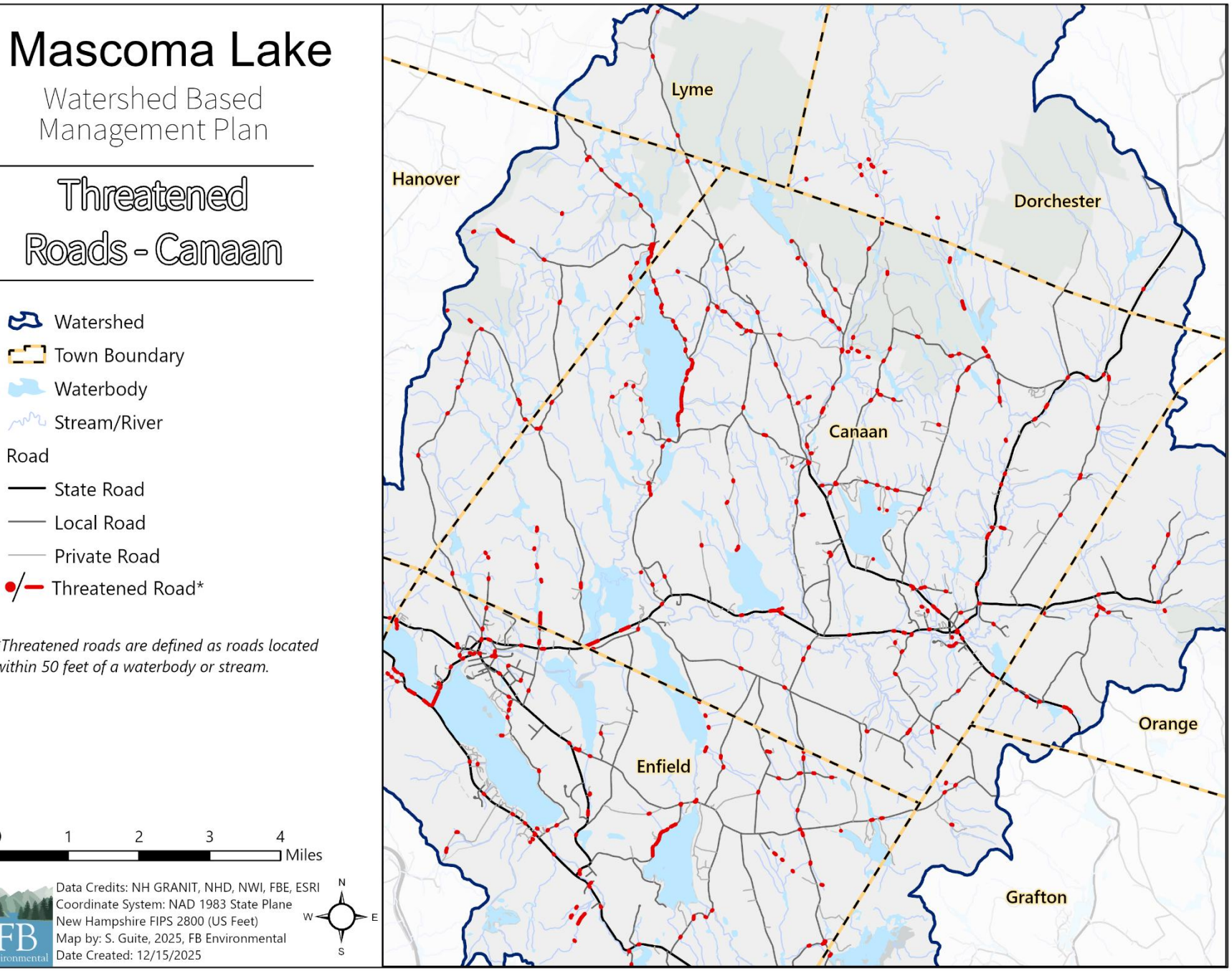
Progress Print
For Review Only
November 21, 2025

APPENDIX D: THREATENED ROADS MAPS BY TOWN

Mascoma Lake

Watershed Based Management Plan

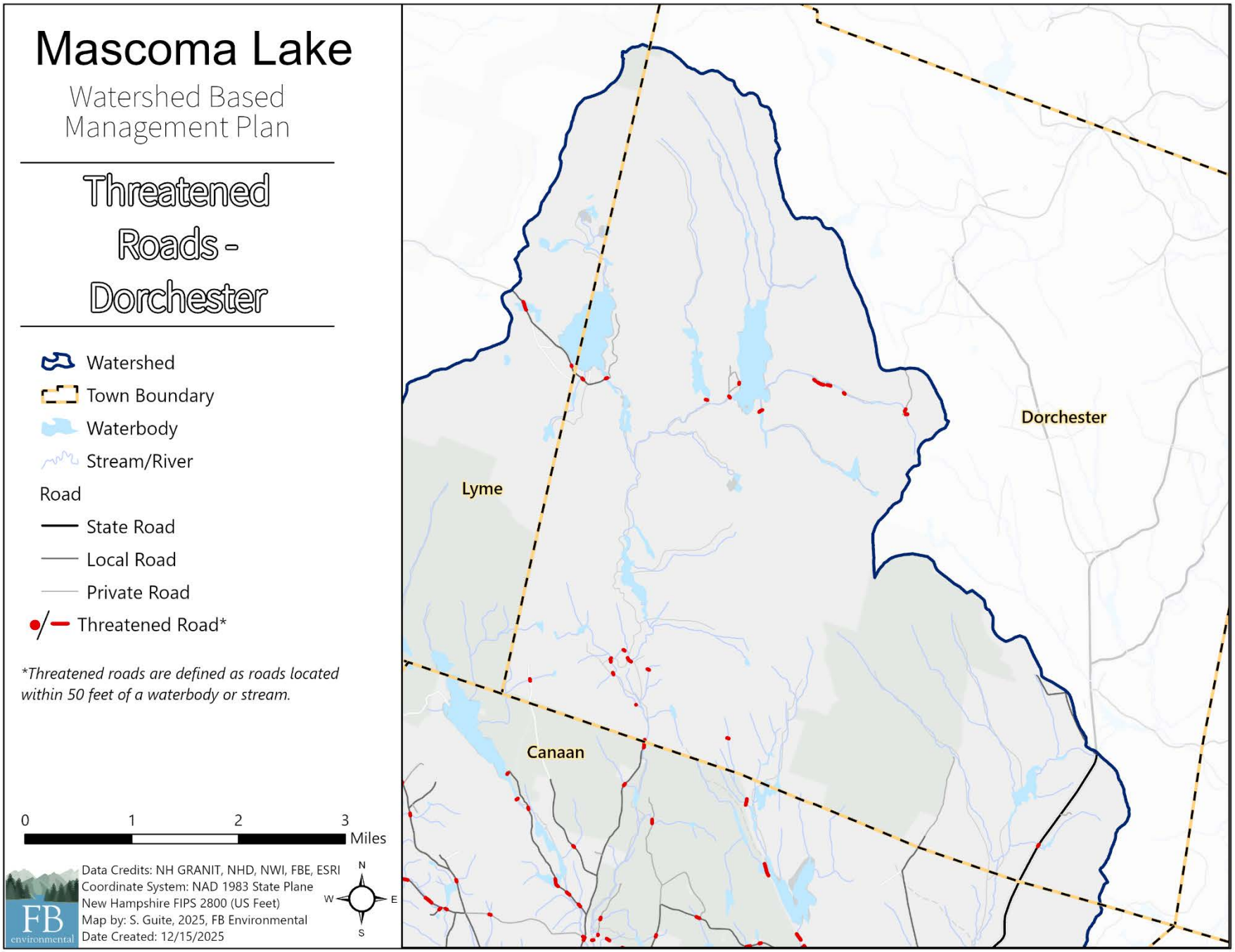
Threatened Roads - Canaan



Mascoma Lake

Watershed Based Management Plan

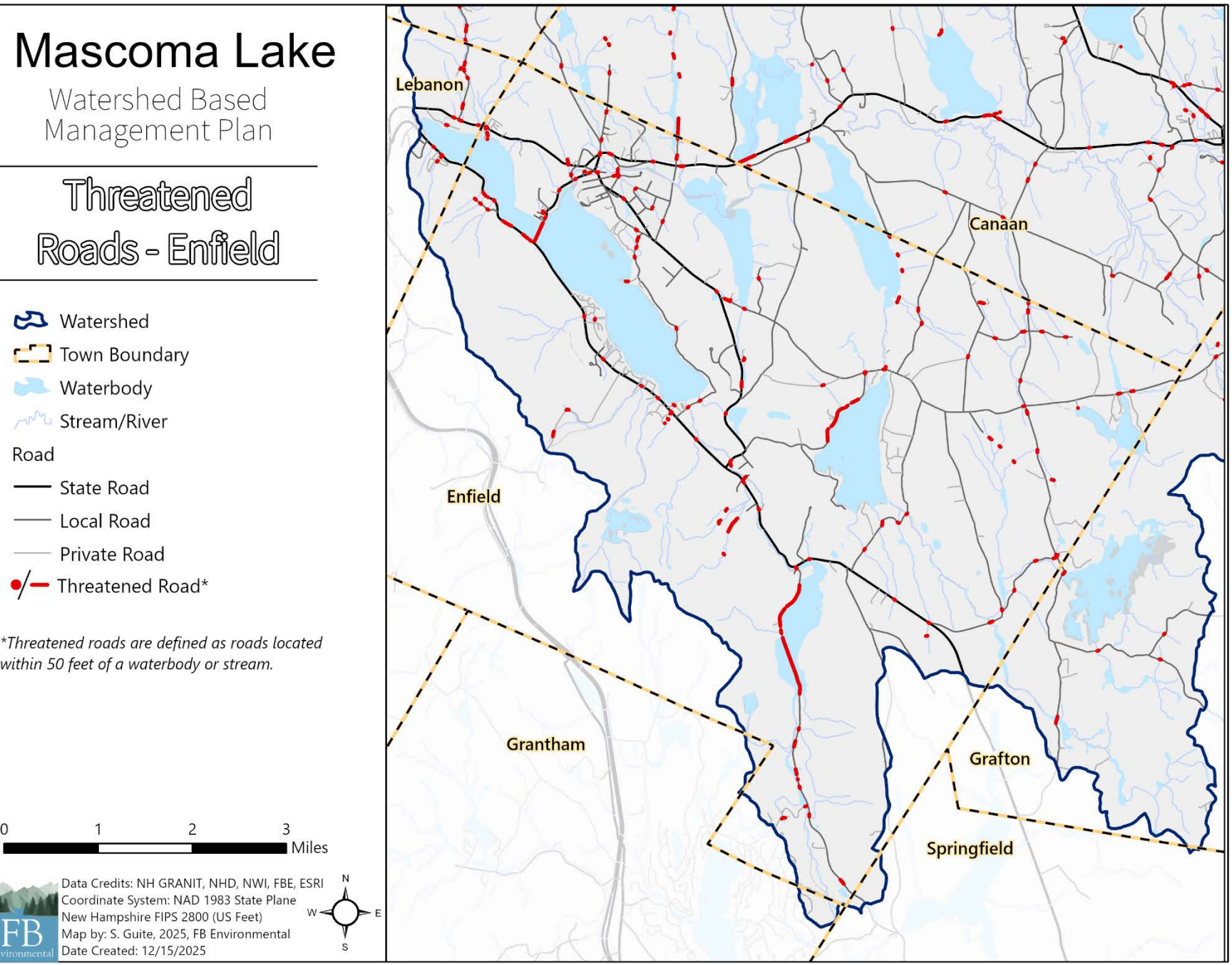
Threatened Roads - Dorchester



Mascoma Lake

Watershed Based Management Plan

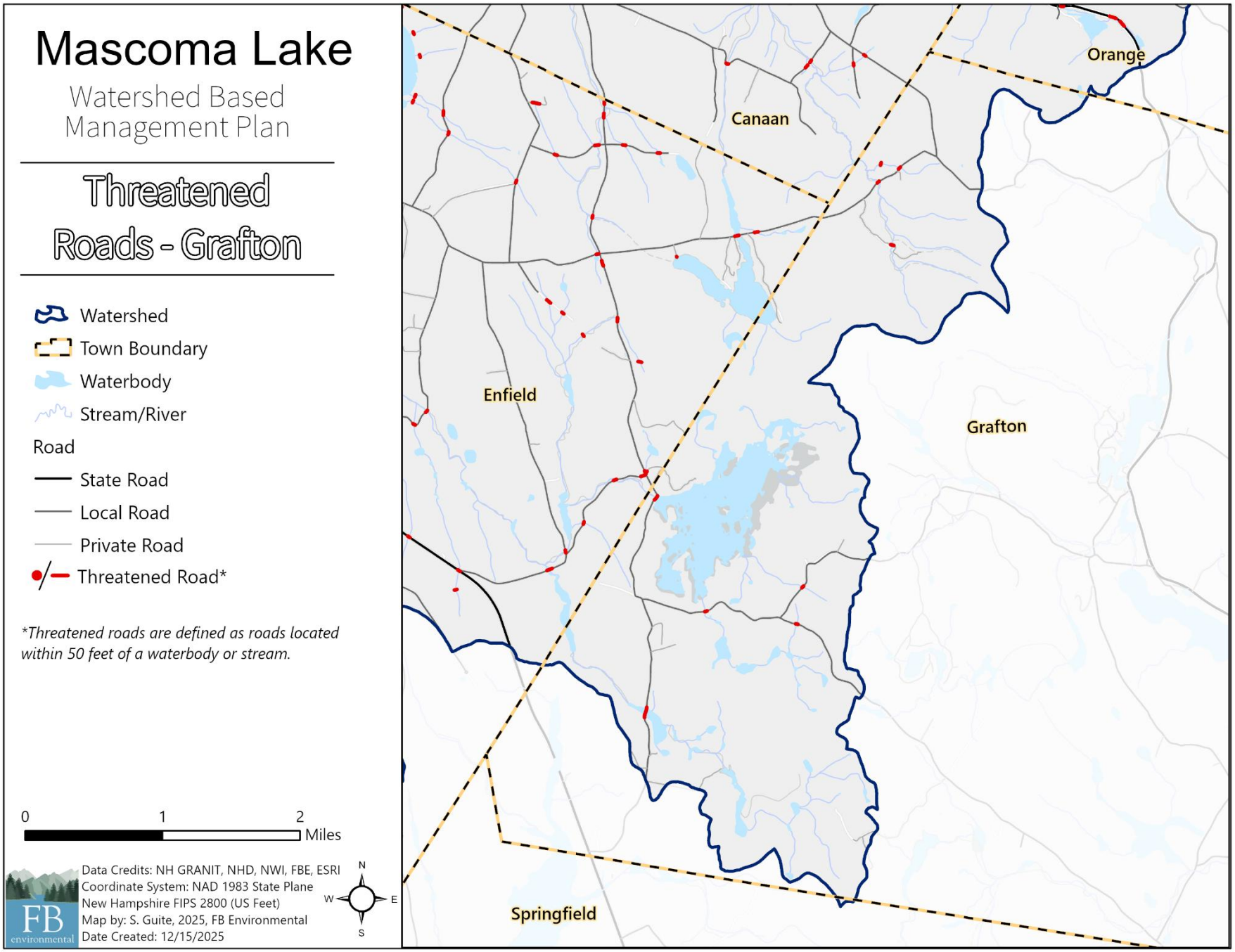
Threatened Roads - Enfield



Mascoma Lake

Watershed Based Management Plan

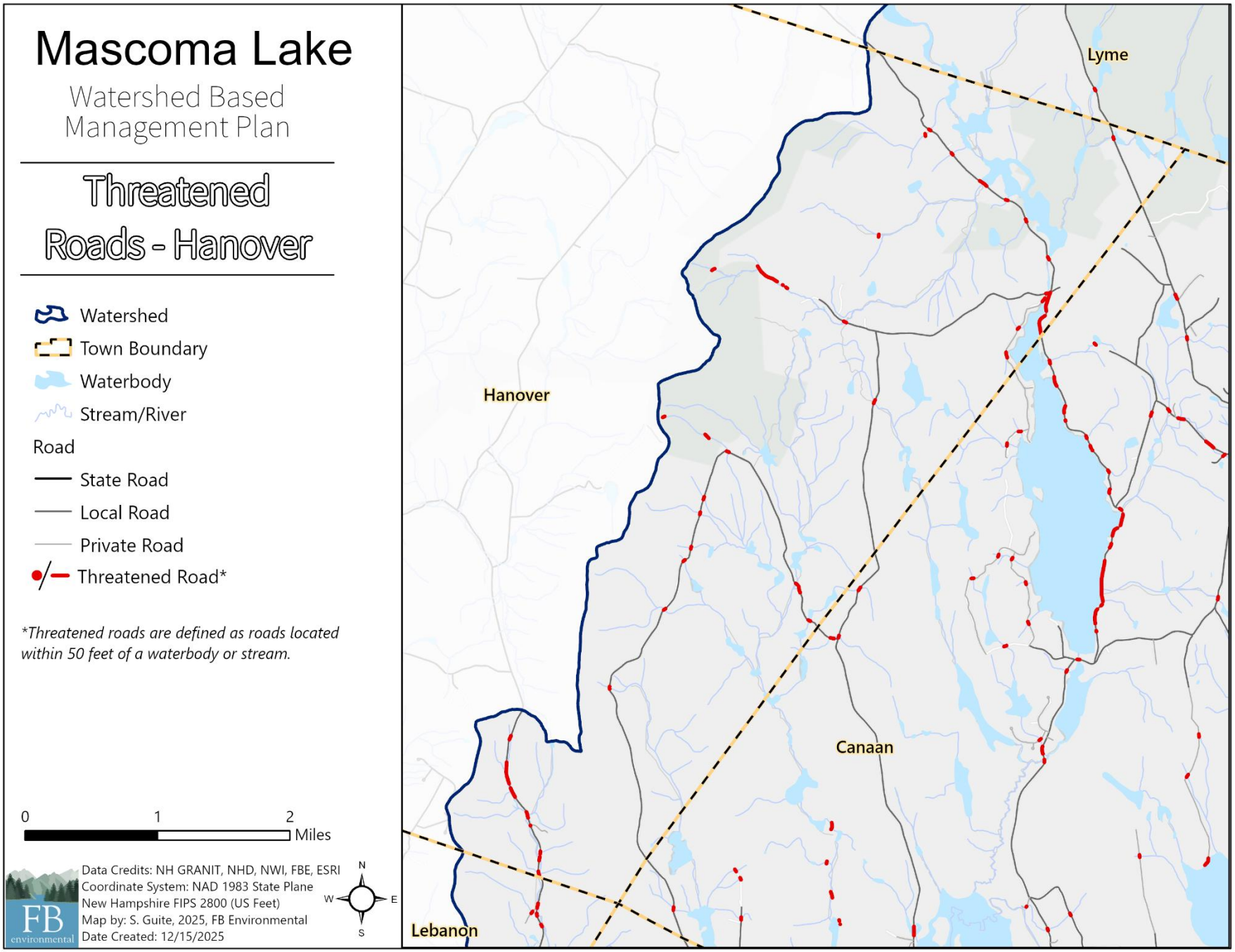
Threatened Roads - Grafton



Mascoma Lake

Watershed Based Management Plan

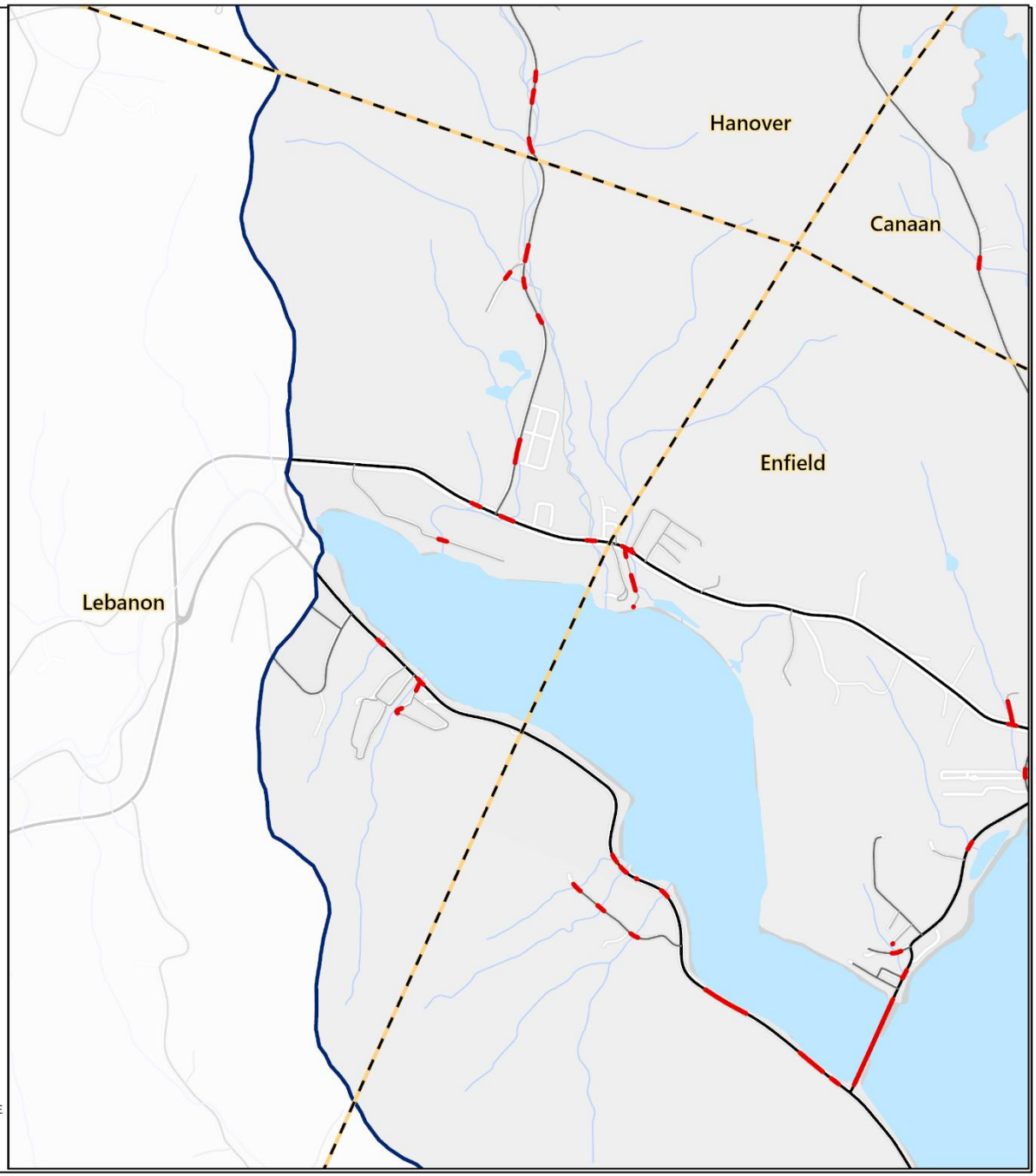
Threatened Roads - Hanover



Mascoma Lake

Watershed Based Management Plan

Threatened Roads - Lebanon



- Watershed
- Town Boundary
- Waterbody
- Stream/River

Road

- State Road
- Local Road
- Private Road
- Threatened Road*

**Threatened roads are defined as roads located within 50 feet of a waterbody or stream.*

0 0.45 0.9 Miles

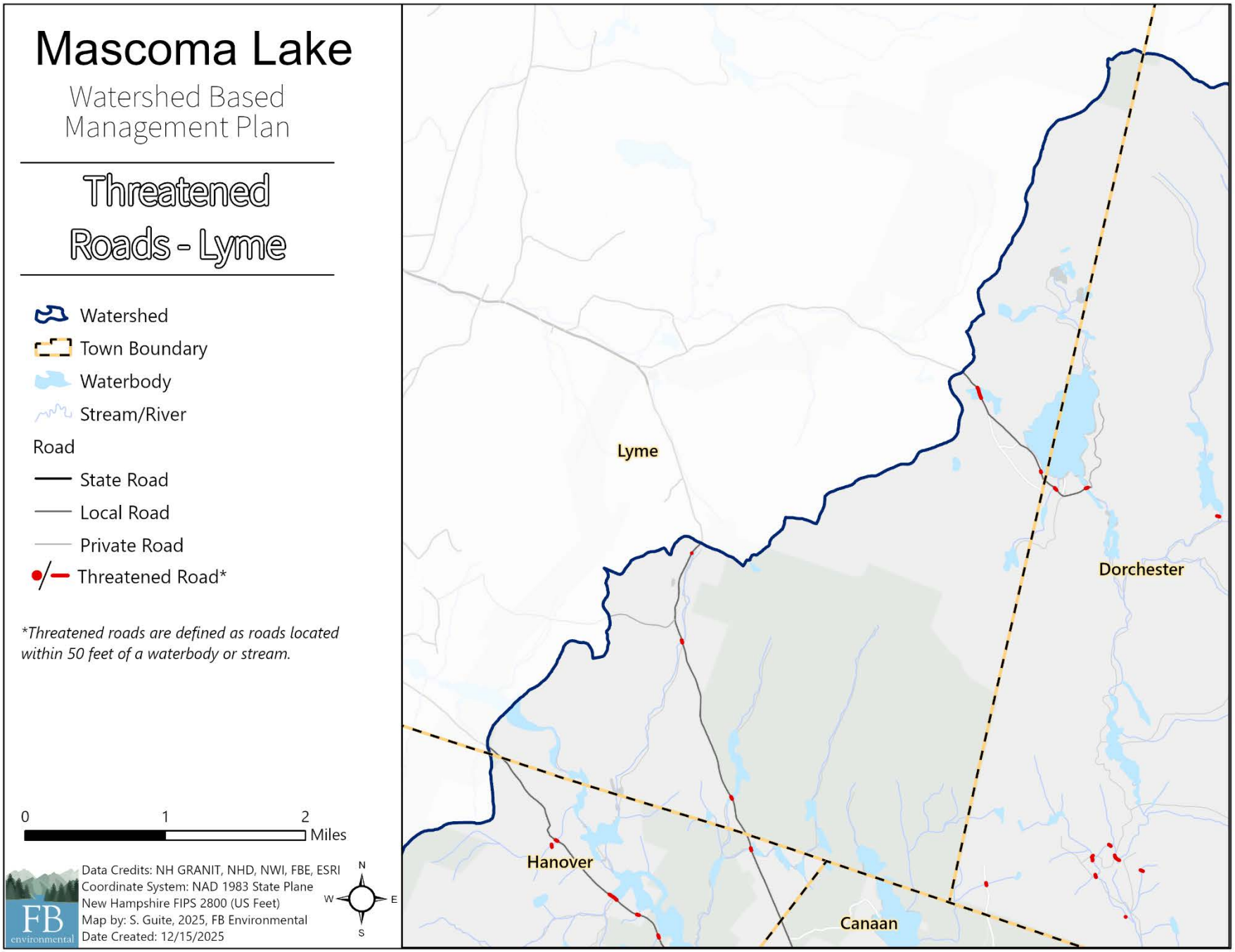
Data Credits: NH GRANIT, NHD, NWI, FBE, ESRI
Coordinate System: NAD 1983 State Plane New Hampshire FIPS 2800 (US Feet)
Map by: S. Guite, 2025, FB Environmental
Date Created: 12/15/2025

N W E S

Mascoma Lake

Watershed Based Management Plan

Threatened Roads - Lyme



Mascoma Lake

Watershed Based Management Plan

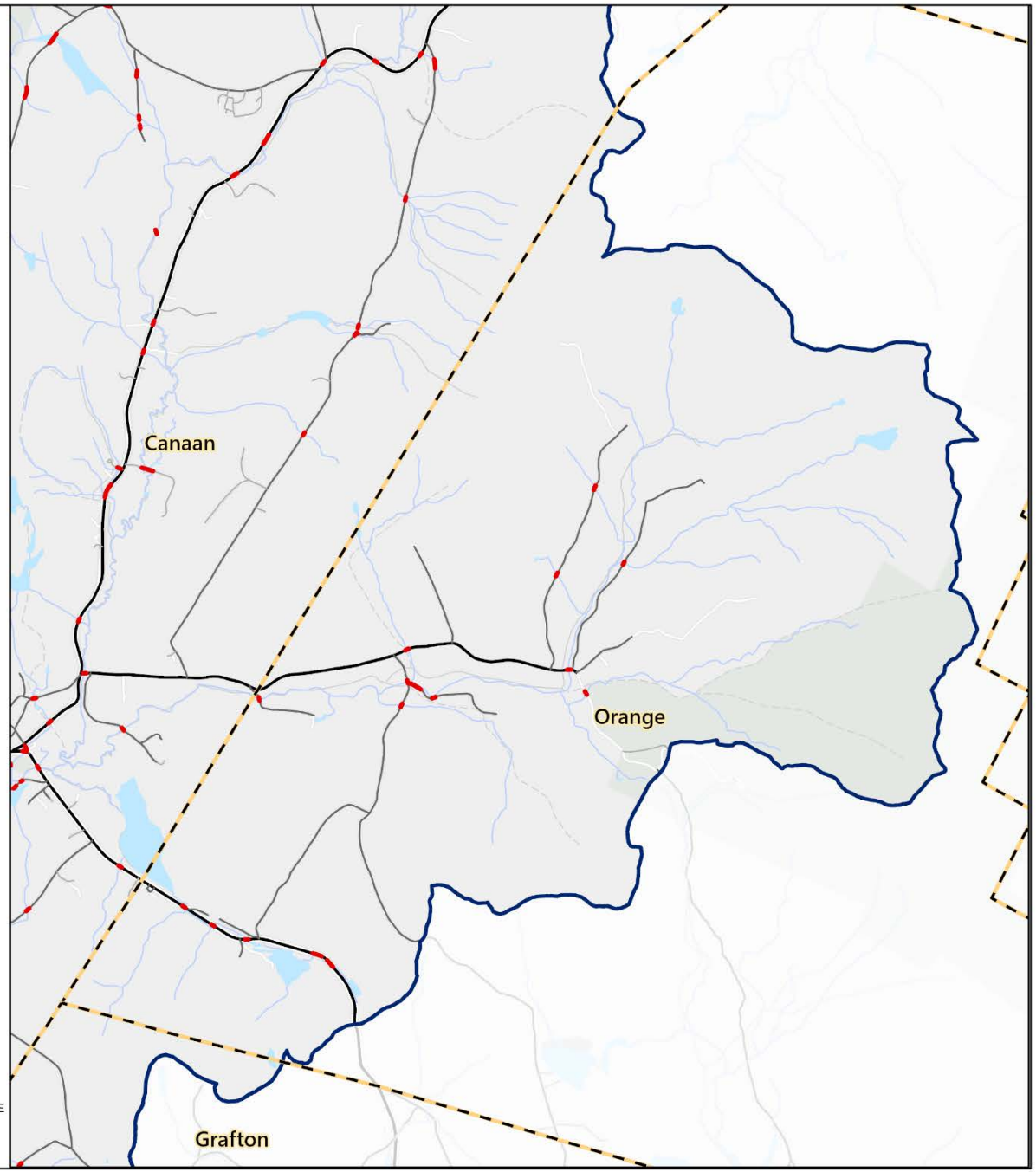
Threatened Roads - Orange

- Watershed
- Town Boundary
- Waterbody
- Stream/River

Road

- State Road
- Local Road
- Private Road
- Threatened Road*

**Threatened roads are defined as roads located within 50 feet of a waterbody or stream.*



0 1 2 Miles

Data Credits: NH GRANIT, NHD, NWI, FBE, ESRI
Coordinate System: NAD 1983 State Plane New Hampshire FIPS 2800 (US Feet)
Map by: S. Guite, 2025, FB Environmental
Date Created: 12/15/2025

N W E S

Agenda

Lebanon Conservation Commission

11 June 2026

Study Item

Conservation-Related Takeaways from the 2024 Northern Lebanon Community Plan

Northern-Lebanon-Community-Plan_2024-11-03_FINAL

Revisit this plan and its recommendations, as well as our previous comments, and forward relevant comments to the Planning Board or other bodies. While the plan is almost two years old, many of our comments and recommendations may remain valid today and may be applied more broadly.

The plan's vision statement

> *Transform the area within the City of Lebanon north of Exit 18 on Interstate 89 into a more complete, walkable neighborhood with easy, safe access to and preservation of natural resources and existing amenities, while providing opportunities for thoughtful, sustainable growth in the form of diverse new housing, community facilities, and enhanced multimodal connections.*

Comment:

> Natural resources need to be prioritized as this area undergoes changes in development types and locations. Not all natural resources should be accessible or promoted, and this point needs to be understood and emphasized where appropriate.

Strategic Goals and Recommendations

> *Building upon the vision statement are a set of strategic goals and actionable recommendations centered around the preservation of natural resources, enhanced connectivity and mobility, and modifications to the existing zoning of the Study Area that will allow the City of Lebanon to realize its vision.*

Strategy 1.

Preserve and enhance the Study Area's existing natural character by protecting existing conservation areas, wildlife corridors, and ecosystems, while providing additional recreational opportunities and enhanced connections to existing natural assets for residents, visitors, and employees that frequent the Study Area.

Comment:

> Increased human access to natural areas could have a significant negative impact on the functionality of natural areas, including animal habitat, wetland buffers, and drainage.

Recommendation 1.1.

Formalize and map a 100-ft wide Wildlife Corridor Passage Overlay District that connects the three existing wildlife corridors, preserving the existing natural features and landscape to allow for the safe passage of wildlife, and require the installation of signage at all existing and new multi-use path and roadway crossings that bisect the overlay district boundary.

Comment:

Regarding Corridor Protection:

A. Portions of the major wildlife corridors from the Landmark Lands, across Mt Support Road and Route 120, to the Nicole Cormen Nature Preserve are not on encumbered land. There could be value in formalizing and mapping a Wildlife Corridor Passage Overlay District.
B. A corridor width of 100 ft is arbitrarily narrow, and would more realistically be 1000 ft. Measurements of corridor widths for the three major corridors mentioned in this Rt 120 study are listed in the 2016 Wildlife Corridor Analysis and vary from 375 ft to 1150 ft.
C. The study area includes more than just the three designated wildlife corridors with crossings. Less used crossings also exist, not to mention unstudied and undocumented smaller ones used by amphibians and turtles.
D. Concom recommends that the City work to expand the width and breadth of protected lands in these greater wildlife corridors by expanding land protection through a variety of tools including but not limited to landowner outreach, conservation proposals, and inclusion in the Planning Board site plan approval process.
E. A few key recommendations from the 2013 and 2016 wildlife studies have not been completely implemented and should be addressed, in particular the 2013 recommendation to "*remove the northerly portion of the iron fence along the sidewalk in front of Timberwood"*. [was this particular recommendation completed in 2025?]
   See appendix for a list of the recommendations from these studies.

Regarding Signage:

A. Install educational signage to showcase crossings where appropriate along multi-use paths.
B. Locate wildlife crossing signs along roadways well in advance of the crossings to alert drivers.
C. Use temporary signage to highlight wildlife crossings at certain times of the year (such as turtle nesting season and early spring amphibian migrations).

Recommendation 1.2.

Study the feasibility of decreasing traffic speeds and upsizing the existing culverts for all three existing wildlife corridors within the Study Area.

Comments:

Regarding Traffic Speed:

A. The current existing speed limits of 25 mph on Mt Support and 40 mph on Rt 120 are likely adequate.
B. Enforcing existing speed limits is likely the more relevant action. Understanding what enforcement measures are already in place and collaborating with the Lebanon Police as to suggesting additional enforcement measures

could be beneficial, such as flashing speed signs, etc.

C. Add traffic calming measures, with a focus on the areas near the wildlife crossings.

Regarding Culvert Upsizing:

A. Upsize the existing culverts for all existing wildlife crossings within the Study Area.
B. Design and install culverts to allow for amphibian crossings, especially near wetlands.
C. Develop improved standards for all culverts that will improve flood resiliency and wildlife passage See 2020 NH DES fact sheet Stream Crossing Design: Building Structures that are Compatible with People, Streams and Wildlife

> "*The purpose of Chapter Env-Wt 900 is to "enhance public safety by establishing standards for stream crossings that are designed to lessen the risk of blockages and wash-outs of culverts and bridges, and the associated flooding, which can jeopardize property and human lives upstream and downstream of such crossings." The purpose is also to "preserve and enhance the functions and values of existing streams, support the restoration of impacted streams to their natural state, and improve aquatic organism passage and sediment transport". The goal is therefore to design crossings that are compatible with the hydrology, geomorphology, and the passage of aquatic organisms in the stream*."

Recommendation 1.3.

In partnership with the Lebanon Conservation Commission and the New Hampshire Fish and Game Department, develop public-facing educational materials on the importance of the wildlife corridors and make them available at key City facilities.

Comment:

> The Conservation Commission agrees that the City, with guidance from the Conservation Commission, should regularly share relevant educational materials (e.g., signs, brochures, etc.) in key locations, virtual and physical.
>
> Furthermore, we suggest that private developers also share responsibility for building awareness. The City could consider adding requirements to site plan approval that private developers share educational materials on the importance of wildlife corridors, natural areas, and the impacts of people on wildlife, and make them available at appropriate locations in the development.

Recommendation 1.4.

If a parcel of developable land borders conservation lands, consider requiring a 100-foot, wooded or landscaped buffer between the property line and any new development to maintain a natural buffered area between existing preserved lands and any new developments.

Comment:

> Consider defaulting to the Planning Board development review process, with input from the Conservation Commission, to include buffers when deemed necessary to avoid adverse impacts to the corridor or any conserved lands.

Recommendation 1.5.

Install signed and directional trailheads throughout the Study Area to promote the use of the extensive network of trails

through existing conservation lands in and around the Study Area.

Comment:

The Conservation Commission has significant concerns about the potential impacts of trails on the ecological integrity of certain areas.

Increased human access to natural areas could have a significant negative impact on the functionality of natural areas including animal habitat, wetland buffers and drainage.

The trail network, including the number of trailheads and the number and location of trails, should be carefully planned, and must be balanced with habitat protection.

The City, developers, and landowners should follow the Guidelines in NH F&G's Trails for People and Wildlife to evaluate the existing trail network. Any addition to or removal of trails should follow these guidelines. The TFPW tool recommends that while some areas can be well signed and promoted for recreation, other areas need to remain undeveloped, even for passive recreation. For example, Rix Ledges is designated as a wildlife preserve, with no hiking or biking trails.

The City should host a Trails for People and Wildlife workshop.

Signage at trailheads and on trails should promote safe and responsible trail usage.

Recommendation 1.6.

Mandate a percentage of new developments require dedicated public open space in the form of a landscaped plaza, pocket park, or a community garden.

Comment:

Next Step: See previous note (in 1.4) regarding PB process and conditioning of development approvals.

The Conservation Commission agrees that public space should be required in any new development. Huge developments should be required to have their own parks. Dog parks are needed as well, to reduce environmental impacts on adjacent natural areas.

Recommendation 1.7.

Approach DHMC regarding their three parcel assemblage north of Lahaye Drive (Parcel IDs 10-23, 10-24-200, and 10-25 for a total of approximately 9 acres) to gauge their willingness to dedicate the land to the City for the purposes of creating a community park inclusive of amenities and programming of appropriate scale and size to reflect the land's existing natural features.

Comment:

ConCom recommends that if this concept were to be pursued, the already-cleared/disturbed section of this parcel assemblage could be converted into a small pocket park, but the existing forest and wetland area should remain in a natural state. This pocket park should be designed for pedestrian and cyclist access with no paving or parking spaces for automobiles. Invasive species removal and other habitat improvements should be pursued as

part of any initiative.

No net loss of wetlands.

Recommendation 1.8.

Require that any future development within 250-feet of wetlands include a certain percentage of total site land cover as permeable surfaces.

Comment:

Explore additional [natural, vegetated] buffers for existing wetlands within the study area, and rather than requiring a certain percentage of the total site be permeable, consider maximum percentages for impermeable surfaces.

Recommendation 1.9.

Expand the coverage area of the Steep Slopes District to cover the entirety of the Study Area where slopes greater than or equal to 25-percent are located in order to preserve the natural character of neighboring conservation lands, ridgelines, and rock formations.

Comment:

Act. Expand the steep slope district.

Intermittent streams and headwater streams and surrounding intact ecosystems are ever more important for protection from floods and for preserving water quality and habitat downstream.

Additional analysis may be needed to determine whether any of the steep slopes in the study area are outside of what is already encumbered land, and if so, do they warrant zoning protection?

Strategy 2. Connectivity Improvements

Recommendations 2.1 - 2.8 (filling in gaps in sidewalk connectivity; extending multi-use path down to pedestrian bridge and up to DH campus; ped. bridge improvements; NHDOT Exit 18 project)

Comment:

It is important that sidewalks and multi-use paths not eat into more wetlands.

No net loss of wetlands in this area.

Sidewalk/bike path improvements and impacts should be included in the wetland impacts of the larger project.

The study mentions coordinating with NH DOT re the 29612 project for exit 18. It is important to keep our eyes on this and to advocate for zero wetland loss with the exit 18 project. How can we get this concern across to NH DOT?

This study is very focused on trail connections. Not all trails are or should be for commuting. Trail design and usage needs to be balanced with protecting the integrity of the natural area. Any trails need to follow the Trails

for People and Wildlife guidelines.

Strategy 3. Zoning Modifications

Comment:

Wetlands provide essential habitat as well as flood mitigation. It is essential to have strict regulations protecting all the remaining wetlands in the study area.

Floodplains provide long term resiliency as our climate changes as more extreme weather events threaten our environment and infrastructure. It is essential to have regulations in place to protect floodplains from being filled and developed.

Whenever zoning changes are under review, the protection of natural resources, wetlands and floodplains should be given the same or greater consideration as developmental uses.

When considering zoning changes, keep in mind that residential uses generally have more negative impacts on wildlife than 'light' industrial uses.

If we are changing zones, change the ind-l along rt 120 to rl3 to match the Future Land Use Map.

The study area stops at the town line. but the Centerra 'village' is geographically and topographically closer to Hanover than to downtown Lebanon. Did the study look to see if the Hanover zoning corresponds to the Lebanon zoning at the town line? What's the innovation zone? How does that align with adjacent zones in Hanover?

Recommendation 3.6.

As recommended in the Lebanon Open Space Plan (2021), consider implementing the following measures:

- *Develop and incorporate a **maximum lot coverage limitation** to ensure that a portion of all lots remains as greenspace;*
- *Develop **maximum parking requirements** and allow for reductions in parking provided on site, in addition to encouraging adjoining properties to share parking to reduce the creation of new or expanded impervious surfaces;*
- *Conduct a feasibility assessment of increasing the maximum height of buildings within the GC-1 and CBD district to help reduce the overall footprint of development projects.*

Comment:

These are good suggestions. What other recommendations from the Open Space Plan could be included in this plan and subsequent actions? Urban service boundary limits are mentioned in the OSP, as well as in the Nature Conservancy Resilience Workshop summary (see appendix below).

Recommendation 3.9.

Given NHDOT's existing moratorium on new curb cuts along Route 120, north of I-89's Exit 18, require all new

developments on the eastern portion of Route 120 to provide adequate internal road network connections to existing developments to facilitate improved circulation amongst existing and future developments.

Comment:

It is important that the land between Rt 120 and Etna Rd not be scarred by webs of new roads cutting into the open space.

The Open Space Plan suggests that ******regulating the length and design of private roads and driveways would significantly "*reduce the fragmentation effects on open space areas.**** The edge effects of development in interior forest areas will contribute to the degradation of some of the highest value open space areas in the city and region.*"

Appendix

Recommendations from the 2013 and 2016 Wildlife studies - Which ones remain incomplete?

For Route 120, those Recommended Improvements were:

A. Improve wildlife crossing signage.
B. Decrease traffic speeds, set speed limits.
C. Replace all existing culverts with box or archway culverts (min. 4 ft high, 4 ft wide).
D. Prevent artificial feeding stations or other attractants for crossing.
E. Eliminate highway fence on east side, or provide multiple breaks.
F. Allow selected areas near the five crossing sites discussed in 2013 to revegetate up to near the edge of the roadway shoulder
G. At the second crossing locale, replace the existing 42-inch culvert with a six-foot wide, four-foot high box culvert to allow for better under-highway passage of medium to small mammals.

The Mt Support Recommended Improvements were:

H. Protect and preserve a 100-foot wide vegetated strip just south of LeHaye Drive
I. Remove the rip-rap from the roadside banks and stabilize these areas with jute-netting and hydroseed, especially in the area across from the Pat Lumber Jack lot across from the southeast corner of the hay field.
J. Remove the northerly portion of the iron fence along the sidewalk in front of TImberwood
K. Remove the large rip-rap for at least 50 feet adjacent to the Dartmouth College field.
L. Permanently protect the parcel 24-10 & secure development rights for parcels 24-2 and 24-3 on the west side of Mt. Support Rd and parcel 24-8 to the east next to Rt 120.
M. Secure a protective easement for the north 300 feet of the West parcel.
N. Improve the single intermittent stream culvert next to Timberwood by replacing with a 4-foot box culvert and removing 50 more feet of iron fence on the east side of Mt. Support Rd.

The Etna Rd Recommended Improvements were:

O. Secure protective easements from James Campion for the northern strip of his land as a part of his proposed development of his land for a natural gas distribution facility.
P. Continue the good work of the Upper Valley Land Trust by securing an easement to the northern strip of UniFirst land that contains the principal wildlife crossing zone.
Q. Post speed limit and wildlife crossing signage above and below the crossing area.
R. Increase the size of the underpass culvert at the perennial stream to allow for passage by other species.

Community resilience building exercise with the Nature Conservancy in 2024, cited in the NLCP. The results of that Conservancy workshop included numerous conservation-related actions.

Just a few of the relevant action items:

- Maintain and strengthen Lebanon's "80:20 ratio" of undeveloped land to developed land by formalizing the

City's urban growth boundaries, implementing policies that promote compact development away from vulnerable areas, and working with large landowners and local land trusts to permanently protect the remaining large tracts of resilient, unfragmented lands.

- Formalize Lebanon's urban growth boundaries in zoning maps and conditions to keep development compact and walkable while maintaining the City's unfragmented tracks of forested land.
- Build coalitional strength through collaboration and tension reduction between conservation community and re-zoning advocates ahead of the consequential 2025 rezoning ballot initiative.
- Balance of tensions is needed between the demands for increasing density, preserving open space, improving wildlife passage, and minimizing development in flood-prone areas.
- Assess current constraints of natural floodplains to properly capture and retain flood waters and seek ways to enhance the functionality of this natural infrastructure during peak flow events within Lebanon and across upstream communities.
- Identify locations in Lebanon where streams and rivers have been hardened via structural engineering projects and seek ways to replace with nature-based solutions including daylighting streams that have been covered or paved over, where appropriate and feasible.
- Ensure future investment of public funds on infrastructure are focused in areas away from critical natural lands.
- Build upon the wildlife corridor study to develop, fund and implement a new Wildlife Passage Plan, which will analyze wildlife habitat, wildlife-vehicle collisions and options for retrofitting of current infrastructure (culvert and/or bridge upsizing for under-road passage).

Northern Lebanon Community Plan

City of Lebanon, New Hampshire

November 2024

PREPARED FOR

City of Lebanon
51 N. Park Street
Lebanon, NH 03766
603.448.1524

PREPARED BY

260 Arsenal Place #2
Watertown, MA 02472
617.924.1770

Table of Contents

List of Tables

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Introduction

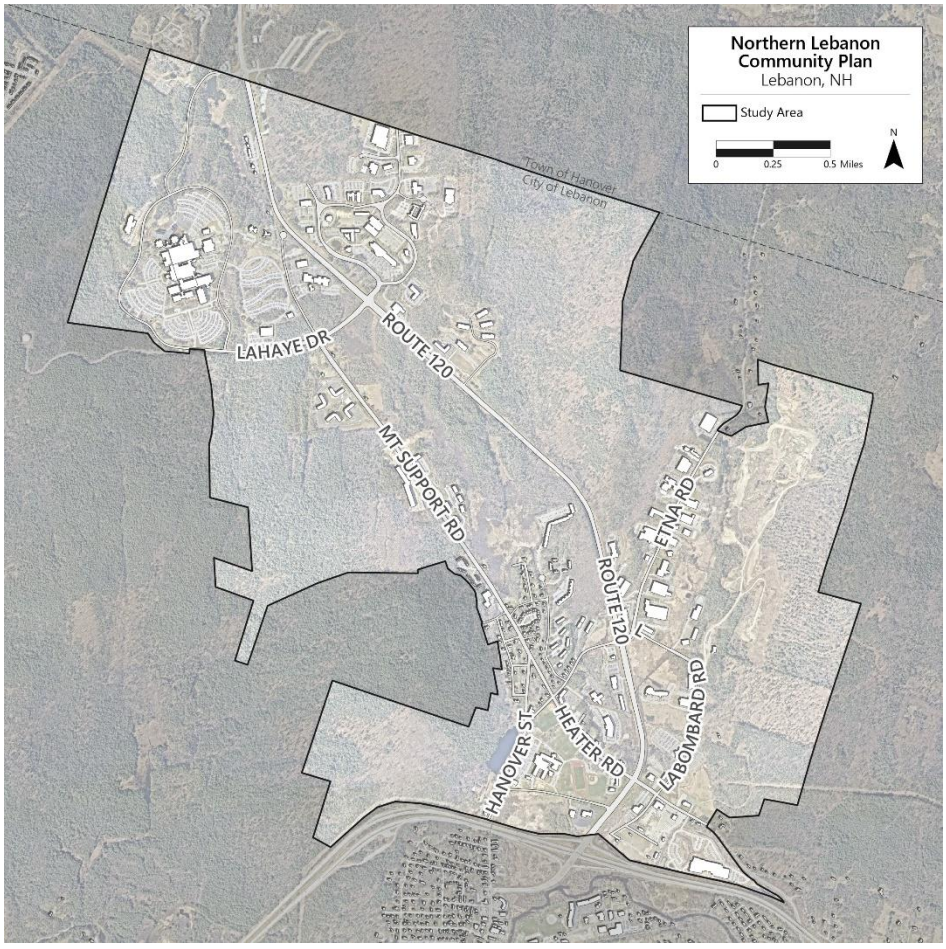
Purpose

The City of Lebanon has led a planning process to prepare the Northern Lebanon Community Plan (the Plan), which considers the neighborhood in Lebanon situated north of downtown and adjacent to Interstate 89's Exit 18, directly east of the Boston Lot Conservation Area and south of the Hanover town line, and just to the west of the Signal Hill Conservation Area (the Study Area), as shown below in **Figure 1**. The purpose and intent of this neighborhood Plan is to establish a cohesive vision, strategic goals, and recommendations to inform future development of the Study Area. The Plan is guided by several areas of need identified through a public engagement effort, including the analysis of land use and zoning, transportation and connectivity, and natural resources.

This document builds upon previous years of planning and analysis conducted by the city to determine the appropriate uses and needs of the community within the Study Area. The need for this study was first identified during the development of the City of Lebanon's Master Plan in 2012. Specifically, the Study Area was identified as part of the Heater Road Land Use Planning Area in Chapter 2: Land Use, Recommendation D-2j:

> *"For the Heater Road area, the general recommendation is to determine the appropriate level and type of future development. The area surrounding the Hanover Street School and Lebanon High School would be appropriate for mixed-use development, including small-scale commercial, light industrial, Office, and residential uses. Because of the proximity to schools and residential areas, surrounding wetlands, and difficult access for traffic from Route 120 onto Evans Drive, development must meet well-defined performance standards for traffic, hours of operation, impervious surface, and parking. A study of the entire Route 120 corridor is needed to address traffic patterns, land uses, and aesthetic concerns." (Lebanon Master Plan, 2012)*

Figure 1: Study Area



Executive Summary

As southern New Hampshire experiences continued growth, the City of Lebanon is proactively addressing the increasing interest from developers and employers, while balancing the need of its current and future residents. Committed to balancing development with the preservation of natural resources, the City has adopted a strategic, comprehensive approach to guide the area's long-term growth. In collaboration with experts, including VHB (Vanesse Hangen Brustlin, Inc.) and key stakeholders, Lebanon conducted an in-depth planning process that involved reviewing existing plans, engaging stakeholders, and evaluating optimal land uses. This planning effort aims to enhance the City's industrial corridor while fostering sustainable, community-oriented development.

The Northern Lebanon Community Plan focuses on the neighborhood north of Downtown Lebanon, near Interstate 89's Exit 18. The area is home to notable institutions such as the Dartmouth-Hitchcock Medical Center (DHMC), Hanover Street School, and Lebanon High School. This Plan outlines a cohesive vision, strategic goals, and actionable recommendations for the future of this significant area. The approximately 2,400-acre Study Area requires coordinated development to ensure balanced progress. Public engagement played a key role in shaping the Plan's priorities, which center on land use and zoning, improved transportation and connectivity, and responsible natural resource management. Building on the 2012 City of Lebanon Master Plan, which underscored the importance of planning around the Heater Road area, this initiative aims to upgrade vital infrastructure along Route 120 and Mt. Support Road, bolster pedestrian and bicycle access, and protect essential natural resources like wetlands and wildlife corridors that sustain the local ecosystem.

The City of Lebanon has outlined a comprehensive vision to transform the area north of Exit 18 on Interstate 89 into a walkable, vibrant neighborhood that balances sustainable growth with the preservation of natural resources. The plan emphasizes thoughtful development of diverse housing, enhanced community facilities, and improved multimodal connectivity. Central to this vision is the integration of natural preservation, connectivity improvements, and zoning modifications to create a cohesive, inclusive community that aligns with long-term environmental and social goals.

- **Strategy 1. Preservation of and Enhanced Access to Natural Resources**

  Preserve and enhance the Study Area's existing natural character by protecting existing conservation areas, wildlife corridors, and ecosystems, while providing additional recreational opportunities and enhanced connections to existing natural assets for residents, visitors, and employees that frequent the Study Area.

- **Strategy 2. Connectivity Improvements**

  Identify and prioritize the completion or enhancement of missing, incomplete, or unsafe pedestrian, bicycle, and multimodal connections to facilitate improved local and regional connectivity between existing neighborhoods, community amenities and facilities, and job centers.

- **Strategy 3. Zoning Modifications**

  Propose changes to the existing Zoning Ordinance and Map to allow for by right mixed-use development and a range of housing choices to support the diverse needs of the community and its current and future residents.

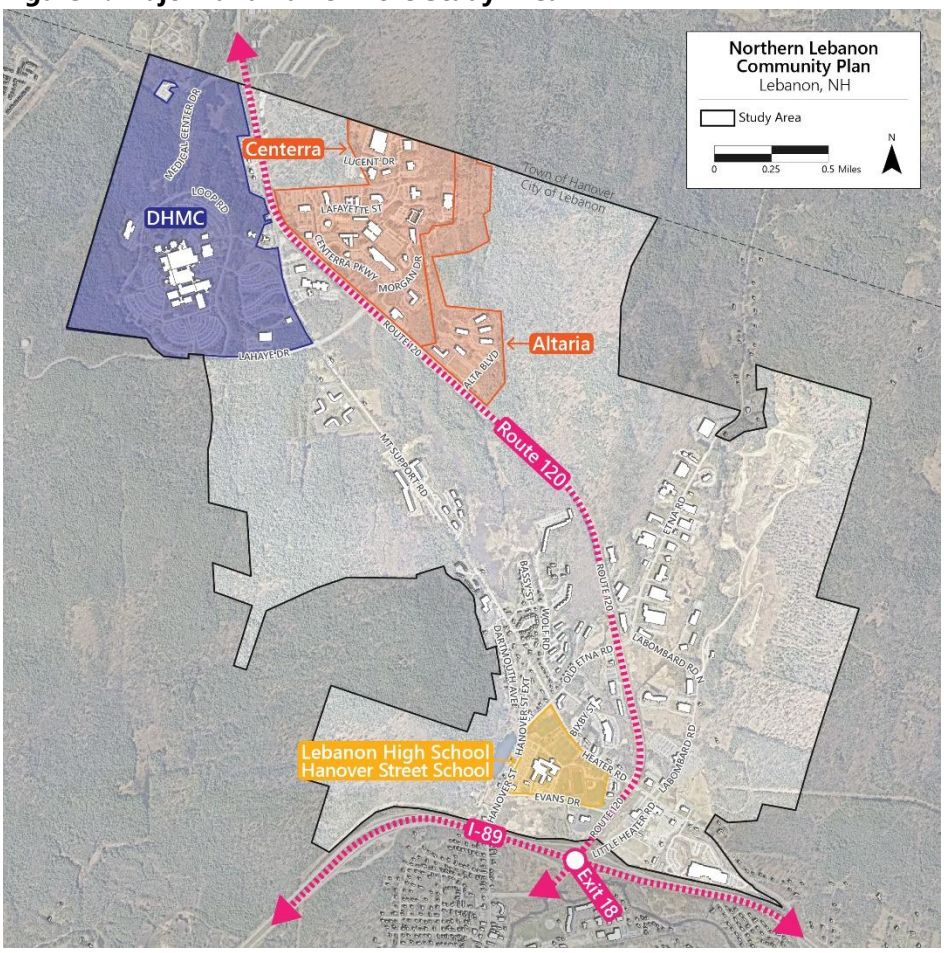
Key recommendations include establishing a Wildlife Corridor Passage Overlay District, reducing traffic speeds near key corridors, and promoting public education on wildlife conservation. Connectivity improvements focus on enhancing pedestrian, bicycle, and multimodal pathways, filling sidewalk gaps, and collaborating with transit and regional partners for improved transportation links. Zoning updates aim to foster mixed-use developments and diverse housing options, supporting growth near employment hubs and community assets. By refining zoning ordinances and partnering with key stakeholders, the plan sets a foundation for sustainable development, promoting green infrastructure and community-centric growth.

2

Existing Conditions

The Study Area consists of approximately 2,400 acres and is situated north of Downtown Lebanon and Interstate 89's Exit 18, east of the Boston Lot Conservation Area, south of the Hanover town line, and west of the Signal Hill Conservation Area, as shown below in **Figure 2**. It is located in the northern portion of the City of Lebanon and is home to existing assets such as the Hanover Street School, Lebanon High School, the Dartmouth-Hitchcock Medical Center (DHMC), the developments of Centerra and Altaria, as well as the highest density of new multi-family housing in the City. As the region's top employer – and the second largest employer in the state of New Hampshire – DHMC is a three-million-square-foot facility inclusive of the Geisel Medical School and employs over 10,000 staff. DHMC anchors the northern portion of the Study Area and serves as one of the primary providers of healthcare services for all of New England.

Figure 2: Major Landmarks in the Study Area



Property Ownership

Properties within the Study Area consist of several large parcels, with 20 parcels greater than 20 acres in size, as shown in **Figure 3 and Table 1**. Additionally, more than half of the total land within the Study Area (53%) is owned by just five landowners, including Mary Hitchcock Memorial Hospital, Dartmouth College Trustees, Upper Valley Land Trust Inc., Choice Storage LLC, and Lane NH Holdings LLC as shown in **Figure 4**. This underscores the need for close coordination with the landowners within the Study Area with regards to future development.

Figure 3: Existing Landowners

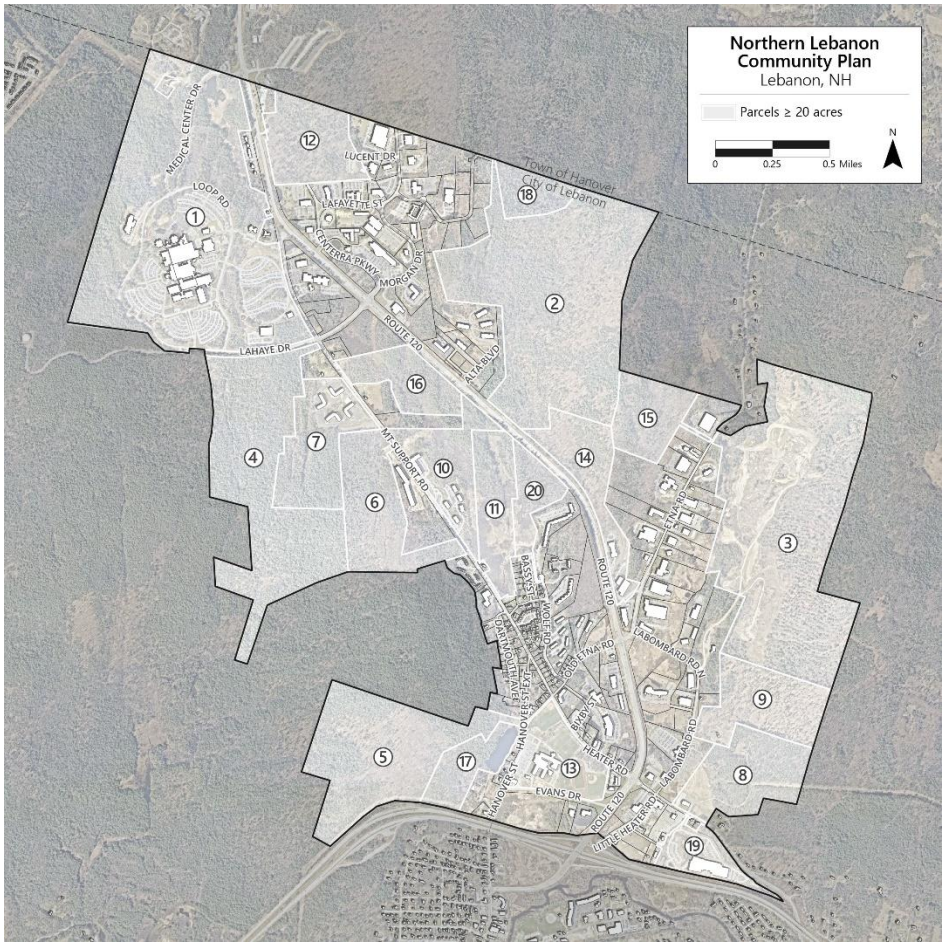
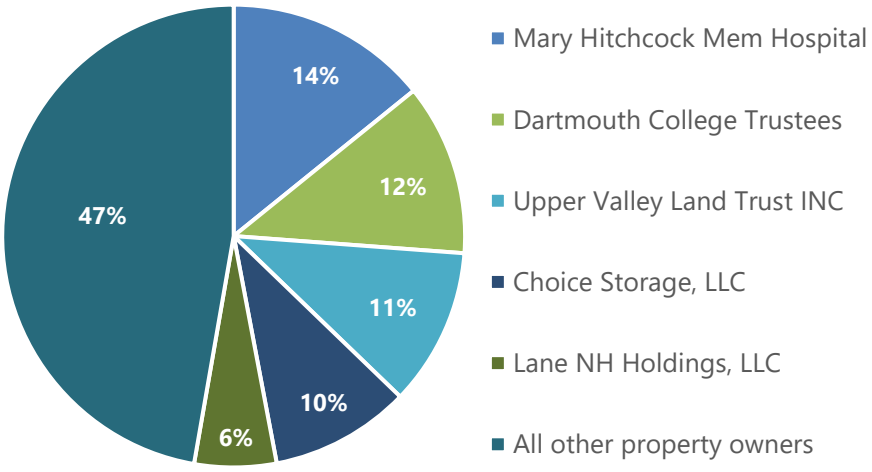


Table 1: Parcels 20 Acres in Size or Greater

Site ID	Acreage	Parcel ID	Site Address	Owner	Zoning
1	287	10-8-701	1 Medical Center Dr	Mary Hitchcock Memorial Hospital	MC
2	205	24-15	0 NH Route 120	Upper Valley Land Trust Inc	INDL
3	182	26-17	0 Etna Rd	Choice Storage, LLC	INDL
4	140	24-4	0 Mt Support Rd	Dartmouth College Trustees	R1
5	101	48-1	0 Hanover St Ext	Lane NH Holdings, LLC	R3
6	57	-	Mt Support Rd	SPNH Mount Support, LLC	R1
7	53	24-2	401 Mt Support	Dartmouth College Trustees	R1
8	51	51-13	150 Heater Rd	Benevolent & Protective Order	RL1
9	51	51-12	24 Labombard Rd	Frederic Hatch	INDL
10	43	24-11	2 Timberwood Dr	Audubon Timberwood LLC	R1
11	41	24-13	0 Mt Support Rd	Sharon Tice Brown	R1
12	39	10-10	0 NH Route 120	The Hitchcock Clinic	GC1
13	38	64-33	195 Hanover St Ext	Lebanon School District	R3
14	37	26-2	67 Etna Rd	ICV Holdings Of NH LLC	INDL
15	34	26-7	0 Etna Rd	Upper Valley Land Trust Inc	RL3
16	31	24-8	0 Mt Support Rd	Dartmouth College Trustees	R1
17	26	48-2	0 Hanover St Ext	Lane NH Holdings, LLC	R3
18	26	12-3	0 Lafayette St	Upper Valley Land Trust Inc	RL3
19	23	78-43	71 Heater Rd	Hypertherm, Inc	INDL
20	20	26-1-100	0 Wolf Rd	City of Lebanon	R1

Figure 4: Largest Landowners by Share of Study Area



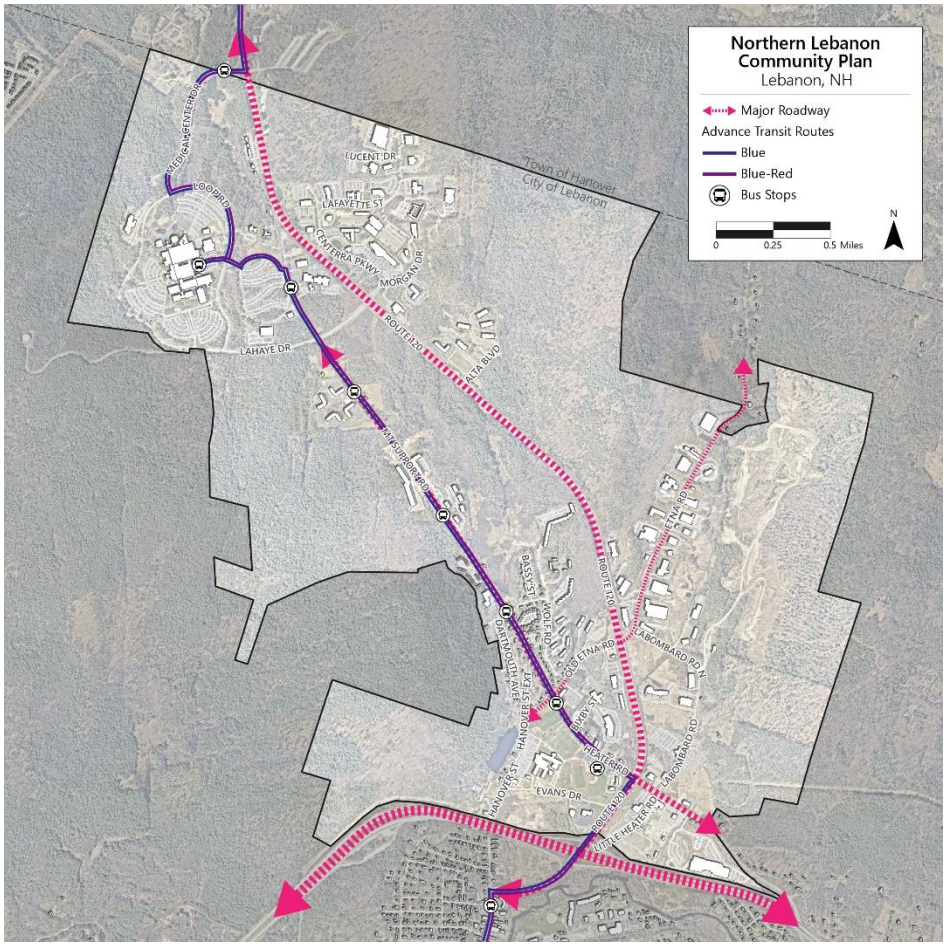
Transportation and Connectivity

The Study Area is situated north of Interstate 89, directly across the highway from Downtown Lebanon, which is to the south. Leading north from Exit 18, Route 120 bisects the Study Area as the primary north-south roadway that connects the Town of Hanover in the north to I-89 and Downtown Lebanon to the south. The majority of Route 120 is four lanes wide, consisting of two travel lanes in either direction. Exceptions include isolated turning lanes as the roadway approaches intersections with Lahaye Drive, Centerra Parkway, Alta Boulevard, Old Etna Road and Etna Road, Heater Road, and I-89. Supporting north-south arterial roadways include Mt. Support Road, Hanover Street, and Etna Road, all of which are two lanes apart from isolated third and fourth turning lanes at intersections. While there are limited east-west arterial roadways, once Mt. Support Road crosses its intersection with the Hanover Street Extension, its name changes to Heater Road and its direction pivots east-west once it crosses over Old Etna Road.

The Study Area is served by Advance Transit public bus service which serves eastern Windsor County and southwestern Grafton County throughout southeastern Vermont and western New Hampshire, respectively, the latter of which includes the City of Lebanon. Advance Transit has two north-south lines, the Blue and Blue-Red, that serve the Study Area via Mt. Support Road running parallel to Route 120. Within the Study Area, bus stops are located along Mt. Support Road and Heater Road, as well as DHMC and Medical Center Drive. The Blue and Blue-Red lines continue to run north to Hanover and south to downtown Lebanon. Roadways and Advance Transit routes and bus stops as of August 2024 are shown in **Figure 5**.

While Advance Transit does not directly serve some areas, like Heater Road, it will roll out a new line, the Pink Route, to serve Centerra, Downtown Hanover, DHMC (including Lot 9), as well as a transfer point with Blue Route buses from Lebanon in September 2024. Plans for the Pink Route include connecting downtown Hanover with the Lot 9 satellite parking lot. It would also include a transfer point with existing Blue Route buses from Lebanon at DHMC and provide brand-new service to currently unserved destinations in Centerra, including the NH 2nd Circuit Courthouse, the Dartmouth Hitchcock 24-hour pharmacy, the Co-op grocery store, and other major employers and service providers.

Figure 5: Transportation Network

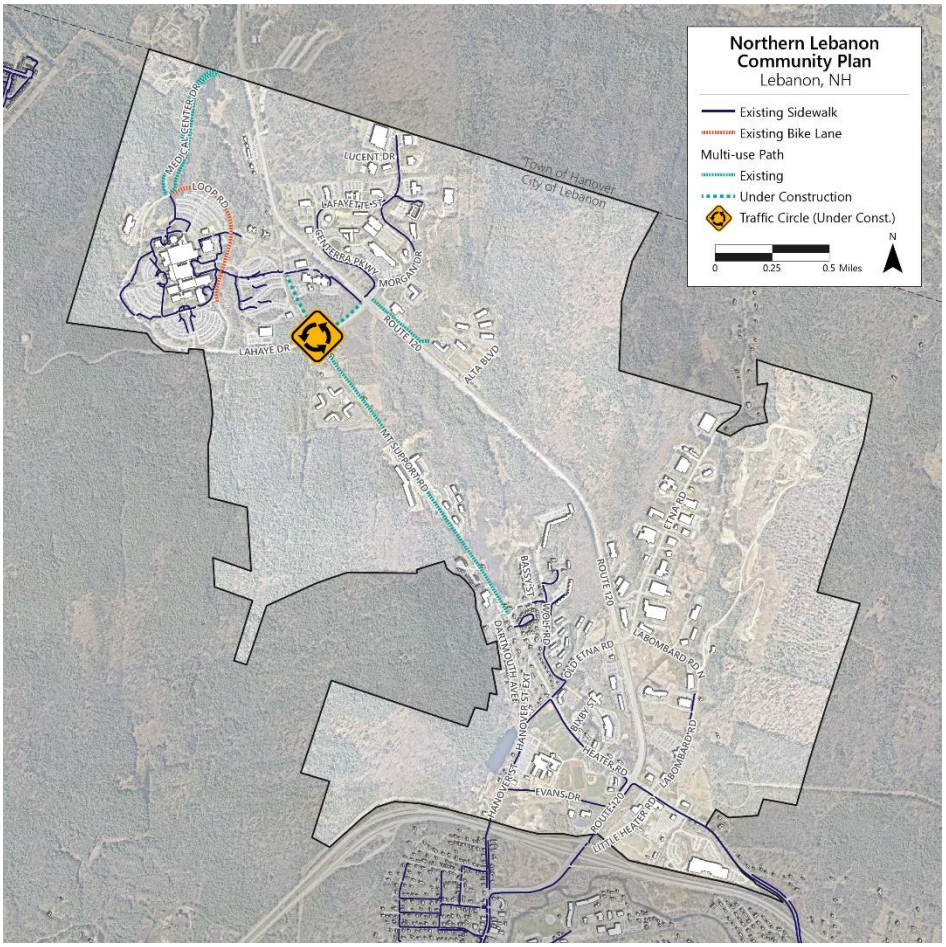


The presence and conditions of sidewalks vary greatly throughout the Study Area. As shown in **Figure 6**, sidewalks are concentrated in the north serving DHMC and Centerra, as well as the south surrounding the two schools and residential area. Very few instances of sidewalks exist outside of these two areas. Sidewalk connectivity is limited throughout the Study Area, as identified by the 2023 Walk Bike Ride Lebanon Plan's network map. Missing links and connections are prevalent throughout, making it difficult for pedestrians to navigate the Study Area safely and efficiently. Marked, safe pedestrian crosswalks are rare along the length of Route 120, despite its many intersections with arterial roadways. Similarly, cyclists have limited safe, connected options to traverse the Study Area.

Multi-use paths exist in three principal areas. The first path starts at the intersection of Mt. Support Road and the residential district around Memorial Drive to the south, extending north to DHMC after a recent extension from Lahaye Drive. Residents of nearby housing developments commonly use this path, especially those employed at DHMC. The second multi-use path is between Mt. Support Road and Centerra Parkway along Lahaye Drive, and the third is between Centerra Parkway and Alta Boulevard. A multi-use path connector is currently under construction in between Mt. Support Rd and Route 120 on the north side of Lahaye Drive, where a new traffic circle is also under construction at the intersection of Mt. Support Road and Lahaye Drive. In addition, as part of these circulation

improvements, the expansion of the multi-use path will continue north to the access drive for the oval DHMC parking area to the west and the medical office park to the east.

Figure 6: Existing Connectivity



Existing connectivity to Downtown Lebanon is limited to the dated and disjointed pedestrian bridge, and intersections within the Study Area are not designed for pedestrians or cyclists

Land Use and Zoning

Several zoning districts are present within the Study Area, as shown in **Figure 7**. These zoning districts are defined as follows:

- Rural Land 1 (RL1): Provides a transition between rural and residential zoning.
- Rural Land 2 (RL2): Provides land for low density rural living.
- Residential 1 (R1): Provides areas for all types of housing at relatively high densities.
- Residential 3 (R3): Provides areas for single family residential housing.
- Residential Office 1 (RO1): Provides for the combination of multi-residential housing as well as office uses at higher densities.
- General Commercial (GC): Provides for the development of general commercial uses.
- General Commercial One District (GC1): Provides opportunities for a mix of commercial and residential uses within close proximity to regional employers, public transportation routes, and pedestrian and biking trails.
- Industrial Light (IND-L): Provides for manufacturing and business development to strengthen the economics of the city.
- Medical Center (MC): Provides for the development of inpatient and outpatient healthcare.

The largest zoning districts present in the Study Area include 736 acres (31%) of Rural Land 3 (RL3), 558 acres (23%) of Industrial Light (IND-L), 376 acres (16%) of Residential 1 (R1), and 295 acres (12%) of Medical Center (MC). Smaller shares of the Study Area include 142 acres (6%) of right-of-way (ROW), 131 acres (5%) of General Commercial 1 (GC-1), and 75 acres (3%) of Residential 3 (R3). The remaining zoning districts present within the Study Area are either one-percent or less of the total acreage. A full breakdown of zoning districts by proportion of the Study Area and associated acreages are shown in **Figure 8**.

Figure 7: Zoning

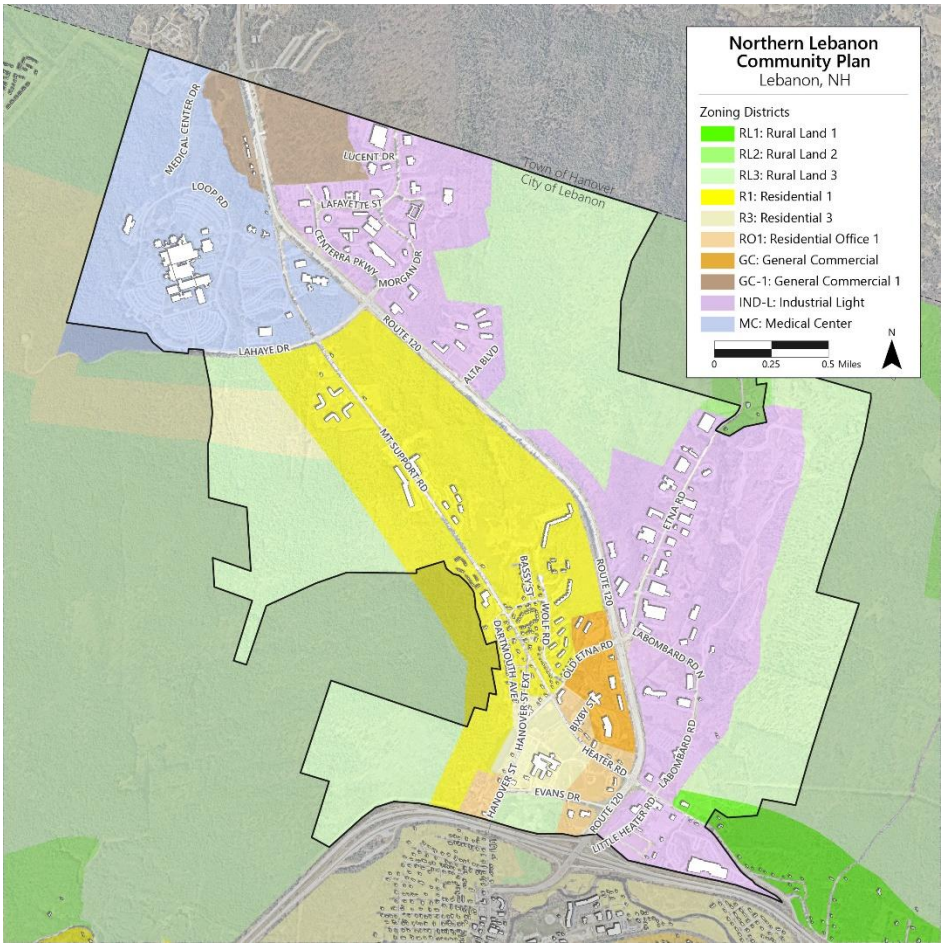
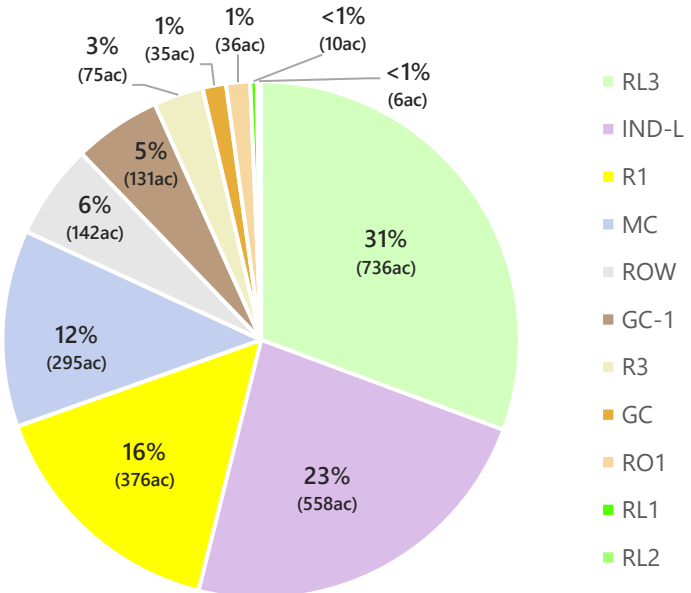
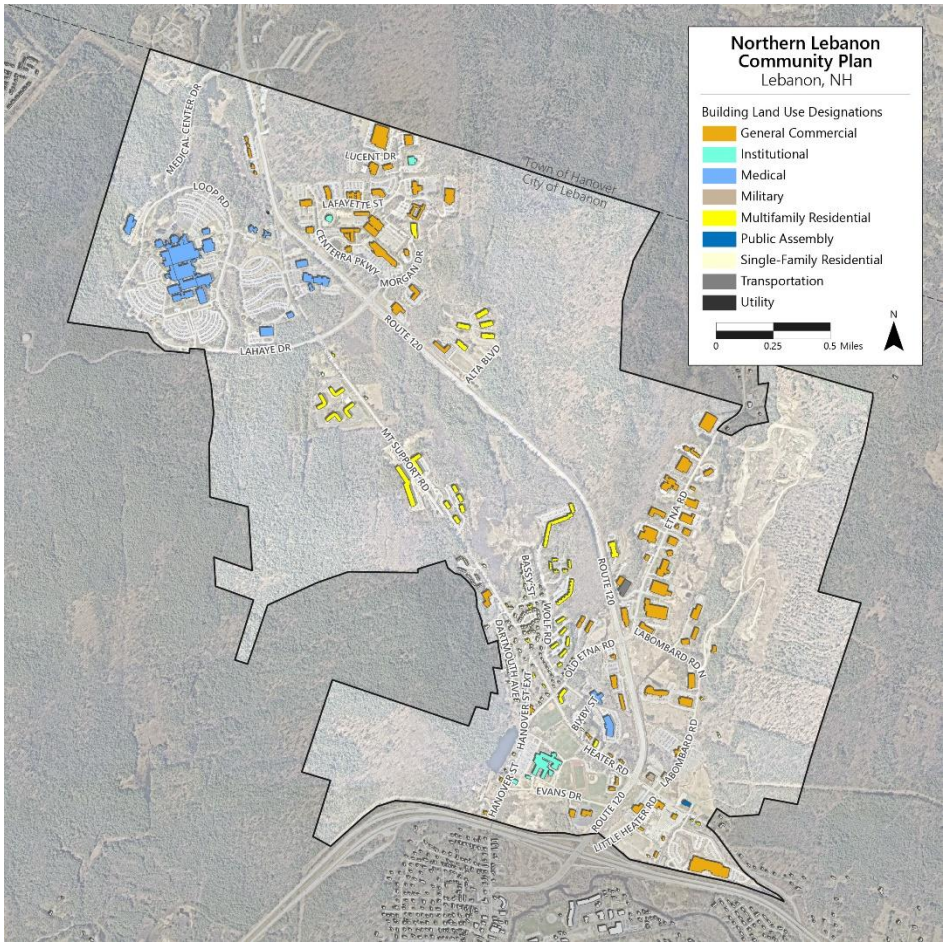


Figure 8: Share of Study Area by Zoning District



Existing development patterns within the Study Area primarily follow the hydrography and topography of the land, as described further in the following section covering Natural Resources. A majority of the existing development is located in the two valleys that converge on the Study Area as a result of the hills to the north, east, and west. Single-family residences are concentrated in the southern portion of the Study Area north of the schools along Mt. Support Road, Hanover Street Extension, Wolf Road, Dartmouth Avenue, Memorial Drive, and Bassy Street. A variety of multifamily housing developments are located in several pockets throughout the Study Area, including Mt. Support Road between Lahaye Drive and Memorial Drive, the eastern portion of Wolf Road to the north of Etna Road, west of Route 120, and in Altaria along Alta Boulevard to the east of its intersection with Route 120. A single multifamily building is located outside of these three areas within Centerra off Morgan Drive. Retail and commercial uses are fairly concentrated in three separate clusters within the Study Area including Centerra, along Etna Road, and in the southern portion surrounding Route 120 and Heater Road. Land uses within the Study Area are shown in **Figure 9**.

Figure 9: Land Use



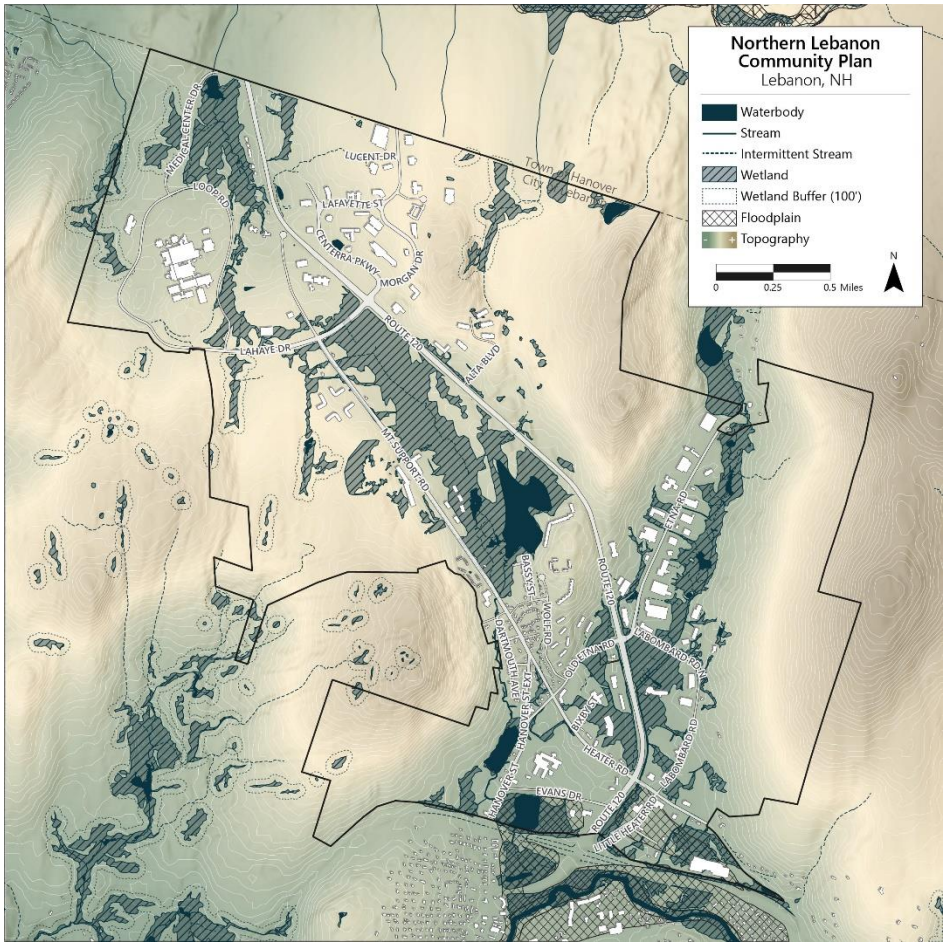
A mix of land uses exist within the Study Area, including single-family homes, townhouses, multifamily apartments, public schools, the DHMC hospital campus, and industrial uses

Natural Resources

The Study Area is home to a large number of protected wetlands, with most located in the center of the Study Area on land between Route 120 and Mt. Support Road, as shown in **Figure 10**. Additionally, wetlands run parallel to Etna Road to the west, with additional wetlands interspersed in both the southern portion of the Study Area around I-89 and the northern portion to the north of Medical Center Drive. Several of the Study Area's wetlands are designated as Prime Wetlands under Title L: Water Management and Protection, § 482-A:15. These wetlands are municipally-designated and have a 100-foot Prime Wetland buffer zone with restrictions on the placement of built structures.

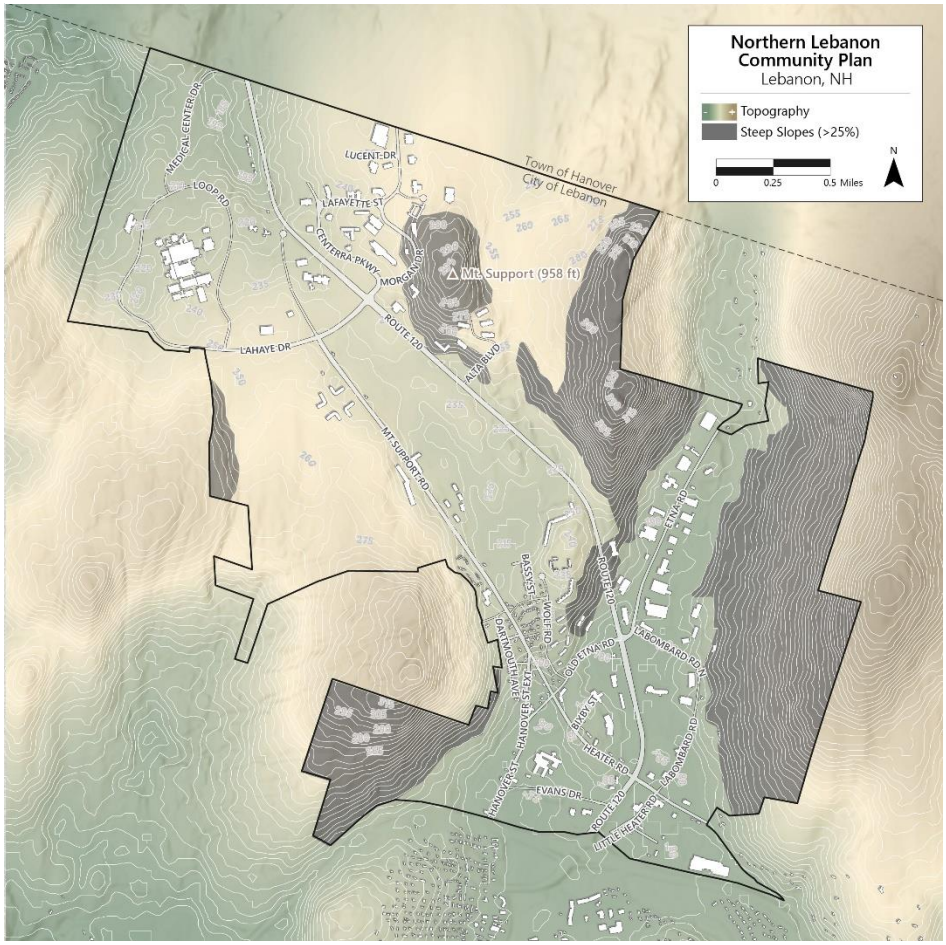
Several waterbodies, streams, and intermittent streams are present within the Study Area, and typically overlap with the presence of wetlands. All streams within the Study Area are located in the Mascoma River Watershed and feed into the Mascoma River to the south, which in turn drains into much larger Connecticut River to the west. The only presence of floodplains in the Study Area are located in the southern portion surrounding the Mascoma River, stretching north to Evans Drive, I-89, and the southern portion of Heater Road.

Figure 10: Hydrography



Wetlands, waterbodies, and streams within the Study Area are directly reflective of the topography of the area. Several hills and sloped, protected conservation lands are located throughout the Study Area including Quarry Hill to the southwest, Boston Lot to the west, Mount Support and Rix Ledges to the north-northeast, and Signal Hill to the east. The topography of the Study Area has not only shaped the natural environment, but the built environment as well. Aside from the isolated developments that have heavily graded the topography in order to develop the land, most of the built environment in the Study Area falls between these hills in two valleys. Route 120 and Mt. Support Road run north-south along the spine of the western valley. Similarly, the spine of the eastern valley is home to Etna Road, which serves as a north-south artery. Steep slopes are present in several locations throughout the Study Area, as shown in **Figure 11**. These areas should be carefully considered for preservation in order to protect the natural character of the area.

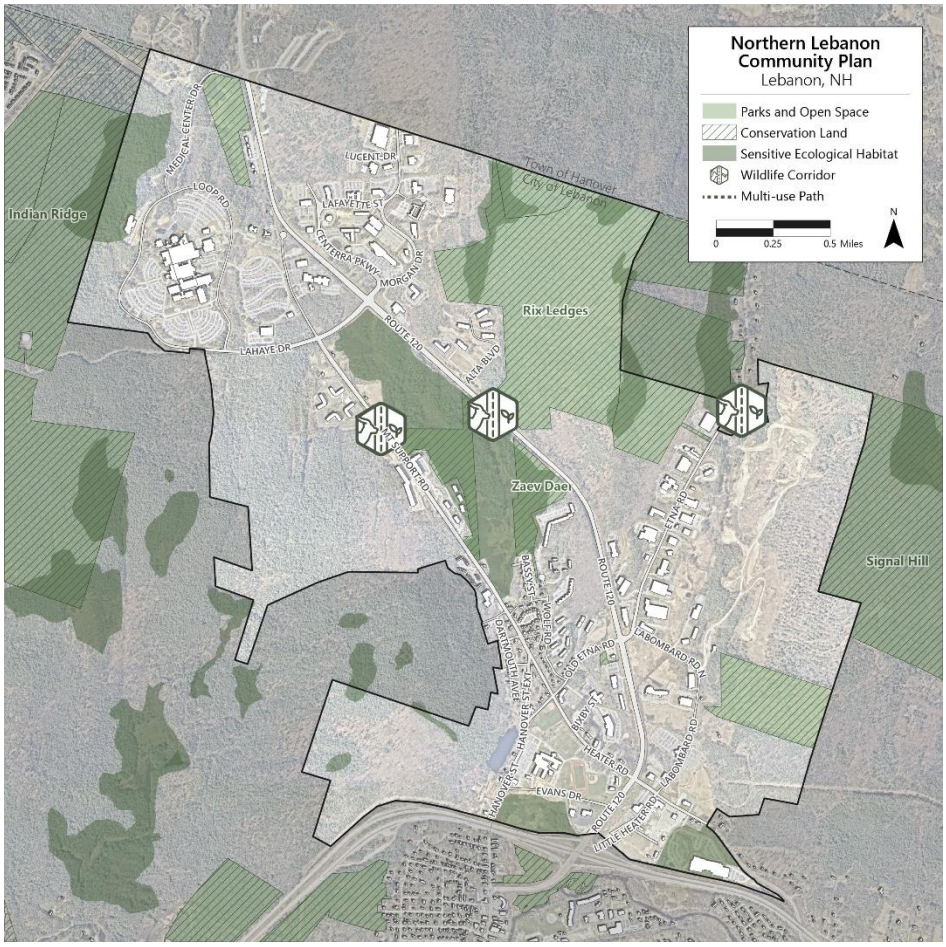
Figure 11: Topography and Steep Slopes



The Study Area is home to a number of protected conservation lands, wildlife corridors, and sensitive ecological habitats, as shown in **Figure 12**. Conservation lands include over seven parcels, totaling approximately 369 acres (16%) of the total Study Area. Three existing wildlife corridors bisect the Study Area at Mt. Support Road, Route 120, and Etna Road, the Study Area's three major north-south roadways. These designated wildlife corridors contain existing culverts and under-road passages that help to reduce wildlife-vehicle collisions. These protected corridors allow for the safe passage of

small animals between the Study Area's handful of sensitive ecological habitats. The Mt. Support Road and Route 120 wildlife corridors connect the Mt. Support Road wetland sensitive ecological habitat, while the Etna Road wildlife corridor allows for connectivity to the Rix Ledges Conservation Area.

Figure 12: Conservation Lands, Sensitive Ecological Habitats, and Wildlife Corridors



Previous Planning Efforts

This section provides a summary of recent planning studies and reports that have informed the key takeaways and recommendations of the Plan, alongside the input gathered during public engagement efforts.

City of Lebanon Master Plan (2012)

The City of Lebanon's Master Plan was adopted by the Planning Board in March 2012, and prioritizes the needs and preferences of its residents. In particular, the plan emphasizes the stewardship of natural and recreational areas and endorses principles of smart growth. The plan aims to balance direct feedback from the community with the projected goals for future development while addressing several key aspects such as land use, economic development, housing, transportation, and energy, among others. Essential areas of focus within the plan include DHMC and the Mt. Support Road Corridor, encompassing the Study Area. DHMC is specifically noted for its surrounding natural features like wetlands, slopes, and crucial wildlife habitats. The plan stresses the importance of managing development in a manner that does not jeopardize these vital resources.

The Mt. Support Road Corridor has seen recent multifamily housing developments that enhance community living conditions by improving walkability, providing job opportunities, and increasing access to downtown resources to the south. Multifamily developments approved since 2020 have been designed to keep clear of the wildlife corridors and easements have been recorded to protect these areas. Further efforts to maintain existing natural and wildlife corridors will continue to be of critical concern. Overall, the plan underlines the importance of protecting and appreciating the town's natural resources and wild spaces, recognizing their role in driving the local economy while also promoting sustainable growth and environmental preservation.

Lebanon's Wildlife Corridors (2016)

After completing Lebanon's Natural Resources Inventory (NRI) in 2010 and adopting the City's Master Plan in 2012, the Planning Department initiated a series of wildlife corridor assessments starting in 2013. These assessments aimed to evaluate areas vulnerable to development and determine their use and significance for wildlife crossings. Building on initial findings, these efforts were expanded in 2014 to assess the use of identified corridors, document species of concern, and explore enhancements for wildlife movement.

By December 2016, a comprehensive study outlined findings for 17 wildlife corridors, highlighting 14 critical areas chosen through GIS data and fieldwork. The report provided detailed mapping and recommendations for improving long-term viability, including signage, structural improvements, conservation strategies, and monitoring. These insights are designed to support Lebanon's planning, incorporating green infrastructure to sustain local wildlife populations and improve ecological connectivity.

Lebanon Open Space Plan (2021)

The Lebanon Open Space Plan outlines the city's strategy to conserve and manage its natural landscapes. The plan emphasizes the importance of open spaces for ecological integrity, recreation, and community well-being. It includes goals such as protecting water quality, preserving wildlife habitats, and maintaining scenic and cultural resources. The plan aims for 78% of Lebanon's land to be open space, with 22% dedicated to developed areas, emphasizing the importance of prioritizing infill and redevelopment over urban sprawl. The plan details several strategies to achieve Lebanon's open space objectives, including public education, partnerships, regulatory protections, and property acquisition. Relevant recommendations including the following:

- Current zoning contains provisions for Planned Unit Developments (PUDs) or Cluster Subdivisions that are intended to preserve significant natural land features and/or open space by providing greater development flexibility. In return for setting aside a percentage of a property as permanent open space, landowners would receive the allowed density for the entire parcel and may also benefit from reduced development costs.
- Lebanon should consider developing and incorporating a maximum lot coverage limitation to ensure that a portion of all lots remains as greenspace. In addition, because a significant amount of lot coverage is typically associated with parking, the City should develop Maximum Parking Requirements and allow for reductions in parking provided on site. Encouraging adjoining properties to share parking may also help reduce impervious surface in the City.
- Increasing the maximum height of buildings should be evaluated and incorporated within appropriate zoning districts as that measure could support reducing the overall footprint of development projects.
- Incorporating additional innovative land use planning techniques, including lot size averaging, density transfer credit, and urban service districts.
- The City should review the advisability of incorporating additional Overlay Districts, where warranted, to protect additional resources deemed important by the community. Examples include a steep slope, a source water, aquifer, and ridgeline overlay protection district.
- When high-value open space lands are available for purchase from a willing seller, the City and its partners should make a reasonable effort to conserve these lands through direct acquisition, easement, or another established protection mechanism.

Housing in Lebanon (2021)

Recent changes to the City's zoning regulations over the past years reflects a trend towards increased flexibility and density in various districts as listed below:

- 2013: Permitted multifamily dwellings and mixed-use buildings in the GC district. Accessory Dwelling Units (ADUs) became a Special Exception use in residential and mixed-use districts.
- 2014: Allowed multifamily dwellings in the PB district with density determined through Site Plan Review.

- 2016: Adopted shared parking provisions for mixed-use developments.
- 2018: Removed the minimum size threshold for ADUs, allowed multiple principal structures on residential lots with Planning Board approval, and changed ADUs to permitted uses in all districts.
- 2019: Increased maximum building height in the Central Business District (CBD), added PURD as a permitted use in RO/RO1 districts, and expanded the definition of "family."
- 2020: Continued enabling ADUs as permitted uses in all districts.
- 2021: Expanded allowed residential dwelling types in Commercial and Industrial Planned Unit Developments (PUDs) and Business Parks, relaxed off-street parking requirements for one and two-family dwellings and ADUs, and permitted increased building height in R1 district to include parking underneath the building.

To streamline the review process of smaller projects, a new Minor Site Plan Review process was implemented. This process impacts housing developments, including the conversion of existing structures to residential or mixed-use and minor expansions of existing multifamily uses. In addition, provisions have been made to exempt multi-building residential developments from the Subdivision Review process to make development easier. Together, these updates have contributed to a rapidly evolving housing market in Lebanon. It was estimated that 667 dwelling units were created between the years 2010 and 2019 in Lebanon, of which, 609 were from new construction (551 multi-family, 58 single-family) and 59 were created by conversion (includes ADUs, single-family to duplex, or multi-family conversions).

Lebanon fosters equity in the competitive housing market by incentivizing the creation of affordable units through the 79-E Community Revitalization Tax Relief Incentive Program. This program allows city council to grant temporary tax relief for owners who undertake substantial rehabilitation of a qualifying structure that provides at least one public benefit as defined in the statute. The tax relief period can extend up to five years for compliant projects, with possible extensions of up to two years for residential units and up to four years for affordable housing. Additionally, projects involving the rehabilitation of historic structures that follow the U.S. Secretary of Interior's Standards may receive up to four more years of relief. Since 2016, two 79-E districts have been designated under the program. More recent provisions under 79-E have led to two new provisions that impact housing:

- HB154: Establishes a "Housing Opportunity Zone" for new construction, which does not have to be limited to downtown or town center areas and can instead be designated by city council. At least one-third of the units must be for households earning 80-percent or less of Area Median Income (AMI) or meeting RSA 204-C:57 criteria. Tax relief can be granted for up ten 10 years upon the issuance of a Certificate of Occupancy.
- SB102: Proposes "Residential Property Revitalization Zones" for rehabilitating existing structures. Tax relief is offered to owners of one- or two-family or attached multifamily properties (up to four units) that are at least 40 years old and undergo significant improvements in quality, condition, and/or use.

City of Lebanon Housing and Community Development Plan (2022)

The City of Lebanon Housing and Community Development Plan, amended and readopted in July 2022, builds upon Lebanon's Principles for a Sustainable Community adopted in September 2009, further revised and readopted in March 2015. Lebanon is actively managing its growth, focusing on

increasing housing options while preserving its small-town charm. From 2010 to 2020, they added 552 housing units, and since 2020, over 900 units have been approved, signifying a strong upward trend in residential development. However, this growth has been accompanied by a sharp increase in rental rates, with a 28.9% rise since 2016 and a significant 61% jump since 2011, pointing to an escalating affordability issue. In response to these challenges, the city council has implemented measures aimed at promoting affordable housing. These measures have encouraged town management to work collaboratively with agencies like the Lebanon Housing Authority and the Twin Pines Housing Trust to develop and expand housing solutions that cater to varying income levels.

Economically, Lebanon has witnessed substantial growth, particularly through expanding sectors like healthcare, social assistance, retail, and education, primarily around the Route 12A and Route 120 corridors. To support this economic development and enhance the quality of life, the City has updated zoning regulations to foster mixed-use developments, allowing for the creation of conditions where residents can live, shop, and engage with the community, reducing the need for prolonged commutes.

Upper Valley Lake Sunapee Regional Planning Commission Regional Corridor Transportation Plan (2022)

The Upper Valley Lake Sunapee Regional Planning Commission Regional Corridor Transportation Plan studied existing conditions and developed an action plan to implement several public improvements to the region's transportation network to increase safety, accessibility, resiliency, and equity and health outcomes, all while balancing mobility, aligning transportation with community planning to create livable communities, managing existing demand, and prioritizing maintenance. In addition, the plan developed performance measures that will be used to track progress towards implementation of the overall plan and its components. Specific regional transportation goals were developed for the Route 120 north corridor between Lebanon and Hanover, including:

- Manage Demand – Reduce need/demand for single-occupant vehicle travel in the corridor, particularly during peak commuting times.
- DHMC/Centerra Access – Improve pedestrian, bicycle, and public transit access to and from Dartmouth-Hitchcock Medical Center, Centerra Park, downtown Hanover and downtown Lebanon.
- Bus Connections – Increase frequency of public transit services in the corridor and improve pedestrian access to bus stops.

In addition to currently funded regional transportation projections, additional multimodal needs and opportunities for this corridor include the following:

- The need for a comprehensive plan for ped-bike access between downtown Lebanon, DHMC, and Hanover; and
- Addressing the lack of pedestrian and bicycle connections from the Mt. Support Road multi-use path to DHMC.

Walk, Bike, Ride Leb (2023)

This report highlights the City's ongoing efforts in transportation planning, recognizing the necessity for a comprehensive multimodal transportation plan. The plan identifies specific actions to develop a safe, connected network for walking, biking, and public transportation, with a focus on adapting to changing funding sources, public input, and mobility trends. Its primary goal is to incorporate public input received throughout the planning process with a combination of existing recommendations to improve pedestrian, bicyclist, and transit safety and mobility. Key objectives include assessing the needs for pedestrian and bicycle facilities, ensuring equitable network connectivity, organizing and prioritizing improvements, preparing for funding and implementation of key projects, guiding committee and public decisions, and progressing towards Vision Zero goals to eliminate traffic fatalities. This comprehensive approach integrates feedback from various stakeholders and aims to build a modern, safe, and comfortable multimodal transportation network for Lebanon. Specific planned, funded, and proposed strategies for the New Hampshire Route 120-DHMC Corridor include the following:

- Advance Transit Blue Route Expansion – increasing Blue Route to 15-minute service between downtown Lebanon and Hanover, partially funded via the Congestion Mitigation & Air Quality (CMAQ) Improvement Program. *IMPLEMENTED 2023*.
- Mt. Support Road/LaHaye Drive Intersection Improvement – Upgrade Mt. Support/LaHaye Drive intersection, currently in the pre-construction phase. *CONSTRUCTION UNDERWAY 2024*.
- Route 120 corridor improvements from Hanover St to Etna Road – Improve vehicular operations and ped. bike, and transit access along Route 120 corridor from Hanover St to Etna Road, including I-89 Exit 18, with an additional $11 million in funds proposed in the draft New Hampshire (NH) Ten-Year Transportation Improvement Plan. *NHDOT EXIT 18 PROJECT STALLED*.
- Lahaye Drive multi-use path - Construct multi-use path from Mt. Support Road to Centerra Parkway, including improved crossing of Route 120. *CONSTRUCTION UNDERWAY 2024*.
- Route 120/Etna Road pedestrian crossing – Construct pedestrian crossing of Route120 at Etna Road, as identified through the public engagement process.
- Advance Transit new Purple Line – Create a new Purple Line to serve additional destinations in Lebanon, including Mascoma St, Labombard, Centerra/Altaria. *LAUNCHING AS PINK LINE 2024*.
- Pedestrian access to Advance Transit stop at Heater Road/Old Etna Road – Add sidewalk to Advance Transit stop at Heater Road/Old Etna Road.

Lebanon Community Resilience Building (2024)

Ahead of the 2025 rezoning ballot initiative, Lebanon collaborated with The Nature Conservancy and the University of New Hampshire Extension School to complete this report. The process highlighted the City's strengths and areas for improvement concerning resilience, sustainability, and equity. Key partners were identified, including the Public Health Council of the Upper Valley, Upper Valley Lake Sunapee Regional Planning Commission (UVLSRPC), Upper Valley Adaptation Working Group, and The Nature Conservancy. These partnerships will be integral to balancing the protection of open

spaces with new development requirements, safeguarding critical natural resources, and addressing the impacts of climate change and invasive species.

The report identifies mobility challenges due to steep slopes, traffic congestion at Exit 18, and frequent road closures from falling trees as issues that require continued investments in infrastructure improvements. Future goals outlined in the report include formalizing Lebanon's urban growth boundaries in zoning maps to help ensure development remains compact and walkable while preserving the City’s forested lands. This strategic approach aims to balance infrastructure needs with conservation efforts, increasing open space, and supporting the Tree Advisory Board to address heat island concerns and enhanced wildlife passages.

3

Public Engagement

As part of the development of the Plan, a robust public engagement effort was undertaken. This included an online engagement survey, three sets of interview sessions with various targeted stakeholders that took place over the course of three hours on Wednesday, April 24, 2024, and two public workshops. Public Workshop No. 1 was held on Wednesday, April 24, 2024, following the stakeholder interviews and included a presentation of the existing conditions of the Study Area. Members of the public and the community were invited to participate in two interactive exercises during Public Workshop No. 1 that identified the Study Area's strengths and weaknesses and prioritized opportunities for its future. Public Workshop No. 2 was held on Tuesday, July 23, 2024 and included a presentation of the initial draft findings of the Plan, as well as the draft strategies for implementation and associated recommendations. Participants were broken out into small groups to discuss the draft findings, strategies, and recommendations and solicit feedback from the public.

Online Survey

A five-question online survey was developed in order to solicit initial feedback and input on the Study Area's existing conditions, as well as gauge the community's appetite for specific changes that should be explored further during the planning effort. With over 150 responses recorded, a summary of key takeaways are listed below:

- When asked about their relationship to the Study Area, most respondents either frequented the Study Area for shopping trips or personal appointments or passed through enroute to other destinations, indicating that the Study Area is used for a combination of mixed travel, including both local traffic and through traffic. In addition, almost half of all respondents work within the Study Area, indicating that many frequent the Study Area on a routine daily basis.
- When asked about what improvements needed to be made to the Study Area, the top three most popular answers were pedestrian connectivity, the need for bike routes, and additional parks and recreational areas, listed in order of importance. These responses highlight the need for multimodal connectivity improvements outside of vehicular traffic and additional opportunities to access existing natural areas and provide more formalized parks and open space areas.
- When asked about their views on mixed-use development in the Study Area, respondents generally expressed support for this development type, with almost half either strongly agreeing or agreeing that more mixed-use development is needed within the Study Area.
- When asked about what types of new housing could be most successful in the Study Area, the housing types with the most support included townhouses, smaller two or three-bedroom single family homes, condos, and multifamily apartments.

- When considering the most suitable locations for new housing in the Study Area, respondents were most supportive of areas near existing or future transit services, job centers. Respondents also noted that the design of any new housing developments should be compatible with the existing developments in the surrounding area.

A copy of the full survey, including questions and results, can be found in **Appendix A**.

Stakeholder Interviews

Stakeholder interviews are a fundamental component of the public engagement process as part of a community-based planning study. These interviews helped shape the basis of the Plan, leading to more informed planning by establishing context, defining a vision, and laying the groundwork for consensus-building. The purpose and intent of the stakeholder interview sessions were to aid in the gathering of information through local knowledge and identifying and understanding the needs and concerns of different community members and organizations.

Through these stakeholder interviews, challenges and opportunities were identified that may not have been presented through traditional data gathering and analyses. These sessions fostered inclusivity amongst various community representatives and yielded diverse perspectives on issues and opportunities affecting the Study Area. Three stakeholder sessions were conducted and included the following groups:

- Session 1: Large Employers within the Study Area
- Session 2: Local and Regional Real Estate Developers and Property Owners in the Study Area
- Session 3: Lebanon Public School District (SAU#88) and Local Community-based Organizations that serve the Study Area

Each set of stakeholders were asked a series of identical base questions to better understand their relationship to the Study Area, in addition to several unique questions based on the underlying makeup of the individual groups. Stakeholder interview session questions can be found in **Appendix B**. Outcomes and key takeaways from each of the three sessions are organized into categories as summarized below:

Housing

- Issues:
  - Residents and workers are quickly getting priced out of this area of Lebanon due to rising housing costs;
  - Current housing supply is not meeting the demand and is not diverse enough;
  - There is a lack of home ownership opportunities; and
  - There is demand for smaller single-family homes and larger bedroom counts for apartments in multifamily buildings.
- Opportunities:
  - New developments should be thoughtful infill that includes a mix of uses and housing types; and

- New housing should be co-located proximate to existing development and community amenities.

Zoning

- Issues:
  - There is a lack of office and industrial tenants, leaving vacant buildings and undeveloped sites in these zones;
  - The existing zoning regulations are restrictive, leading to developers having to come up with creative solutions to use the existing code, hindering redevelopment due to added time and funding;
  - The variance process is the same for single-family homeowners as it is for a developer proposing a mixed-use or multifamily development, adding time and resources to the approvals process for new developments;
  - Increasing density in the PUDs leads to additional requirements and stipulations; and
  - Multifamily zoning exists within Lebanon, but it is not abundant in the Study Area.
- Opportunities:
  - Allow for multifamily and mixed-use zoning by-right within the Study Area;
  - Streamline the site application review process.

Connectivity

- Issues:
  - The existing multi-use path on Mt. Support Road has no connection to Route 120 or the Town of Hanover;
  - There is either limited or a lack of pedestrian infrastructure on streets that bisect Route 120, making walkability unsafe and difficult;
  - There is a lack of cohesion amongst developments, with limited or no connectivity between existing developments; and
  - I-89 is a barrier between the Study Area and downtown Lebanon.
- Opportunities:
  - Any future community amenities should be co-located near existing development or existing community amenities; and
  - Improve pedestrian, multimodal, and public transit connectivity throughout the Study Area, particularly across Route 120, between existing developments, and across the existing pedestrian bridge across I-89 to downtown.

Natural Resources

- Issues:
  - There are limited connections to the existing trail network; and
  - There is a lack of formalized parks and open space outside of the conservation lands.
- Opportunities:

- Preserve all wildlife crossings, conservation lands, sensitive ecological habitats, and protected wetland areas; and
- Any future developments should incorporate sustainability and resiliency components to preserve and enhance the existing natural character of the Study Area.

Public Workshop No. 1

During Public Workshop No. 1, participants were given a presentation on the Study Area's existing conditions, including property ownership, transportation networks, land use and zoning, and natural resources. Members of the public had the opportunity to share their ideas, express their concerns, and participate in the development of a cohesive vision for the Study Area. Two interactive exercises were conducted during the workshop:

Activity 1: Strengths and Weaknesses

Attendees were given 20 minutes to review and mark up five maps of the Study Area that highlighted existing: housing, retail and commercial, community amenities, transportation networks, and natural resources. Participants wrote what they thought were existing "strengths" of the Study Area on yellow post-it notes, and existing "weaknesses" of the Study Area on pink post-it notes. The outcome was a summary of strengths and weaknesses of the Study Area as follows:

- Housing:
  - There is a high demand for single-family homes;
  - There is a lack of diverse housing types; and
  - New development is typically not located near existing retail and commercial areas, forcing people to use vehicles as their primary mode of transport.
- Retail and Commercial:
  - Existing retail and commercial developments are difficult to access by foot or bicycle; and
  - There is a need for neighborhood-serving retail options within walking distance to existing residential areas.
- Community Features:
  - The Town should increase the safety and preserve the character of the area surrounding the schools; and
  - The Study Area lacks a sense of place and would benefit from a more cohesive identity.
- Transportation:
  - There is a need to expand the multi-use path and install bike infrastructure throughout the area;
  - Pedestrian safety is a major concern; and
  - Connectivity should be enhanced between all modes of non-vehicular transportation, including additional public transportation via Advance Transit.
- Natural Resources:

- Need to protect existing wildlife crossings, conservation lands, and sensitive ecological habitats;
- Consider buffers to protect and preserve existing open spaces; and
- New development should be sustainable and consider its placement within the greater context of the area.

Activity 2: Priorities

Attendees were broken out into two groups with one dedicated facilitator. The group was instructed to develop a list of priorities they would like to see considered in the Plan in 15 minutes. During the last five minutes of the activity, each member of the two groups were given three sticker dots and had to use all of them to vote for which priorities they preferred. Individuals were not allowed to vote for the same priority more than once. The outcome was a list of priorities for the two separate groups for what each would like to see considered in the Plan as follows:

- Group 1 Priorities:
  1) More housing in a cohesive, sustainable way
  2) Better, safer pedestrian connections
  3) Tie between:
     - More 3-bedroom apartments
     - Incorporate climate resiliency measures in new developments
  4) Preserve the wildlife corridors
- Group 2 Priorities:
  1) Rezone Etna Road from IND-L to more residential friendly [zoning]
  2) Tie between:
     - Keep historic nature of the brickyard site, connect to the schools, incorporate community use, retail, or commercial
     - Quality of life values: more green space and protect current values
     - Mixed-uses and adaptive reuse
     - Establish housing partnership with DHMC

Boards and comments from Public Workshop No. 1 can be found in **Appendix C**.

Attendees identify strengths and weaknesses of the existing conditions of the Study Area

Public Engagement Findings

Using input and feedback from the online survey, stakeholder interviews, and Public Workshop No. 1, in addition to the existing conditions analysis and previous planning efforts, the following findings and key takeaways were identified:

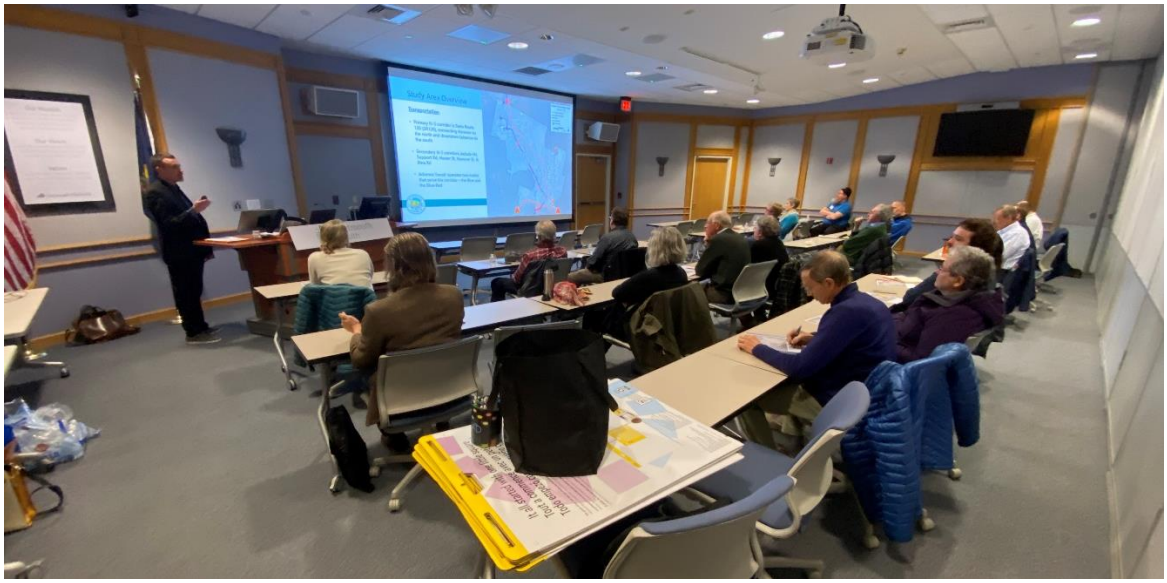
- Concerns over pedestrian and bicyclist safety, combined with the lack of contiguous sidewalks and the existing multi-use path, result in unsafe and fragmented non-vehicular circulation patterns within the Study Area.
- Recent developments occur in isolation from one another and lack interconnectivity, resulting in a built environment that can be cumbersome to navigate.
- The rise of multifamily developments within the Study Area have sparked concerns over the preservation and protection of wetlands, the wildlife corridors, and protected open space assets such as conservation lands and sensitive ecological habitats.
- The Study Area lacks a sense of place and would likely benefit from additional community amenities, neighborhood-serving retail, and a neighborhood branding campaign.
- Limited housing options within the Study Area have led to either employee turnover or long commute times at several large employers within the Study Area, indicating the need for additional, locally concentrated housing opportunities of varying types.

Public Workshop No. 2

During Public Workshop No. 2, participants were given a presentation on the Plan's findings and draft strategies and recommendations. Members of the public were broken out into small groups to encourage discussion and solicit input and feedback on the draft strategies and recommendations. A summary of public input from the second public workshop is as follows:

- Promote multi-use transportation: develop paths for bikes and scooters, expand pedestrian infrastructure, and maintain sidewalks.
- Support sustainable development: encourage rezoning for residential growth, reduce parking requirements, and focus on height flexibility in new developments.
- Enhance housing and infrastructure: address future housing needs, prioritize diverse ownership options, and ensure new developments support public transit expansion.
- Improve traffic and connectivity: evaluate housing impacts on traffic, maintain Route 120 as a high-speed route, and enhance east-west connections and access in key areas.
- Preserve natural resources and wildlife: preserve wildlife corridors, enhance culverts for animal crossings, and balance development with environmental protection, including wetland areas.
- Revise land use and zoning: develop community parks, update current zoning, and explore targeted rezoning.

Additional comments received following Public Workshop No. 2 can be found in **Appendix D.**



Attendees learn about the findings of the existing conditions analysis of the Study Area

4

Vision Statement, Strategic Goals and Recommendations

Vision Statement

Forming a vision statement is a crucial step in the community planning process as it provides a clear, shared sense of direction and purpose. It encapsulates the collective aspirations and long-term goals of the community, serving as a guiding strategy for all future planning and development efforts. A well-crafted vision statement fosters unity, aligning stakeholders, residents, and policymakers around a common objective. It acts as a benchmark against which progress can be measured, fostering accountability and continuous improvement. By engaging the community in the creation of the vision statement, the resulting vision promotes inclusivity and ensures that diverse perspectives are considered, leading to more holistic and sustainable planning outcomes.

Building upon the existing conditions analysis, the public engagement efforts, and the findings and key takeaways, the following vision statement was created for the Study Area:

Transform the area within the City of Lebanon north of Exit 18 on Interstate 89 into a more complete, walkable neighborhood with easy, safe access to and preservation of natural resources and existing amenities, while providing opportunities for thoughtful, sustainable growth in the form of diverse new housing, community facilities, and enhanced multimodal connections.

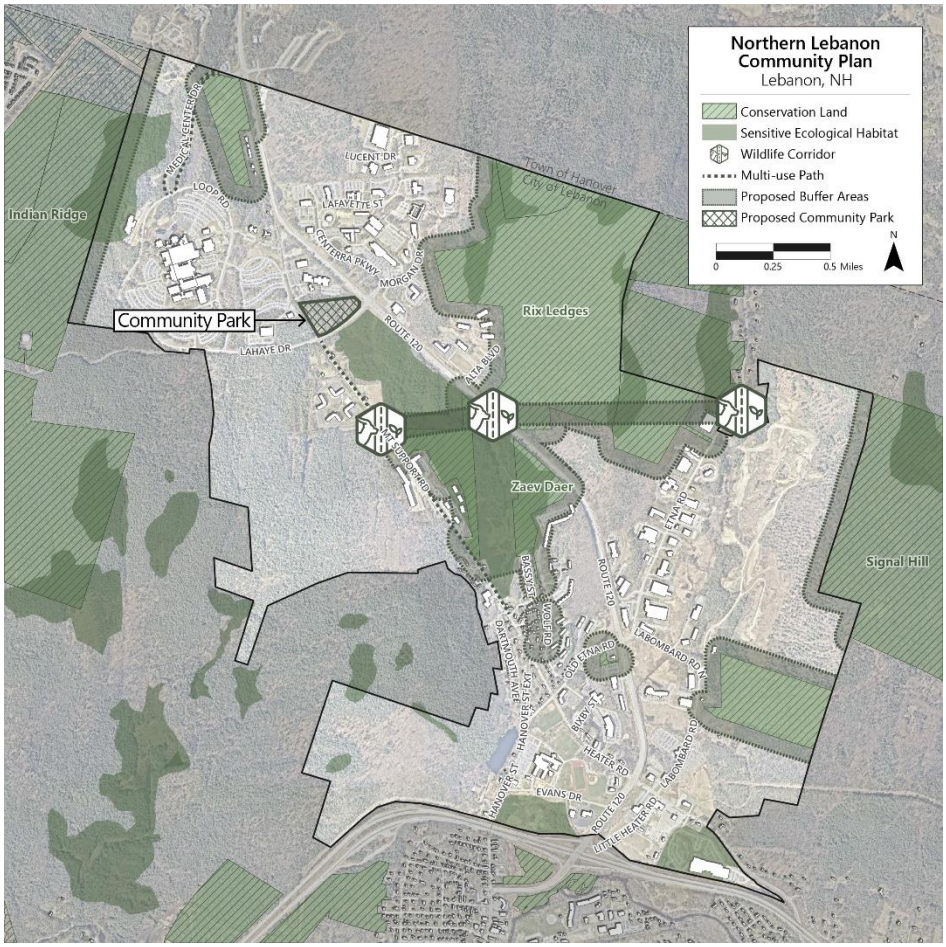
Strategic Goals and Recommendations

Building upon the vision statement are a set of strategic goals and actionable recommendations centered around the preservation of natural resources, enhanced connectivity and mobility, and modifications to the existing zoning of the Study Area that will allow the City of Lebanon to realize its vision.

Strategy 1. Preservation of and Enhanced Access to Natural Resources

Preserve and enhance the Study Area's existing natural character by protecting existing conservation areas, wildlife corridors, and ecosystems, while providing additional recreational opportunities and enhanced connections to existing natural assets for residents, visitors, and employees that frequent the Study Area.

Figure 13: Preservation of and Enhanced Access to Natural Resources



› Recommendation 1.1. Formalize and map a 100-ft wide Wildlife Corridor Passage Overlay District that connects the three existing wildlife corridors, preserving the existing natural features and landscape to allow for the safe passage of wildlife, and require the

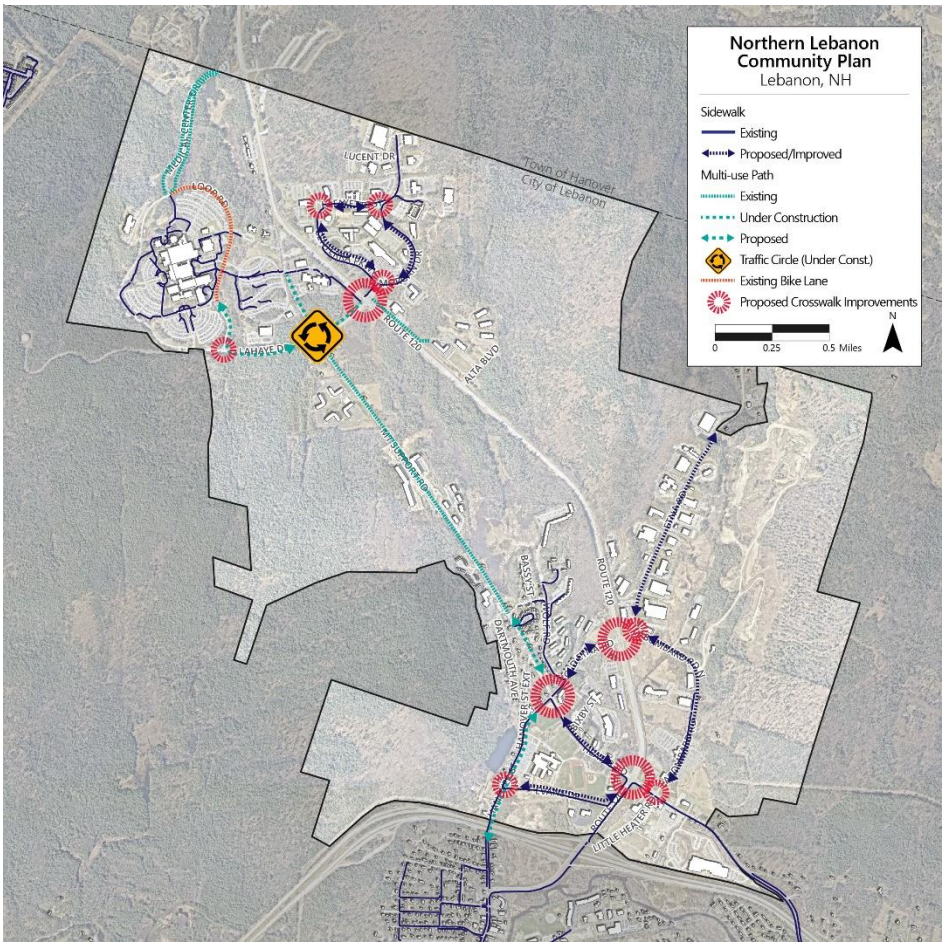
installation of signage at all existing and new multi-use path and roadway crossings that bisect the overlay district boundary.

- Recommendation 1.2. Study the feasibility of decreasing traffic speeds and upsizing the existing culverts for all three existing wildlife corridors within the Study Area.
- Recommendation 1.3. In partnership with the Lebanon Conservation Commission and the New Hampshire Fish and Game Department, develop public-facing educational materials on the importance of the wildlife corridors and make them available at key City facilities.
- Recommendation 1.4. If a parcel of developable land borders conservation lands, consider requiring a 100-foot, wooded or landscaped buffer between the property line and any new development to maintain a natural buffered area between existing preserved lands and any new developments.
- Recommendation 1.5. Install signed and directional trailheads throughout the Study Area to promote the use of the extensive network of trails through existing conservation lands in and around the Study Area.
- Recommendation 1.6. Mandate a percentage of new developments require dedicated public open space in the form of a landscaped plaza, pocket park, or a community garden.
- Recommendation 1.7. Approach DHMC regarding their three parcel assemblage north of Lahaye Drive (Parcel IDs 10-23, 10-24-200, and 10-25 for a total of approximately 9 acres) to gauge their willingness to dedicate the land to the City for the purposes of creating a community park inclusive of amenities and programming of appropriate scale and size to reflect the land's existing natural features.
- Recommendation 1.8. Require that any future development within 250-feet of wetlands include a certain percentage of total site land cover as permeable surfaces.
- Recommendation 1.9. Expand the coverage area of the Steep Slopes District to cover the entirety of the Study Area where slopes greater than or equal to 25-percent are located in order to preserve the natural character of neighboring conservation lands, ridgelines, and rock formations. Consider special exceptions upon review and approval by the Conservation Commission.

Strategy 2. Connectivity Improvements

Identify and prioritize the completion or enhancement of missing, incomplete, or unsafe pedestrian, bicycle, and multimodal connections to facilitate improved local and regional connectivity between existing neighborhoods, community amenities and facilities, and job centers.

Figure 14: Proposed Connectivity Improvements



- Recommendation 2.1. Identify gaps in sidewalk connectivity and portions in need of repair or expansion and construct adequately sized sidewalks and associated infrastructure to accommodate the safe passage of pedestrians and wheelchair users along and across Route 120 between its intersections with Evans Drive, Heater Road, and Old Etna Road, and Lahaye Drive and Centerra Parkway.
- Recommendation 2.2. Apply for the Fiscal Year 2025 Recreational Trails Program grant round through the New Hampshire Division of Parks and Recreation's Bureau of Trails to extend the multi-use path on Mt. Support Road south to the Hanover Street pedestrian bridge.
- Recommendation 2.3. Coordinate with the Town of Hanover and DHMC to leverage private funding from DHMC to extend the Mt. Support Road multi-use path north to connect across the town line with Hanover.

- Recommendation 2.4. Enhance the existing pedestrian bridge over I-89 through the addition of wayfinding signage throughout the southern portion of the Study Area inviting users to the bridge, remove overgrown plant species, install native landscaping, and commission a public art installation from a local artist to showcase the bridge.
- Recommendation 2.5. Commission a branding, signage, and wayfinding study to identify locations for pedestrian, bicycle, and vehicular wayfinding signage north of Exit 18.
- Recommendation 2.6. Prioritize pedestrian and streetscape improvements around the Hanover Street School and Lebanon High School in Lebanon's Capital Plan.
- Recommendation 2.7. Coordinate with Advance Transit to identify additional routing options or bus stops for the Pink, Blue, and Blue-Red lines based on existing demand and areas of projected future development.
- Recommendation 2.8. Coordinate with the New Hampshire Department of Transportation (NHDOT) on their Lebanon 29612 project that is currently evaluating alternatives for Route 120 from the Hanover Street intersection through Exit 18 and north to Etna Road. Any zoning changes as a result of the Northern Lebanon Community Plan should be shared with NHDOT's District 2's Bureau of Traffic.

Strategy 3. Zoning Modifications

Propose changes to the existing Zoning Ordinance and Map to allow for by right mixed-use development and a range of housing choices to support the diverse needs of the community and its current and future residents.

Figure 15: Future Zoning Conditions

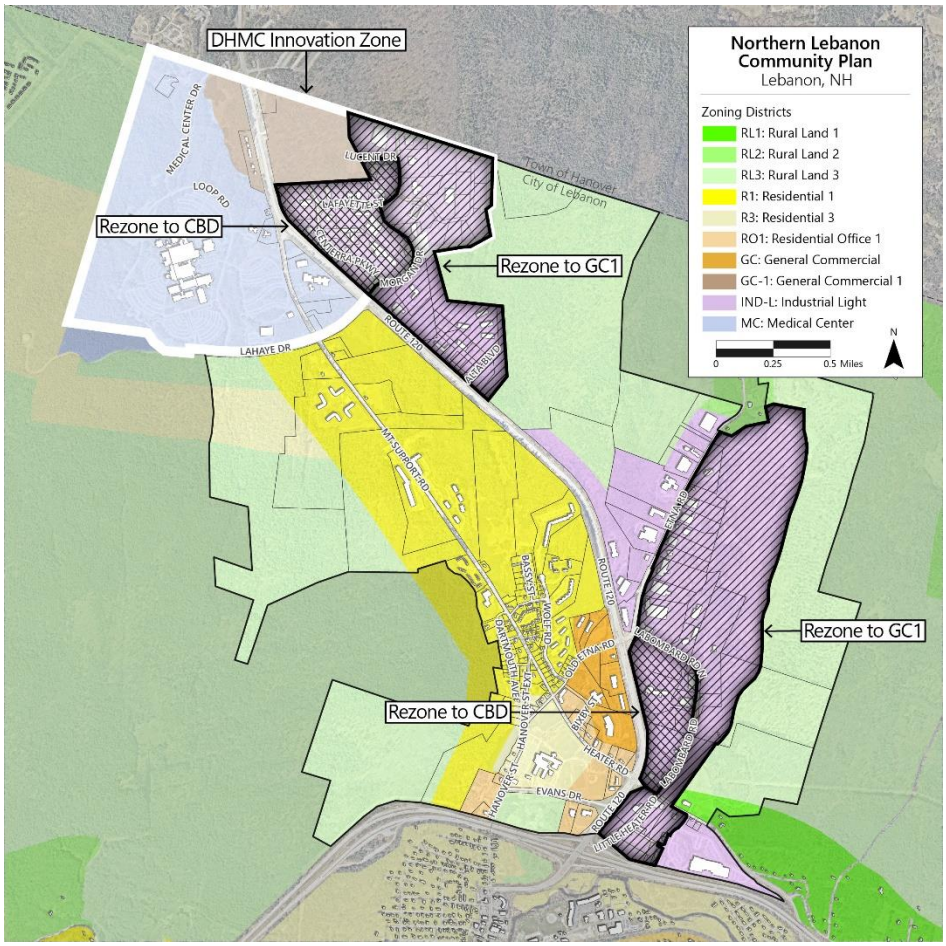
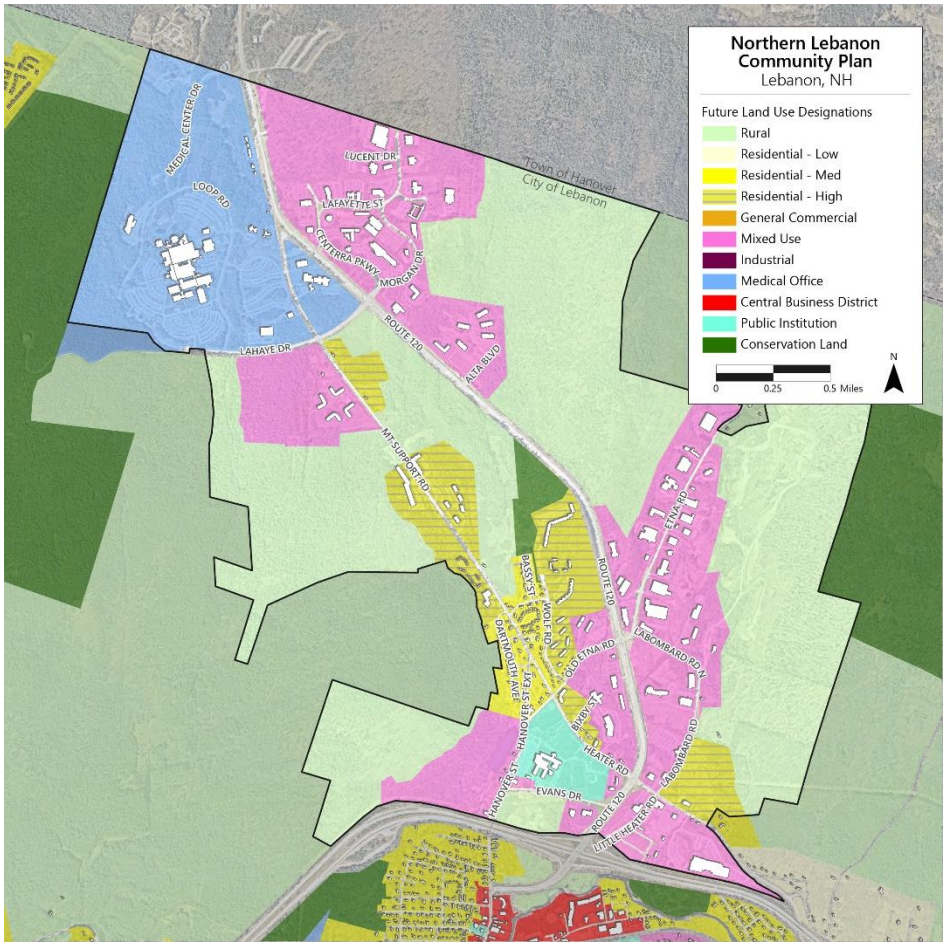


Figure 16: Future Land Use Map



- Recommendation 3.1. Rezone the following existing INDL districts:
  - South of Heater Road, north and east of Labombard Road, and east of Etna Road; and
  - North of Lafayette Street and south and west of Morgan Drive

  to General Commercial One District (GC1) to allow for multifamily dwelling units by-right in close proximity to larger employers, community assets, and existing transportation infrastructure.
- Recommendation 3.2. Rezone the following existing INDL districts:
  - East of Route 120 in Centerra to the southern edge of Lafayette Street and northern and western edge of Morgan Drive; and
  - East of Route 120, south of Etna Road and west of Labombard Road

  to Central Business District (CBD) to allow for the construction of dwellings above first floor retail/commercial and multifamily dwellings by-right to begin to develop a new mixed-use neighborhood to anchor the northern end of the Study Area, and to create a critical mass of new development in the southern portion of the Study Area northeast of Exit 18 that has already experienced significant redevelopment.

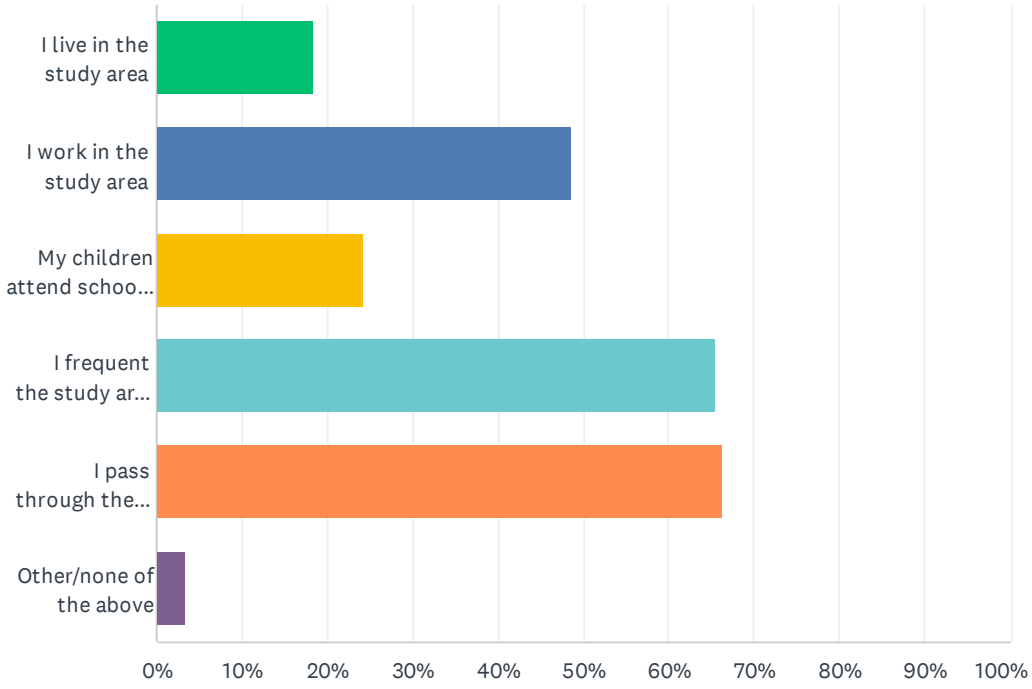
- Recommendation 3.3. Amend the permitted uses in the General Commercial One District (GC-1) to include retail stores and restaurants.
- Recommendation 3.4. Upon the completion of the City's public residential single and multi-family construction projects on City-owned land at Barrows Street, Hanover Street Extension, Seminary Hill, and South Main Street, consider using these projects as a model to guide future development in the Study Area by providing a mix of housing types in future private development, including cottage courts, smaller single-family homes, townhomes, duplexes, and triplexes. This could include updating the Residential 1 (R1) district to include these housing types under permitted uses, and amending minimum lot size and dimensional requirements in R1 to encourage these housing types.
- Recommendation 3.5. Require all new developments to install sidewalks, designated bicycle parking, and make streetscape improvements that extend and connect to the next nearest existing sidewalk.
- Recommendation 3.6. As recommended in the Lebanon Open Space Plan (2021), consider implementing the following measures:
  - Develop and incorporate a maximum lot coverage limitation to ensure that a portion of all lots remains as greenspace;
  - Develop maximum parking requirements and allow for reductions in parking provided on site, in addition to encouraging adjoining properties to share parking to reduce the creation of new or expanded impervious surfaces; and
  - Conduct a feasibility assessment of increasing the maximum height of buildings within the GC-1 and CBD district to help reduce the overall footprint of development projects.
- Recommendation 3.7. Facilitate a partnership between the City of Lebanon, Twin Pines Housing, the Lebanon Housing Authority, and DHMC to leverage funding resources, existing housing subsidies for DHMC employees, and DHMC's relocation office to assist in the creation and preservation of affordable housing units.
- Recommendation 3.8. Designate DHMC and the portion of Centerra north of Morgan Drive as an "Innovation Zone" and leverage the resources of Lebanon's Economic Development Commission, the New Hampshire Division of Economic Development, the Upper Valley Business Alliance, and DHMC to promote the area and attract startups and develop an incubator space in vacant structures, with an emphasis on companies that can benefit from the existing synergies and research occurring at DHMC.
- Recommendation 3.9. Given NHDOT's existing moratorium on new curb cuts along Route 120, north of I-89's Exit 18, require all new developments on the eastern portion of Route 120 to provide adequate internal road network connections to existing developments to facilitate improved circulation amongst existing and future developments.

Appendix A

Online Engagement Survey

Q1 What is your relationship to the Route 120 Corridor north of Interstate 89?

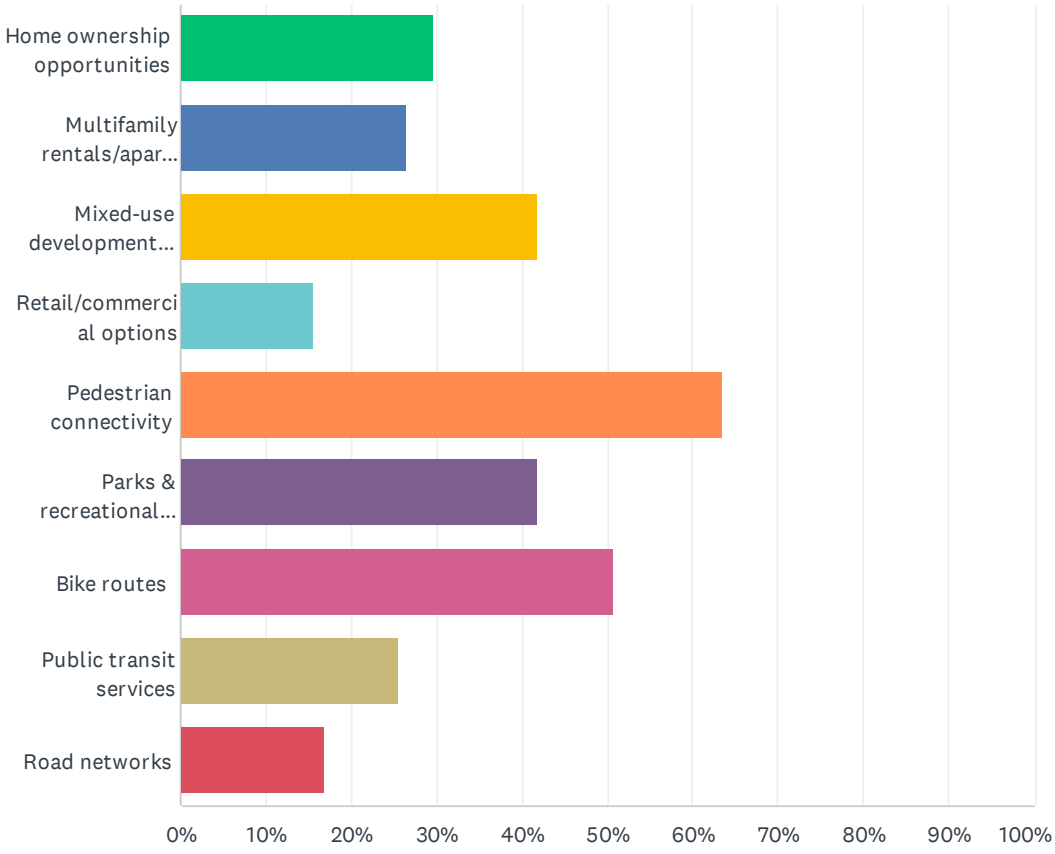
Answered: 148 Skipped: 0



ANSWER CHOICES	RESPONSES	
I live in the study area	18.24%	27
I work in the study area	48.65%	72
My children attend school in the study area	24.32%	36
I frequent the study area for shopping trips or personal appointments	65.54%	97
I pass through the study area en route to other destinations	66.22%	98
Other/none of the above	3.38%	5
Total Respondents: 148		

Q2 The Route 120 Corridor Study area needs better/more... (Select top four choices)

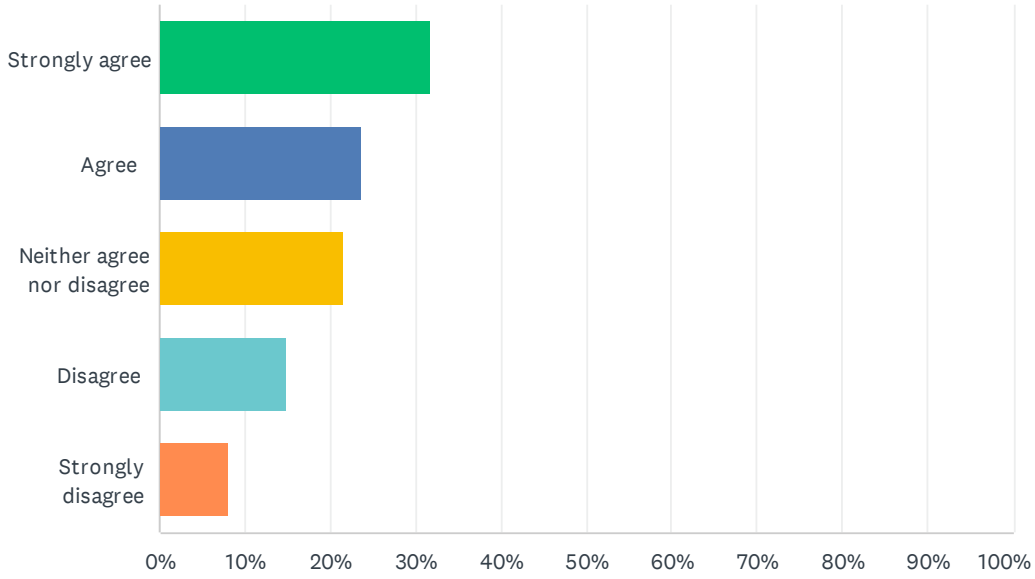
Answered: 148 Skipped: 0



ANSWER CHOICES	RESPONSES	
Home ownership opportunities	29.73%	44
Multifamily rentals/apartments	26.35%	39
Mixed-use development (retail, commercial, office, residential)	41.89%	62
Retail/commercial options	15.54%	23
Pedestrian connectivity	63.51%	94
Parks & recreational areas	41.89%	62
Bike routes	50.68%	75
Public transit services	25.68%	38
Road networks	16.89%	25
Total Respondents: 148		

Q3 How much do you agree or disagree that we need more mixed-use development in the study area? This could include a combination of retail/commercial, office, residential, and light industrial.

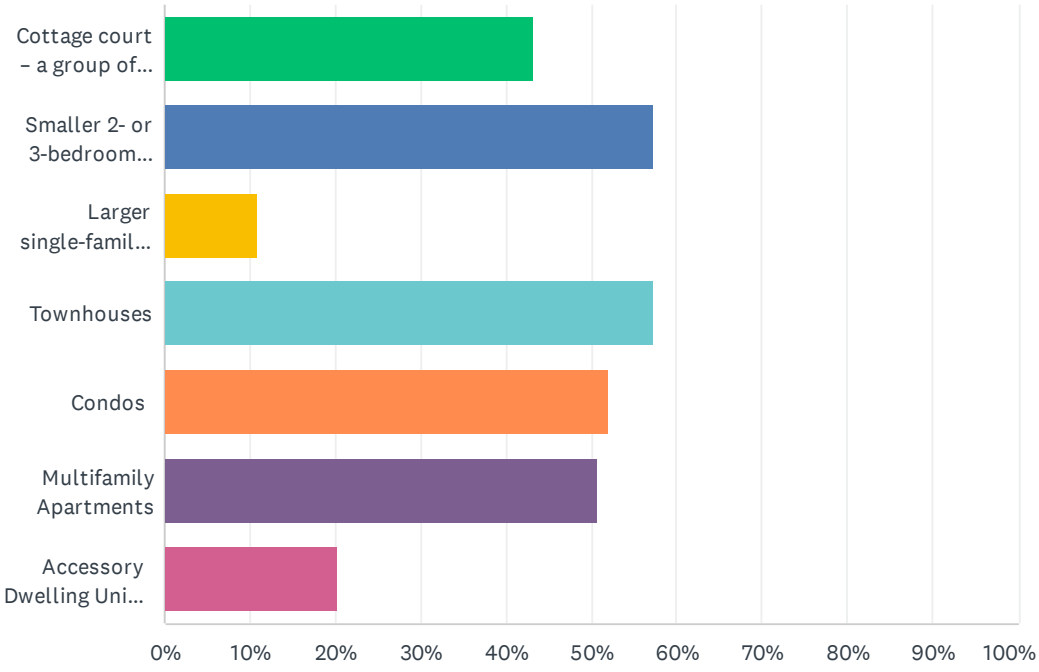
Answered: 148 Skipped: 0



ANSWER CHOICES	RESPONSES	
Strongly agree	31.76%	47
Agree	23.65%	35
Neither agree nor disagree	21.62%	32
Disagree	14.86%	22
Strongly disagree	8.11%	12
TOTAL		148

Q4 What new types of housing do you think would be most successful in the study area? Select all that apply. “Successful” means, if available, people would want to live in this type of housing. (Select all that apply)

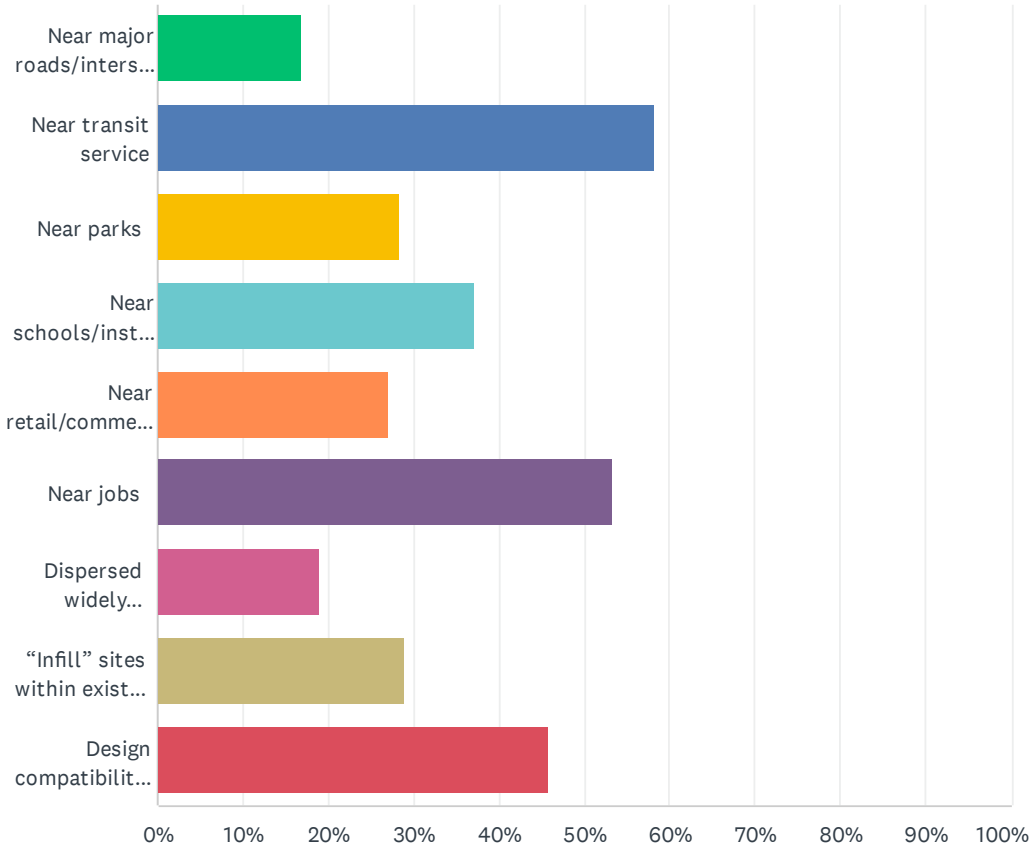
Answered: 148 Skipped: 0



ANSWER CHOICES	RESPONSES	
Cottage court – a group of small homes that share a yard	43.24%	64
Smaller 2- or 3-bedroom single-family houses	57.43%	85
Larger single-family houses (4+ bedrooms)	10.81%	16
Townhouses	57.43%	85
Condos	52.03%	77
Multifamily Apartments	50.68%	75
Accessory Dwelling Units (ADU) – a unit located on the same property as the primary house, typically above a garage, a separate structure, or attached to the primary house	20.27%	30
Total Respondents: 148		

Q5 What are the most important factors to consider when deciding where to locate new housing opportunities? (Select top four choices)

Answered: 148 Skipped: 0



ANSWER CHOICES	RESPONSES	
Near major roads/intersections	16.89%	25
Near transit service	58.11%	86
Near parks	28.38%	42
Near schools/institutions	37.16%	55
Near retail/commercial centers	27.03%	40
Near jobs	53.38%	79
Dispersed widely throughout the study area	18.92%	28
“Infill” sites within existing neighborhoods	29.05%	43
Design compatibility with surrounding development	45.95%	68
Total Respondents: 148		

Appendix B

Stakeholder Interview Questions

Stakeholder Interviews

Date:	April 24, 2024, 1-2pm	Prepared By:	VHB
Place:	Council Chambers, Lebanon City Hall 51 N Park St., Lebanon, NH 03766	Re:	Session 1: Stakeholder Interview Questions Route 120 Corridor Study

Session 1:

1. What is your relationship to the study area?
2. What challenges have you experienced when trying to retain existing staff or attract new staff to the area?
3. Do you have any long-term plans that we can help support and/or reflect in the plan?
4. What do you believe are the most important development, land use, or zoning issues facing North Lebanon?
5. What types of uses should be encouraged (or discouraged) to maximize the potential of the North Lebanon neighborhood?
6. Are there specific areas that should be targeted for new development or redevelopment?
7. What additional public investments or regulatory strategies do you believe would facilitate the area becoming a true mixed-use town center?
8. Is there anything we haven't asked you that we should know, or do you have any closing thoughts or concerns you'd like to share with us?

Stakeholder Interviews

Date:	April 24, 2024, 2-3pm	Prepared By:	VHB
Place:	Council Chambers, Lebanon City Hall 51 N Park St., Lebanon, NH 03766	Re:	Session 2: Stakeholder Interview Questions Route 120 Corridor Study

Session 2:

1. What is your relationship to the study area?
2. What factors influence the types of developments you build? What factors hinder you from building other types of development (e.g. zoning/policy constraints, profitability, financing availability)?
3. Are there zoning regulations, tools and practices from other jurisdictions that you would like to see Lebanon consider exploring?
4. What do you believe are the most important development, land use, or zoning issues facing North Lebanon?
5. What types of uses should be encouraged (or discouraged) to maximize the potential of the North Lebanon neighborhood?
6. Are there specific areas that should be targeted for new development or redevelopment?
7. What additional public investments or regulatory strategies do you believe would facilitate the area becoming a true mixed-use town center?
8. Is there anything we haven't asked you that we should know, or do you have any closing thoughts or concerns you'd like to share with us?

Stakeholder Interviews

Date:	April 24, 2024, 3-4pm	Prepared By:	VHB
Place:	Council Chambers, Lebanon City Hall 51 N Park St., Lebanon, NH 03766	Re:	Session 3: Stakeholder Interview Questions Route 120 Corridor Study

Session 3:

1. What is your relationship to the study area?
2. What do you believe are the most important development, land use, or zoning issues facing North Lebanon?
3. What types of uses should be encouraged (or discouraged) to maximize the potential of the North Lebanon neighborhood?
4. Are there specific areas that should be targeted for new development or redevelopment?
5. What additional public investments or regulatory strategies do you believe would facilitate the area becoming a true mixed-use town center?
6. Is there anything we haven't asked you that we should know, or do you have any closing thoughts or concerns you'd like to share with us?

Specifically for SAU#88:

1. What challenges have you experienced in the last five years accommodating students new to the area?
2. Do you have any thoughts on the built environment immediately surround the school facility (e.g., safety, etc.)?

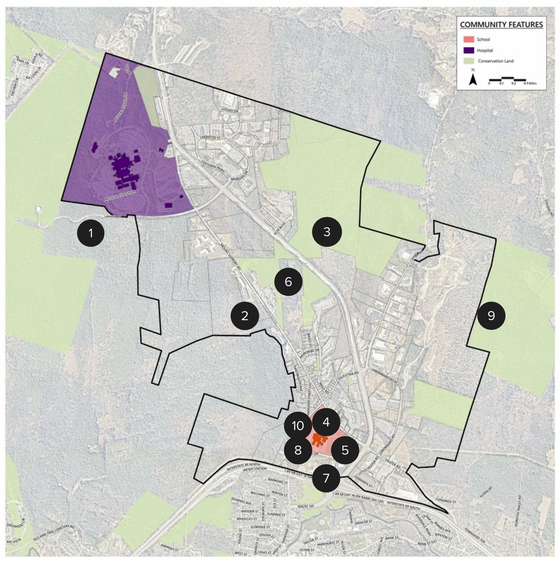
Specifically for Community Organizations:

1. Can you please briefly describe the services your organization offers and its role in the community?

Appendix C

Public Workshop No. 1 Activity

Community Features



1
- Sense of Place is weak to non-existent
- Accidental organization of community features
- Ditto

2
- Make Mt Support Rd Bike friendly
- Public transport etc. away from 120

3
Important for Wildlife - The Fen

4
Love our schools protect them!

5
How do we keep schools safe?

6
These wetlands (both between Mt Support + 120 & along Etna Rd are so important and they need to be protected for all the ecosystem & flood storage services provided

7
Need a pharmacy somewhere

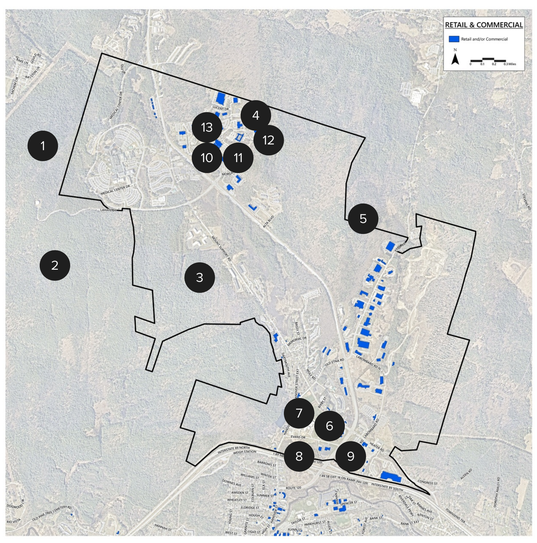
Key Takeaways:
- Protection of schools
- Protection of wetlands and natural areas for the community
- Expansion of goods and services
- Develop bike/ped friendly spaces

8
- No access for school kids to the natural areas just west of the schools
- Ditto

9
Signal Hill Conservation Area needs a buffer & connectivity to Rix Ledges

10
School needs to be protected from expanded retail development

Retail & Commerical



1
No car dealership in the 120 corridor is needed or appropriate

2
Concentration of uses encourages vehicle use, can't walk to anything

3
If you live here, all stores are too far to walk

4
No one lives here (no nearby housing)

5
Over development/ congestion reduces desire to remain and quality of life

6
Weak retail - should be more

7
(Affordable) grocery store here?

8
Just car dealership central?

9
Minimal retail and commercial development in immediate vicinity of school

10
Recognized area for connection, shopping

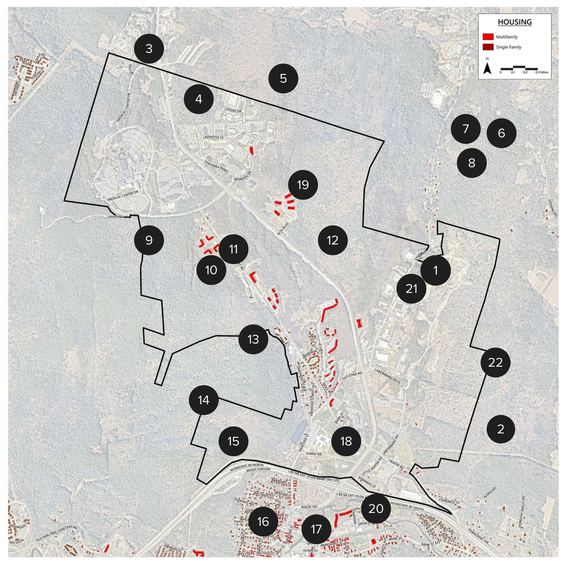
11
Supermarket & drugstore

12
Difficult pedestrian access across 120

13
Strength with more selection

Key Takeaways:
- Difficult pedestrian access - minimal walking spaces for pedestrians
- Meaningful retail and commercial development within walking distance for residents

Housing



1
Unused space that could go to housing

2
- Housing on Mt Support Rd begins by cleaning everything - so ugly
- Keep the big trees keep the massive stones and build around those - buildings should fit there

Key Takeaways:
- More single-family home development
- Missing a mix of housing typologies
- Protection of natural spaces during development process
- Development is far away from commercial areas - forcing people to drive

3
Need fire & EMS @ North Leb

4
Good Location for single family homes

5
Does Hanover have a role for DHMC housing? (Should!)

6
No more single family homes

7
Need more single family homes

8
Missing a mix of housing types

9
Housing potential

10
Too many apartments

11
Not enough apartments

12
This part is a beautiful wildlife area

13
All Mt Support Rd nowhere to walk to (no retail, corner store, businesses, restaurants)

14
Housing potential

15
Housing potential behind Densmore

16
I love my little neighborhood (Starr Hill / Uhaul Heights)

17
Let's just do more of this

18
Little diversity of housing types (few or no rowhouses or small apt buildings) mixed use bldgs narrow or no setbacks - too spread out

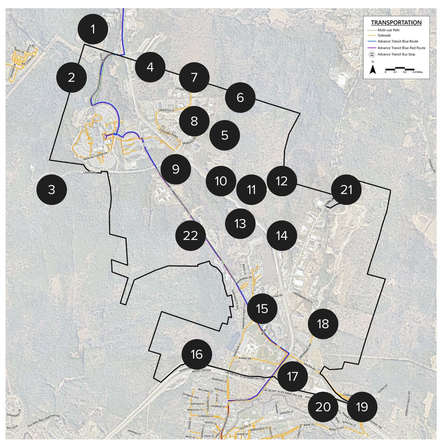
19
Developments are spread out and force people to drive

20
Not enough 3-bedroom apts and single family housing for families, but not saying it should necessarily be in this corridor

21
- Limit housing in this area
- Conserve unused areas west of Mt Support Rd

22
Potential for increased housing and mixed uses with active and passive recreation

Transportation



1
Need multi-use path or protected bike lanes to connect to Hanover on 120

2
Need connected walking, biking, transit to Sachem

3
Width of 120 encourages speeding - terrible traffic experience

4
There are not many reasons (i.e. destinations) to walk, even if you could

5
Need Advance Transit stop

6
No more parking lots. Build parking garages, more expensive but less maintenance and wasting forests

7
This style of development is hard to service with transit - buildings should be on the way, don't make the bus wander

8
Advance Transit access to Dartmouth - Coach & Centerra

9
Good plan for upcoming multi-use path and rotary

10
No safe bike infrastructure

11
Route 120 vehicle speed & bike/ped roadway safety

12
High speeds dangerous for pedestrians

13
- Traffic flow from hospital to 89
- Need for wildlife bridge or tunnel

14
Everything is far apart and separated

15
- NHDOT needs to change their priority. Build Rt 120 so cars don't go so fast - smaller, fewer lanes; wildlife crossings
- More lanes don't solve traffic problems, more cars will come
- Shift to prioritize bike & ped

16
Useful pedestrian bridge (could be wider and prettier)

17
The intermodal bus station is not connected to walking / biking network

18
Need to complete walking and biking connection to Dartmouth Coach

19
Park and Ride at Exit 18?

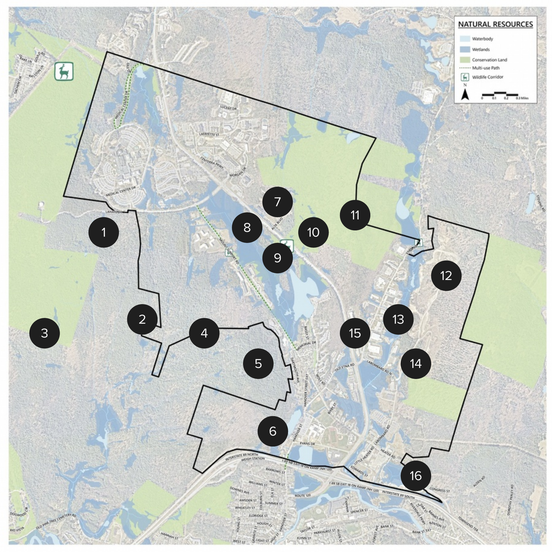
20
Already heavy traffic

21
Need space for people walking and biking

22
Great to have Mt Support as an alternative to Rte 120 - but it needs to be kept as bike/ped friendly as possible - very low speed limit

Key Takeaways:
- Need development of multi-use path and protected bike lanes
- Greater bike/ped connectivity to Dartmouth
- Speed limit control/ protection for pedestrians
- Connected walking paths
- Development of protected wildlife crossings

Natural Resources



1
Mountain Biking

2
Over development reduces quality of life

3
- Fragmented natural spaces
- Either very forested or spaces lacking cover
- Roads not shaded
- Ugly roads

4
Large blocks of open space need buffers to protect them we keep eating into them

5
Beautiful quarry

6
Develop area of former brickyard as a recreational and historical space playing fields etc. for school and also a nature/ history preserve

7
Wildlife collisions, high speeds

8
Preserve land in area

9
Beautiful area needed for wildlife - both sides of street

10
Wildlife corridor (used to be bear crossings)

11
Provide wildlife underpass for safe crossings

12
View of hills

13
Protect the corridor

14
Trees

15
Build a decent wildlife viaduct 50 yards wide across 120 and strictly enforce speed limit (Speed bumps, or CCTV with fines)

16
Flood water storage disappears & needed, especially with development

Key Takeaways:
- Development of wildlife crossings and protection of wildlife corridors
- Tree and land preservation
- Buffers to protect open spaces
- Enforcement of speed limit

Appendix D

Public Workshop No. 2 Comments

Q1 Do you have anything to add about the study area before the final draft is presented?

Answered: 236 Skipped: 0

#	RESPONSES	DATE
1	SINCE HIGH SPEED SEEMS TO BE THE NORM, HOW ABOUT A DIVIDER AND GUARD RAILS?	8/6/2024 1:32 PM
2	40 mph is way too low of a limit between Etna and Centerra. It is almost more dangerous to travel that slowly through that area. Consider increasing to 50mph and adding a center barrier to protect from oncoming traffic in the left lanes	8/6/2024 1:15 PM
3	If the area is to be further developed, a wildlife bridge or tunnel should be built to allow the safe travel of wildlife.	8/6/2024 12:06 PM
4	There is nothing but residential and non residential development proposed, nothing proposed for recreation or public space. Rte 120 traffic is already beyond capacity. Lebanon does not need another Rte 12 mess. I am totally apposed to this plan.	8/6/2024 11:21 AM
5	Keep as much green space as possible; if building housing, please make it 'affordable' and have opportunities for a range of bedrooms from 1-4.	8/6/2024 11:00 AM
6	There are limited protected pedestrian and cycling pathways, which is a significant concern. Biking and walking along 120 without risk of getting hit by a motor vehicle would be a significant upgrade, and have benefits for the environment and public health.	8/6/2024 9:36 AM
7	Create arterial roadways and pathways to control traffic. Promote established businesses and employers, such as LHS and DHMC. Maintain quality schools, which leads to increased property values and potentially increased investors. Consider bringing in commercial income to cover development costs. Encourage home ownership versus transitional housing and low income housing options. Compare communities and studies about reducing crime. Compare Lebanon to other small towns and consider the strengths and weaknesses of each. Why is one school district better rated than another? Increase budget for good teachers and law enforcement. Create smaller medical, medical specialist, and urgent care centers to distribute the need for medical care. Avoid noise pollution. Keep community parks away from busy streets and noise. Consider the style of architecture to maintain New England small town feel and to minimize tall buildings and visual obstructions to natural environment. Stimulate the economy with competition in the markets such as alternative options for gyms, clothing stores, and grocery stores. Provide a good balance of commercial, residential, and environmental developments.	8/6/2024 9:31 AM
8	I believe that conservation efforts are needed to maintain the delicate ecosystem of the wetlands surrounding the Route 120 Corridor. This sector has become increasing commercialized creating less habit for existing wildlife.	8/6/2024 9:20 AM
9	What changes to the current roadway are going to me made to accommodate the additional traffic on an already busy road.	8/6/2024 8:57 AM
10	Add additional lanes so the traffic won't back up so far during the busy times of the day.	8/6/2024 8:45 AM
11	Make sure you are going to keep green areas.	8/6/2024 8:21 AM
12	not at this time.	8/6/2024 8:15 AM
13	can the route 89 on and off ramps be improved to move cars more efficiently, especially during rush hour?	8/6/2024 7:43 AM
14	please make space available for affordable housing for workers. I work at the hospital and live an hour away and cannot afford $ 2500 a month for housing in Lebanon.	8/6/2024 6:14 AM
15	The only thing I have to say is 40 is too slow for that area. We feel the police like to get their quota for speeding tickets up there.	8/6/2024 4:56 AM

16	I am concerned about how it will impact traffic on Rt 120 for my morning and evening commute.	8/5/2024 3:58 PM
17	provide affordable housing. this does not mean a one bedroom apartment for $2000. there are so many people working mid level jobs that dont qualify for low income housing but also dont make enough to live close to work. lets aim for $800. or a housing complex with separate houses. thank you.	8/5/2024 3:36 PM
18	It needs to be 3 lanes in each direction and raise the speed limit to 50.	8/5/2024 3:30 PM
19	Traffic needs to be managed and be reasonable for patients and staff going to and from 89 to the hospital.	8/5/2024 3:28 PM
20	Affordable housing for middleclass families/single people Starbucks coffee or PEET's coffee cafe trader joes wholefoods market	8/5/2024 3:25 PM
21	Need more lanes to DHMC, alternative roads to by-pass DHMC & high school, light for Hanover Street/High School turn,	8/5/2024 3:24 PM
22	please just add rotaries. They will drastically improve the flow of everything. They are evidence backed and just need to be implemented.	8/5/2024 3:20 PM
23	Please allow for adequate traffic flow especially during weekday hours for hospital employees.	8/5/2024 3:18 PM
24	Please build an indoor soccer facility for use in winter!	8/5/2024 3:16 PM
25	consider increasing the walk-ability /cycle-friendliness of this area. Right now there are several disjointed "hubs" of activity, but walking and even cycling throughout is rather dangerous given the heavy car traffic. Quality of life, and economic stimulation, for those who live and work in this area would be greatly enhanced by making this area more pedestrian and cyclist friendly (would also help reduce the carbon footprint). Also, I'd encourage increasing development of small local businesses that cater to the hospital crowd and local families (coffee shops, restaurants, etc that employees ans resident could walk or cycle to).	8/5/2024 3:15 PM
26	Please minimize additional encroachment on Boston Lot and wooded areas off 120. I know housing is a need, but our rural and wooded setting is one of the things that make the area special, and it's painful to watch large swaths of the area off Mt. Support road be clear cut to make way for apartments; I would not be eager to see the same done off 120 for strip malls.	8/5/2024 3:10 PM
27	For the love of all that is holy, no more round-a-bouts. People simply don't know how to use them. Please don't clear cut every bit of wooded land along 120.	8/5/2024 3:07 PM
28	Traffic is already heavy along this corridor so I just hope that will be taken into consideration for any future further development here.	8/5/2024 1:12 PM
29	Before developing the 120 corridor, something has to be done about the traffic, especially in the morning with LHS & HSS school and DH commuters. The traffic is often backed up to Hanover Street as well as on the Interstate. I have to allow an extra 30 minutes just to get through the lights. Could the road be expanded? Could there be a separate exit for DH from 89?	8/5/2024 10:53 AM
30	The approach to DHMC from the light at 120/Lahore needs to be seriously looked at. During the morning commute, the line of cars waiting to turn left at the light often extends as far down as the entrance to the Element Hotel.	8/3/2024 8:55 AM
31	Putting in a rotary is stupid. Maybe have three lanes going toward the hospital, one turning towards Coburn Hill and the other two going straight. After going past the out patient surgery, have one lane turn to the parking garage and the other going straight.	8/2/2024 11:05 PM
32	Protect wetlands, wildlife habitat, groundwater resources	8/2/2024 12:18 PM
33	Affordable Condos/ Apartments instead of luxury apartments! If we are going to continue to build apartment complexes we do not need any more luxury options instead we need reliable affordable housing!	8/2/2024 11:49 AM
34	anything that will improve traffic flow on Lahaye Drive	8/2/2024 8:33 AM
35	Make it less "corporate feeling" the development is the aesthetic of no-where or everywhere. Large highway, indistinctive construction. Centerra has no heart, most of the landscape is devoted to cars, the roads, parking with everything set back from the roads so cars are in front	8/2/2024 7:39 AM

	and what you see. This whole area is going to be and is already a traffic choke point. Better bike a bus infrastructure. Remote parking and shuttles for workforce. pay attention to the sounds and sightline that affect the green spaces.	
36	Hurry up	8/1/2024 7:29 PM
37	My comments are that I favor preserving forested & green areas b/c this is what gives our area such beauty. I believe there should be limits on development (to reasonable infill rather than concentrations of proposed new condos and rental construction such as the Brick Yard across from Lebanon High). In addition, I think it is important to take into account the fact that Rte 120 is already highly-trafficked (especially during DHMC commuting times). Under current conditions, drivers routinely speed down Rte 120 and run red lights along the main corridor. It is often dangerous for those who have the green light at cross streets to proceed. I realize the town wants create another town center, but it seems to me there is an obvious danger in terms of life-quality in doing so.	8/1/2024 7:23 PM
38	Has there been any thought put into the idea of a pedestrian bridge over Route 120 at the intersection of Route 120 and Lahaye Drive? The increase of pedestrian traffic and vehicle traffic between the apartment complexes on Mt. Support Road will be a constant bottleneck as residents of Mt. Support Road walk to and from Centerra Park for shopping needs.	8/1/2024 4:21 PM
39	I'm concerned about more traffic congestion as evening rush hour is already horrendous. Building that up more means more congestion and that is also a wildlife crossing. The wetlands along that corridor also act as flood buffer. I'm not really not wanting to see that developed. Why not develop the southern part of 120 going towards Cornish instead?	8/1/2024 4:19 PM
40	Lebanon needs more SINGLE family housing; NOT more apartment buildings. Single family housing will help with the sky-rocketing property tax rates, which are driving long time residents out of their homes. Make sure to include lots of green space--parks, trails, etc. in this development plan.	8/1/2024 3:26 PM
41	I think of SR120 as The Racetrack. Everyone travels at at least 10mph faster than the speed limit. It doesn't make sense to add pedestrians and cyclists and the infrastructure like sidewalks to a racetrack.	8/1/2024 10:45 AM
42	Thinking about the growing population of Lebanon and the positioning of DHMC (one of NH's largest employers) this seems like a great area to build new AFFORDABLE housing. Not luxury apartments or high-end buildings, affordable housing!	8/1/2024 10:19 AM
43	Can the traffic lights be better coordinated as we travel this corridor? Can time of day taken into consideration as well?	8/1/2024 10:18 AM
44	Please keep in mind that development along the Rt. 120 corridor has a major impact on wildlife in the area. This area has been an important way for animals to move between the higher regions (including all the way up to Moose Mountain), the Boston Lot, and the Connecticut River. The more development we encourage along Rt. 120, the more the natural vibrancy of our region is threatened.	8/1/2024 10:02 AM
45	Please include bike lanes, walking areas, public and natural spaces.	8/1/2024 10:02 AM
46	It's it possible to consider switching traffic lights to flashing yellow/red at night? Sitting at a light for multiple minutes while no one passes the intersection in common after 9pm.	8/1/2024 9:28 AM
47	Impacts to traffic/commute time	7/31/2024 8:02 PM
48	Could you please place a traffic light at the entrance of Altaria Apartments? Thanks	7/31/2024 6:42 PM
49	Where exactly is the proposed new 'third Lebanon village center" ? how much area does it cover?	7/31/2024 5:02 PM
50	There is already too much traffic. Adding more businesses will make it harder for commuters, residents and people depending on bus transport to get to and from work.	7/31/2024 4:26 PM
51	I would love to see more small to modestly-sized single-family homes organized into communities, connected to DHMC, shopping and recreational hubs and Hanover by protected and/or separate biking/walking paths. This is a very outdoorsy, health-conscious community, and many would be happy to safely walk, run or bike to work, school or shopping.	7/31/2024 4:05 PM
52	I lived in Stuart, Florida and we had an old bridge that wasn't working anymore in the way of growth and was having structural issues. The new bridge was put right over the old bridge. You	7/31/2024 3:55 PM

	can see this on Google (Repair of Roosevelt Bridge) It turned out beautiful and is so functional!!	
53	Please conserve as much nature as possible	7/31/2024 3:55 PM
54	speed limit needs to be much higher on this road.	7/31/2024 3:46 PM
55	no	7/31/2024 3:27 PM
56	having sidewalks is great! please encourage lower rent in the Centerra plaza to encourage local businesses to enter this area!	7/31/2024 3:19 PM
57	I am a homeowner residing in West Lebanon. My family and I would greatly appreciate the City fixing the bridge from our village to the 12A shopping plaza. This crosses the railroad and has been in abysmal state for several years now. Can we fix/maintain the roads and bridges we already have before assigning resources to new projects? The recent asphalt patches are not a solution.	7/31/2024 3:12 PM
58	Would love to see more housing options, both apartments for young professionals (less of these 700 sq ft studios) and new build construction neighborhoods. I would also like to see opportunities for more businesses to open to improve local variety of restaurants and shopping (specifically Trader Joe's, Costco, chipotle, self car wash, another steak house, hobby lobby, nothing Bundt cakes, aldi, etc).	7/31/2024 3:12 PM
59	Traffic must be addressed!	7/31/2024 3:11 PM
60	Affordable housing (not linked to income). Townhouse or single smaller home style. Improvements to local transportation. DHMC as one of the largest employers in the state struggles to recruit staff to provide care to our community due to local housing costs. Young responsible professionals/families that contribute positively to the local community/economy and work in the healthcare/service field are an asset to add to our community.	7/31/2024 3:09 PM
61	Wider shoulders/separate bike lanes would be great for the stretch of 120 between exit 18 and the Centerra plaza/DHMC for bike commuting. Thanks for reviewing and inviting comment on the plans!	7/31/2024 3:09 PM
62	Affordable real estate is pretty much the only thing Lebanon and Hanover need to focus on right now. Any other construction without that is pointless. If someone making 20 / hr working at DHMC can't afford/find housing, there is no point in expanding because there will be no one around to pay/afford services.	7/31/2024 2:45 PM
63	We could really benefit from more protected bike lanes and walking paths/sidewalks	7/31/2024 2:22 PM
64	I think the ability to walk and bike is key. The project along 120 right now even though it is not finished has provided a safe path for walking from apartments on 120. Better and more housing are also really important. I think mixed type housing is probably best as different needs exist. Of course additional commercial space to support the folks living on 120 should be considered.	7/31/2024 2:19 PM
65	An actual right turn lane for Alta Blvd so people flying down 120 don't hit you.	7/31/2024 12:24 PM
66	More housing.	7/31/2024 11:45 AM
67	This area is too spread out to be a village center. It is a corridor and is unlikely to develop a walkable village center. It would be nice to have the area accessible & safe for bikes. It is good to have a mix of shopping, high density housing, industry, and offices.	7/31/2024 11:19 AM
68	Would be nice to know the goal and what the plan will entail	7/31/2024 10:59 AM
69	Dealing with traffic around DHMC and assuring this stretch of road is plowed better in the winter would be helpful. This is always the worst part of commute on a snowy day	7/31/2024 10:59 AM
70	There is not enough space in this box to include my comments Please send a link to jay.campion@gmail.com	7/31/2024 10:58 AM
71	No	7/31/2024 10:53 AM
72	No	7/31/2024 10:43 AM
73	No	7/31/2024 10:41 AM
74	In previous meetings with Hanover Bike Walk, a shared-used path for the study area was	7/31/2024 8:58 AM

	proposed but does not appear to be pursued at the moment. I would like to add that as an experienced bike commuter and member of the Dartmouth Cycling Team, I will personally not use any on-road unprotected bike lanes along 120 due to the extreme speeds at which cars speed along that route, and that if the corridor is to include a sidewalk or pedestrian right-of-way, that the team SERIOUSLY considers turning it into a multi-use path that bicycles can also take, as this is a long-term investment.	
75	Will the Route 120 Corridor housing development create communities for people of color by improving housing opportunities that will lead to home ownership?	7/30/2024 7:38 PM
76	Shared-use paths to accommodate people walking and bicycling, instead of sidewalks, unless additional separated bicycle infrastructure will be provided Safe well-lit crossings for people walking and on bicycle, including across 120Safe separated or protected bicycle infrastructure on all approaches to the high school (continuing Mt. Support path to pedestrian bridge is terrific!) Separated or protected bicycle infrastructure or shared-use path along Etna Road Continue separated Bicycle infrastructure along Heater Road to 120 Improve and widen pedestrian and bicycle bridge over the highway so that it is welcoming and appealing Add bus shelters and benches, with bike racks and solar powered lights Consider zoning for mixed-use near the hospital and high school so easy access to things such as cafes, corner stores, bike shops	7/30/2024 6:11 PM
77	Right now this area is filled with apartments and businesses. We need more retail, restaurants, single family homes, and condos. I also greatly appreciate that this is naturally beautiful area that needs to be preserved. Perhaps large portions can remain parks? What we do not need is more apartments or more million dollar homes. Another grocery store in this area would also be good. Public transportation on Rte. 120 would be very helpful.	7/30/2024 5:46 PM
78	Addition of safe usable sidewalks and bike paths for pedestrians. Would the use of traffic circles mitigate some the traffic backlog which occurs at peak travel times? This is a frequent travel route for the college, the hospital, multiple businesses and high school when school is in session.	7/30/2024 5:10 PM
79	Yes, this is the first I'm hearing about it!	7/30/2024 3:04 PM
80	please prioritize affordable housing and child care options.	7/30/2024 2:10 PM
81	It's super busy along that section of Route 120 due to business and hospital traffic. It's worse now than ever with Mount Support Road residence and dorm additions over the past few years. PLEASE maintain as much of the property in conservation or similar. We don't need to turn Route 120 into 12A. Lebanon needs more taxpayers, not section-8 housing and non-profit businesses that pay minimal taxes. Our community/public services are limited and already over-whelmed. Thank you!	7/30/2024 1:47 PM
82	It's nice the way it is; please don't develop any more than it is already!	7/30/2024 12:08 PM
83	combination of ledge and swamp will present significant challenges. Also one of last larger connected 'wild' spaces in town. Needs to be protected from development and a wildlife corridor sustained.	7/30/2024 11:06 AM
84	Even though this area seems heavily developed already, it nonetheless includes natural areas, tree shade, and other assets that could be lost in further development. Runoff, heat islands, and pollution from more industry, pavement, and large-scale development could endanger the beautiful environment we love and should be weighed against these risks. We don't need more car dealers, parking lots, or factories taking up our natural space.	7/30/2024 10:59 AM
85	I believe this area has the underlying "bones" for a walkable and sustainable work-life community. There are already well paying employers, shopping, grocers, education, and healthcare providers but what is lacking is ample affordable housing. For example, one of the primary drivers of the DHMC nurse unionization effort was the inability of even well-paid nurses to afford living in the community they serve. This part of Lebanon, in balance with nature, could benefit from desirable affordable housing (town-homes, working class condos) that is deed-restricted to full-time Lebanon residents/workers. No AirBnB or investors. This housing could be focused around DHMC & Centera as its hub. This could make use of developed and underused land. For example, the Altaria apartments has cleared and prepped sites to nearly double their capacity, yet they have not moved forward with additional units. Lastly, with growth, attention needs to be paid to city revenue. As a resident in this area, I can anecdotally attest there are numerous new residents, particularly in Altaria apartments that have lived here for over a year and will not register their vehicles in NH and pay the town taxes. Many of these	7/30/2024 10:59 AM

	are well paid physicians & dentists that drive $100K luxury cars yet keep their vehicles registered out-of-state. They are benefiting from our infrastructure, jobs, and community; yet refuse to contribute to it. Furthermore, its tax fraud. Please consider regular enforcement efforts.	
86	Raise the speed limit	7/30/2024 10:17 AM
87	Include pedestrian friendly and bicycle safe lanes not adjoining/alongside the traffic lanes; ie multi use pathways	7/30/2024 10:15 AM
88	The Advance Transit line along Route 120 is a vital service - keep it! Keep the shoulder and make it a Complete Street so that it's safe for cyclists and pedestrians.	7/30/2024 8:49 AM
89	There are few traffic bottlenecks and crowded signals. Hope those addressed well	7/30/2024 8:28 AM
90	PLEASE: MUPs on both sides of the road. There is plenty of room and narrowing lanes will slow down the (consistently speeding) traffic. This would be an amazing change for the Upper Valley community!	7/30/2024 8:28 AM
91	If you build, build what is sustainable and affordable for locals, not just doctors, DH VPs and executives or Professors. You are pricing out your life-time residents. Also, be thoughtful about the impacts to the environment and animals. We do not need to be an overdeveloped corridor.	7/30/2024 8:24 AM
92	Do not do anything that will increase traffic. It is bad enough during rush hour as is.	7/30/2024 8:13 AM
93	SEPARATE PEDESTRIAN, BIKE, AND VEHICLE ROUTES PLEASE	7/30/2024 8:11 AM
94	It would be great to see some more housing (specifically studio and 1-bedroom options aimed at young professionals) in addition to improving the walkability of the area (the emerging bike path connection between Mount Support Road and the Coop for example)	7/30/2024 8:00 AM
95	I would like to see an expansion of bike access across this development, the pedestrian and bicycle pathing at the top of Mt. Support Rd is the only area I feel safe biking in this region, and I commute via bike much of the year.	7/30/2024 7:55 AM
96	DHMC should be considered for an alternate exit to alleviate traffic on the 120 corridor and assist with direct entry for ambulances, staff, and patients without disruption to the upcoming/developing third village, businesses, and other residents.	7/29/2024 8:11 PM
97	A longer arrow light exit 18	7/29/2024 7:06 PM
98	This route has become a super-highway of sorts, partly because of the volume of traffic and partly because the natural lay of the land lends itself to higher-speed travel. A new design should embrace this reality, and allow for entrance and exit ramps (similar to a highway bypass) to facilitate access to businesses and other locations alongside Route 120, while providing a safer, "high-speed" travel area for those motorists who are commuting through the area. Stop lights should be eliminated, as they impede traffic flow and provide opportunities for serious accidents.	7/29/2024 6:16 PM
99	The portions of this area that are not already developed are home to hiking trails and wildlife that would be severely damaged if this area was developed beyond what it already has been.	7/29/2024 4:30 PM
100	Traffic at new Starbucks next to Centerra, how will this all work, who approved?	7/29/2024 4:24 PM
101	There needs to be pedestrian activated crosswalk signals within the Centerra Marketplace roadways. When walking on the paved path toward the Co-op and DH Pharmacy there is no safe way to cross that road. Cars drive very fast when leaving the businesses associated with Centerra Park. Not sure if this is under the city of Lebanon's jurisdiction but it is rare for vehicles to stop for me in the crosswalk. Thank you.	7/29/2024 4:16 PM
102	Zoning laws are archaic way of city planning. They constrict housing supply which makes the area unaffordable to live in. This then makes employment challenging, and cascades from there.	7/29/2024 4:07 PM
103	The entire length of this corridor needs to include pedestrian friendly paths/walks, including connection to DHMC, and could be made more aesthetically pleasing and less "big highway" appearing with landscaped medians in select areas.	7/29/2024 4:05 PM
104	for route 120, please make reaistic speed limits. The 40MPH speed limit is too low and should realistically be 50MPH for the sections between heater road and LaHaye drive. traffic flow is	7/29/2024 3:51 PM

	consistantly at this speed or higher currently, so up the legal limit to match the flow of traffic. 40MPH is too slow for un undeveloped 4 lane stretch of local highway.	
105	Great project, and much needed. Please take care to minimize encroachment and disruption of the existing Boston Lot trails and wildlands, which is a true treasure of this area that is essentially bordered by highly developed lands. thank you	7/29/2024 3:42 PM
106	Please consider outdoor spaces, communal areas, accessibility, and walkability. This area is too dependent on motorized transportation.	7/29/2024 3:38 PM
107	It is very hard to get on and off 120 without lights. One issue is in the winter the last thing you want are more lights. I have already gone through the one at the bottom of 120 on a snowy evening. I am also concerned for the ambulance travel. More traffic and more lights will slow them down, for some patients this might be okay but for others it will be life and death.	7/29/2024 3:38 PM
108	no	7/29/2024 3:32 PM
109	Yes, the absence of a change in the walking bridge over I-89 on Hanover Street to convert to a dual/multipurpose route continues to be a huge oversight in this planning process and is terribly shortsighted. The traffic on I-89 that is already a topic of distress for Lebanon residents will only worsen if there is further development along the Route 120 corridor without this change, making life and commutes unbearable for those of us closer to downtown. I urge the planners to do the right, commonsense thing and open this up to automobile and other public transportation traffic. It makes no sense to have the town and the I-89 traffic all converge on a single "artery" to the two largest area employers. Additionally, the relatively low use of the bridge outside of the hours when school begins and ends leads to bad behavior by passersby with ill-intent, clearly demonstrated by the graffiti, trash, and paraphernalia that decorate the bridge. I am hesitant to take my children across the bridge anymore lest they pick up half-empty bottles of booze, half-empty cigarette packs, or happen upon folks "parked" at the dead-end next to the Comcast building. These are not hypotheticals; they have happened regularly to myself and my neighbors, all of whom are taxpaying residents of Lebanon. Increased traffic in that area would create a safer and cleaner environment, and importantly dramatically alleviate the traffic that is an absurdity in this small community.	7/29/2024 3:24 PM
110	Would be nice to have a third driving lane from exit 18 to the hospital, even if it was only from Old Etna to Alta Blvd. Other considerations would be to add more affordable childcare and housing (apartments, condos, etc.) --affordable meaning all income levels can afford, not just doctors and people making six-figures. May also be nice to have a second grocery option between DH and 89. The Coop is great but so expensive.	7/29/2024 3:20 PM
111	1. The speed limit needs to be regulated. So many locals are in the area still where they remember it be 50mph between the stop light near Wilson tires and right before you get to Jesse's. It needs to either be re-increased to 50 mph, or monitored more regularly at the 40mph. 2. There needs to be better signage for entering the hospital. Too many people going for appts. often enter the wrong lang which leads employees to Lot 20. Rather than going down that road to see if there is another entrance to the hospital or to turn around, they hold traffic up or worse, sometimes cut into the other lane and almost cause an accident. There is signage once you make that turn from the intersection on 120 with Centerra parkway, but not SOON ENOUGH for patients and visitor.	7/29/2024 3:18 PM
112	As a newer employee to Dartmouth, more reasonable housing (purchase vs. rental) as the market has been extremely competitive and new employees that are not physicians are being outbid for homes in closer proximity to the hospital. I'm currently a full-time, permanent employee with a specialty area of practice and currently living full time in my RV and will need to find a rental for the winter if unable to find a suitable home. Traffic is also challenging up 120 from 89 headed towards the hospital, at certain clusters of time. Staggered start times may help spread out the back up of traffic. Off Etna Rd, there seems to be a number of businesses that are no longer there and unused area for commercial or residential needs. Centerra complex also seems to be the same. Areas or buildings of unused space could be better utilized.	7/29/2024 3:16 PM
113	Affordable housing is a priority. Please preserve the natural beauty of this area and don't turn it into continuous sprawl!	7/29/2024 3:13 PM
114	DHMC should make an access road from the West Lebanon side (Rte 10) instead of all traffic using 120. It would be much quicker for ambulances coming from that direction instead of	7/29/2024 3:08 PM

	taking the interstate and then up 120. It would lighten commuter traffic as well. I thought I saw something year ago showing that DHMC was actually close to Rte 10.	
115	The traffic lights at the I-89 interchange need to be addressed, traffic during the schoolyear is terrible. The walking bridge should be converted to another entrance/exit to the school to help reduce the traffic.	7/29/2024 3:08 PM
116	I believe that it is important to maintain and support the wildlife corridors that exist in this area. There is good to very good habit for black bear, whitetail deer, porcupine, wild turkeys, and ruffed grouse among other animals and plants in this area. We need to preserve these natural resources that make this area unique.	7/29/2024 3:06 PM
117	The speed limit needs to be increased as 40mph is too slow up the hill especially in the winter. There needs to be more affordable housing. You can't keep putting up housing that no one can afford. The apartments on the left by the Element have a tough time getting out in the morning, maybe having a road go around back and come out at the lights by the coop would be a good idea. You need to plow Lahaye Drive better in the winter, people keep getting stuck and that backs up the traffic on 120. Also, there are over 5000 vehicles a day to the hospital not including ambulances and it is the worst plowed road in Lebanon.	7/29/2024 1:34 PM
118	No.	7/29/2024 10:46 AM
119	No	7/29/2024 9:04 AM
120	no	7/29/2024 6:07 AM
121	More affordable housing and more bus stops and routes. Sincerely, A. Ryder	7/27/2024 1:46 PM
122	Much of the development area covers the Landmark Tract, which is a vital community resource for mountain biking, hiking, and trail running, particularly the areas bordering Heater Road. The local mountain chapter of Vermont Mountain Biking (VMBA) is active in developing the local trail network in partnership with the owners. Please ensure they are included in the planning process and consider the benefits the land in its current state has to the local community for outdoor recreation, mental health, and relationship building.	7/27/2024 8:54 AM
123	The corridor, in its current state, is very unfriendly to pedestrians and any development should include more sidewalks, crosswalks, and walking signals at intersections. The pedestrian access is especially poor at and around the intersection of Route 120, Old Etna Road, and Etna Road, as well as the entire Labombard Road. There is a residential anchor at 69 Etna Road, a condominium building with 75 units. There is no sidewalk access, and I've observed many people walking or running on the streets mentioned in dangerous proximity to cars and large vehicles that go to the FedEx and Dartmouth Coach throughout the day. Please include sidewalk upgrades to all of these streets in the interest of pedestrian safety.	7/27/2024 8:52 AM
124	The route is clearly overworked, per se. It has condensed traffic. I live on the route 120.	7/27/2024 8:23 AM
125	Please know that folks of most ages use this area to commute by foot and bike to work, school, and leisure. Being the minimum of three feet or have protected travel is paramount for community safety. We need to put eyes on the road and off the screens. All of this will enhance the mental well-being of our residents and guests.	7/26/2024 8:12 PM
126	No	7/26/2024 2:29 PM
127	Priority should be given to find alternative traffic patterns for both the high school and Hanover Street Schools. Adding development without proper infrastructure will only continue to hamper an already hectic school pick up and drop off	7/26/2024 1:55 PM
128	I'm very concerned about the safety of the elementary school so close to current construction plans. The safety of our school ages children should be the cities highest priorities as it moves through this process.	7/26/2024 12:34 PM
129	Increase cycling infrastructure when developing new roads / improving old roads.	7/26/2024 11:15 AM
130	NO more apartments! We need more homes to bring in more people or allow them to move here. I have lived here for 10 years and we have struggled finding a house. Too much low income housing or tiny homes, not enough next level housing. I know so many people are leaving the area because they cannot find a house because all that is available are apartments. It would also be nice to maybe have a park in that end of the town??	7/26/2024 10:57 AM
131	It is a highly traveled corridor, and I have concerns about adding more businesses,	7/26/2024 10:38 AM

	intersections, congestion. Part of what makes our area so special is the wildlife and woodlands and wetlands around us and we continue to diminish these making us more and more like any other city/urban area.	
132	While I understand the need for more housing, I have serious concerns about whether this plan will add significant traffic flow to Hanover Street in front of Lebanon High/Hanover Street and the surrounding roads during the morning and afternoon times.	7/26/2024 10:26 AM
133	I attended the meetings, very good job,	7/26/2024 9:16 AM
134	The links that provide valuable information about this project are hidden in links at the very bottom of the page (after the 'for more information consct...' section). It would be nice to mention these links above or include links further up in the page.	7/26/2024 8:11 AM
135	We need to stop allowing development that is completely car-dependent. None of these new apartments or condos are walkable to anything. We're creating traffic congestion when we do this. It's a very expensive way to build. We should be focusing growth in existing walkable transit-oriented areas like downtown, and require the 120 corridor to become safer and more convenient for walking, biking, and accessible to bus stops. No more widening the road! We're going to end up ruining the natural beauty of Lebanon if it's wall-to-wall cars.	7/26/2024 7:17 AM
136	Please stop making exceptions for developers to add housing in this area. It’s time neighboring towns also share the burden of trying to solve the Upper Valley’s housing crisis.	7/26/2024 6:27 AM
137	Yes	7/26/2024 2:05 AM
138	Use the space behind lot 9 (by Jesse's) to increase housing	7/25/2024 10:17 PM
139	I would love to just preserve the land areas.	7/25/2024 9:22 PM
140	I do not support this. Boston Lot is in the rural land-3 zoning district and should not be rezoned solely for development. Boston Lot is a vital natural resource our community members utilize that brings in tourism dollars for our businesses. Different friends come from Colorado, California, and New York to visit for the mountain biking available in the upper valley. We want them to be welcome here instead of sending away that income to Woodstock or Ascutney.	7/25/2024 9:02 PM
141	Yes. The potential for the large planned developments in that area involving wetland areas are very concerning. At this point, the one across the pond from LHS is ridiculous, poised at the very edge of wetland. Even though the developer may have taken the technical appropriate steps to mitigate impact, a development that large cannot help but to negatively impact the wild lands for some distant around it. And that is to say nothing of the huge volume of traffic added to an area around one of our elementary schools and high school. Also of concern is the wetland area on the east of 120, that has recently been shrunk by a hotel and bus depot. Yes the impacts can be mitigated, but the total wetland area is still decreased. I don't want to see the town grasping for straws to hastily add housing. Do not hand out variances and tax incentives like they are candy. If this is such a hot area to build in, the market will make it attractive enough for developers. What about the areas to the east of 120 up the hill from etna road? I will happily comment more. Ralph Horak 603-520-0907 ralphhorak@gmail.com	7/25/2024 8:52 PM
142	Raise the speed limit to 50 between Old Etna Road and Centerra.	7/25/2024 8:28 PM
143	Change the zoning of Etna Rd to Industrial/ Residential. The market will decide whether properties are more valuable as Industrial (Dog Kennel) or Residential (apartment building).	7/25/2024 8:05 PM
144	Our daughter attends Hanover Street School and traffic is already a problem at drop off and pickup. I strongly disagree with this proposal, particularly the housing complex to be built in the wetland area near the school. Lebanon does not need more apartment complexes. We need more affordable single family homes for middle income earners. Since moving here eight years ago we have seen so many apartment buildings in Lebanon be built. We have not observed the same in the surrounding towns. To build up this area will only make driving in the area more difficult. We work and live in Lebanon instead of the greater Boston area to avoid such congestion. Please reconsider.	7/25/2024 7:41 PM
145	That it is in desperate need of a protected bike lane. The road is currently too dangerous and right now there is no bike access from Hanover to downtown Leb.	7/25/2024 5:47 PM
146	Complete safe bike route.	7/25/2024 5:27 PM
147	Consider construction for a bridge reconnecting Hanover street over I-89	7/25/2024 5:21 PM

148	Lebanon should not have to lose so much of its attractive qualities and increase wear and tear on its environment	7/25/2024 4:52 PM
149	no	7/25/2024 4:35 PM
150	Buy intelligent / synchonized stop lights to aid traffic flow.	7/25/2024 4:29 PM
151	O	7/25/2024 4:23 PM
152	How much development area could be infilled in areas where large surface parking lots exist(DHMC & Centerra), and what does the cost benefit analysis suggest? How can bike and pedestrian infrastructure influence zoning and shorter vehicle trips?	7/25/2024 4:19 PM
153	I believe this is a great are to continue to develop. Exit 20 has potential as well. The narrow roads around exit 19 do not as easily lend itself to the development that should take place at exit 18.	7/25/2024 4:14 PM
154	Be VERY careful about the long-term impact of the large-scale housing proposal across from LHS on wetland, Boston Lot, school and hospital traffic patters, and overall safety. Please also be as transparent as possible with the public.	7/25/2024 4:08 PM
155	1. There is a missing pedestrian bicycle link from DHMC to Hanover. You must walk in the break down-bike lane between Buck Road and the North Access Road. For 20 years the Hanover Bike Walk Committee has promoted, planned, found funding and helped build a protected and connected path from Hanover to Buck Road and Buck Road to the hospital. Hanover funded the last section in Lebanon. Please use your influence to help persuade DHMC in Lebanon, Hanover and the state to finish the missing link. 2. Service Road along east/north side of route 120. This area is crying out for a service road to reduce traffic, risk of accidents and improve multi-modal transportation options Thanks. Bill Young. william.w.young@dartmouth.edu.	7/25/2024 4:07 PM
156	Seems like a bad plan to put apartments across from a high school on a dead end road.	7/25/2024 3:58 PM
157	1) The massive housing proposal across from LHS (on wetland) should be very carefully examined in terms of both wildlife habitat impact as well as traffic congestion during peak times and the City should be more proactive in keeping opportunities for public comment more visible in more places (than usual). 2) Please consider carefully the inclusion of mixed use (commercial/retail--residential) development on this corridor. It can offset retail traffic in other parts of Leb and West Leb if done right. 3) Boston Lot is a natural treasure and community asset. Once lost, it's gone forever. Please consider minimizing impacts to this space.	7/25/2024 3:56 PM
158	Looks neat, but central planning isn't a good idea, let people build where they want, disband the zoning board if ya can	7/25/2024 3:51 PM
159	Please be sure whatever is planned does NOT increase the property tax for property owners.	7/25/2024 3:40 PM
160	This area needs a splash pad and/or a park, as it's got so many growing residential areas.	7/25/2024 3:36 PM
161	Adding that much traffic and people next to the schools is a horrible idea. This would put our kids safety in jeopardy in more ways than one. Traffic getting to school is already congested, are we going to have to leave an hour ahead of time to make it to school on time?	7/25/2024 3:28 PM
162	Consider the burden to current Lebanon residents. Build homes not housing. We need people who want to live here for life and not just for school or work.	7/25/2024 2:59 PM
163	Concern of the traffic flow going into the Hanover school street area as well as the residents in that area already established. There is already heavy traffic with no regard to individuals in the cross walks. Adding more traffic is going to make the situation more unsafe for that neighborhood and the families that attend the schools	7/25/2024 2:58 PM
164	Wetlands and floodplains should be excluded from development areas as critical natural infrastructure for flood resiliency and water quality.	7/25/2024 2:58 PM
165	Preserve wilderness and allow dense developments close to existing highways.	7/25/2024 2:58 PM
166	Enforcement of the 40 MPH speed limit on that corridor. It is a wildlife corridor and many people travel at 60-70 MPH as if they were on an interstate highway. Non-existent police surveillance and enforcement of the speed limit.	7/25/2024 2:54 PM
167	No	7/25/2024 2:47 PM

168	Adjust the lights getting off exit 18 going southbound. Often, when the light turns green the next light is red and it causes backup and intersections get blocked. Also, consider a light during school hours at Heater Rd.	7/25/2024 2:38 PM
169	How can the City dictate how to develop privately owned land? Can't the owner or owners develop (or not) their land based on its current zoning?	7/25/2024 2:34 PM
170	How will this affect our taxes, road infrastructure, stress on the school system and stress on the police department and fire department?	7/25/2024 2:15 PM
171	Please do not upzone the Rural Land-3 area that covers the Landmark parcels west of Mt Support Rd. This area is critical for wildlife and recreation and is home to a beloved community trail system managed by Upper Valley Mountain Bike Association. Also, existing wildlife corridors across Mt Support Rd and Route 120 need to be preserved in perpetuity. This could be done with a zoning overlay. Wetlands need to be protected too. Overall, the City should not encourage additional development along Route 120. New development should be clustered in and near existing developed areas, like downtown and the hospital. Route 120 is a high speed, four lane road that is not walkable. New development would put more cars on the road and require expensive transportation infrastructure upgrades to create safe intersections.	7/25/2024 2:12 PM
172	The area of proposed apt buildings is already a high traffic, dangerous area where a ton of kids go to school. Increasing that traffic will make it incredibly unsafe! It's too tight of an area to pack any more people in, and doing so will chip away at the charm of our town. Focus on building actual houses for people, for them to own, and become further invested in this community.	7/25/2024 1:51 PM
173	no	7/25/2024 1:50 PM
174	Walkability is a major challenge in this area. We looked at buying, but found the housing felt completely isolated from the businesses on the other side of 120. It would be great to have more mixed-use zoning in areas with higher density housing to support that. Thanks!	7/25/2024 1:50 PM
175	I would suggest extending the study area along Etna Road to the Hanover border, since those houses are affected by traffic flow along this general corridor.	7/25/2024 1:49 PM
176	I would like to see the development of a third village. Adding more stores and restaurants to the area. I support more high density housing.	7/25/2024 1:49 PM
177	No	7/25/2024 1:46 PM
178	As there is a severe housing shortage in the Upper Valley I think there should be ample housing development included in the area. Or at least there should be opportunities for housing development. I think development should be open to multiple housing types as well and not just so called 'affordable housing.' Housing becomes more affordable when supplies are adequate. I would be nice if my kids could one day live in Lebanon (their hometown) and the chronic housing shortage in the area may make it difficult for them to do so. It would also be nice to allow for some commercial and possibly industrial development as well. I like the idea of a third village (why not call it city) center. It would be cool to have some mixed-use areas of high-density housing with ground floor retail. I'm not advocating for out of control and thoughtless growth but as a resident of Lebanon I support development. Thank you for asking!	7/25/2024 1:43 PM
179	There is a great opportunity here to add new walkable, bikeable, and livable neighborhoods with mixed residential and commercial uses. A new zoning district in this corridor should encourage this opportunity by creating a new village center that is based off a development pattern that might include smaller lot sizes and setbacks, more multimodal pathways, fewer parking spaces, and opportunities for communal green space. Exciting stuff!	7/25/2024 1:37 PM
180	mixed development. Single and multi-family dwellings, small commercial for retail and restaurants, a park or connection to trails for public space, safe and reliable transportation options	7/25/2024 1:34 PM
181	Deal with traffic that is expanding exponentially on this route.	7/25/2024 1:32 PM
182	Needs bus service to Centerra. Also a better way to get from Sachem to Centerra. They are so close to one another but completely disconnected.	7/25/2024 1:30 PM
183	My understanding from family who have lived in this area for many generations is that when the hospital DHMC was constructed, part of the plan included its own exit off I-89. I'm not sure why this never happened, but continuing to develop the 120 corridor would certainly increase	7/25/2024 1:28 PM

	traffic and the option to have a direct exit off the highway to the hospital would help mitigate traffic flow considerably, I would think.	
184	The last thing that this area (and the city of Lebanon as a whole) needs is more huge apartment buildings. The majority of current residents who rent, as well as those who work at the hospital, want affordable housing that THEY CAN PURCHASE. I know many families currently in condos or apartments that have been searching for homes to purchase for years, and are unable to. I understand individuals need an apartment to live in when they first come to the area, but as people form families and desire a home large enough for a family, there are few options in Lebanon. I have seen numerous families relocate to other areas simply because there was no way they would ever be able to purchase a home in this area. Lebanon needs to focus on single family home developments that are affordable for families to purchase. Also, putting a 400 + apartment complex directly across the street from the high school and elementary school is a horrible idea. At certain times of the day, traffic in this area is already awful, and adding an additional 800 cars to the mix is not going to help traffic. Traffic is dangerous in this area, as cars from the hospital speed through intersections and travel through the area without regards to school zone speed limits. There is also the issue that part of this area includes wetlands. Putting up numerous apartment complexes completely changes the landscape that many associate with Lebanon. I do understand the dire need for housing in Lebanon and surrounding areas, but Lebanon is not solely responsible for providing the solution. Other neighboring communities need to provide housing solutions as well. As long as Lebanon continues to build massive, unsightly apartment complexes, more and more families will continue to leave the area. The massive apartment complexes that seem to be a focus of this plan are short sighted. Home ownership is a focal part of the "American Dream," and the city of Lebanon needs to realize that. A community thrives when its members are invested in it. The transient population that these massive apartment complexes promote do not remain long enough in the area to become involved in their community, nor does it provide any solution to helping these people achieve home ownership. I agree with more pedestrian/biking options in this area. But the goal of this 3rd village center in Lebanon needs to be mostly focused on single family homes and town homes that allow home ownership, not rentals. Having the focus on this would provide the much needed family homes the area needs, as well as lessening the impact of traffic in this area.	7/25/2024 1:18 PM
185	When looking at creating a “third village” I believe Lebanon is not poised to take on an increase in additional students. The tax payers are still paying on two school bonds. I am also concerned our public works department is at it limit in providing services. The landfill is also approaching a finite limit. I’m concerned Lebanon is over developing with surrounding communities benefiting from the NIMBY. Please allow other towns to share in the need of creating more housing.	7/25/2024 1:16 PM
186	Please make sure there are safe and plentiful options for biking and walkers.	7/25/2024 1:08 PM
187	Bowling alley and other recreation.	7/25/2024 1:05 PM
188	Leave the land alone. Lebanon is getting to crowded already. More businesses/apartments will only make things worse. Commuting to DH, and the college, will take longer and likely have more accidents since people run red lights all the time already. Leave Lebanon alone. Leave the upper valley alone. City people need to stay in the city if that is the way they like things.	7/25/2024 12:59 PM
189	Stop focusing on big, ugly apartment buildings that only offer studio and 1 bedrooms and shift the focus to NEW single family housing so we can attract and retain FAMILIES who want to live here but can't find family housing. We don't need more apartments, we need houses. And by that I don't mean 2 bedroom houses either.	7/25/2024 12:45 PM
190	No	7/25/2024 12:41 PM
191	I'm fine with studying the idea as long there is public input once the study is complete.	7/25/2024 12:38 PM
192	I know NH-120 is managed by NHDOT, and not the city. But this road really needs centerline rumble strips. The safety benefit of this improvement are likely 20x the cost. Due to noise concerns from nearby residents sinusoidal rumble strips should be installed instead of the typical ones.	7/25/2024 12:36 PM
193	Please consider bike and foot traffic separated from the vehicle traffic by a real, physical barrier or maybe a separate, parallel path	7/25/2024 12:35 PM
194	The current state of the Landmark/Boston Lot land adds immensely to the character and draw of the Lebanon community, brings recreation money into the area, and provides a contrast to	7/25/2024 12:24 PM

	the sub-urban nature of the wider Upper Valley within the core of our area and should be protected in it's current state without further encroachment.	
195	I think that maintaining open space and minimizing the feel of suburban sprawl is essential, as is attention to traffic to the medical center and the school.	7/25/2024 12:21 PM
196	Keep as much green space as possible. Make the area pedestrian and cyclist friendly. Preserve the charm and quaintness of our region.	7/25/2024 12:04 PM
197	I think the idea of a giant apartment complex across the street from the school is terrible. We should attempt to Maintain minimum traffic around the campus, not increase it. It's already nightmare trying to leave the school and get to the highway. Lebanon is taking on too many apartment complexes in this area. Other towns should do their part. As a nurse working at DH, no one has a problem finding an apartment in town. What we can't find are AFFORDABLE apartments and AFFORDABLE single family homes. Stop allowing "luxury" apartment buildings - apartments in Timberwood and Emerson are already outrageously priced - let alone new construction projects that are going to try to outdo them. If I have to move an hour away to afford to buy a home, I'll change jobs away from the Upper Valley. This project is an insult to medium and low income professionals that are trying to financially get ahead in this area.	7/25/2024 12:00 PM
198	My largest consideration is traffic. Pre-pandemic, it took 15+ minutes just to go from the hospital, down 120, and to the intersection with the Fort gas station. This has been much improved since the advance of remote work, but may worsen again with the city center concept. Please preserve the current quick commute for DH workers.	7/25/2024 11:58 AM
199	Please keep in mind recreation, natural habitat, and keeping the character of our area. While we could use housing etc, what makes our area unique and beautiful. Overdevelopment or development without being cognizant of the area's charm will ruin the landscape	7/25/2024 11:56 AM
200	final draft? How about a first or second draft? First time ive heard of this study.	7/25/2024 11:53 AM
201	According to the Keys to the Valley study, Lebanon needed to build 534 rental units to address the housing crisis; we have already built over 2000 rental units. Lebanon should not be the only municipality in the Upper Valley that is working towards combating the housing crisis. No more apartments, please. It's time to invest in affordable single-family homes.	7/25/2024 11:52 AM
202	I wonder if people in the Upper Valley realize the impact to the environment the development will bring. Rte 120 itself is not going to be able to handle the amount of traffic development will inherently bring. At some point new roads will need to be built. Lebanon/ West Lebanon is already at capacity for traffic along 120/12a/ Miracle Mile. What plans/ideas are being floated to mitigate the traffic problems that will occur with the development of the 120 corridor?	7/25/2024 11:51 AM
203	Please allow for an over abundance of (affordable) housing to alleviate the housing crisis. Also, please include a carve-out for children's activities, which will be a win-win draw for retail businesses. Thank you.	7/25/2024 11:46 AM
204	It's going to add so much more traffic to 120 & Evans drive getting to & from schools and hospital. Horrible idea! Can't get thru there as it is. Stop building all of this unaffordable housing! People who have lived here for years are having to move out of Lebanon because taxes are going up so much. Stop giving tax breaks to businesses. There should be a tax break for people who have lived here 20+ years.	7/25/2024 11:45 AM
205	Lebanon has gotten so spread out it has lost its hometown feel and I grew up here	7/25/2024 11:45 AM
206	I don't think any more development should be done in this area. It is already heavily developed with several large new apartment buildings, Centerra and the hospital complex. More development would absolutely generate much heavier traffic in an already heavy traffic area. Many people would be drawn away from the Lebanon green area, which itself needs more business development, especially a general/grocery store of some kind.	7/25/2024 11:42 AM
207	1. Create north and south bound parking areas at exit 18 specifically for DHmC and Dartmouth bound passengers, and have busses run from there every 1/2 hour to key bus stops on Dartmouth campus and DHmC. Norwich and Hanover have had success in reducing traffic congestion by having a parking lot with bus service on tbe Vermont side of Ledyard bridge. 2. Improve bikeways along 120 3. Traffic light at evans drive onto 120 for left turns only 4. Install raised medians with landscaping along key areas of 120	7/25/2024 11:39 AM
208	I do not like the idea that we are creeping into Boston Lot, Rich Ledges, and Signal Hill. Isn't this corridor congested enough? What ever happened to developing Meriden Road and making	7/25/2024 11:39 AM

	that a small village?	
209	add traffic circles to help with traffic	7/25/2024 11:36 AM
210	Think about adjusting the times of DHMC and LHS & HSS start times to help with congestion and traffic backups caused by everyone going through the area at the same time.	7/25/2024 11:33 AM
211	There should be a blue line bus spur that runs along route 120 connecting with the Dartmouth coach, the many commercial businesses along 120, the co-op and joining back with the blue line at DHMC. This spur would connect Hanover with the spur and any future developments but also give access to the CO-OP more directly. I would be interested if more dense mixed use zones could possibly be implemented to massively reduce car greenhouse emissions by connecting residents to stores with easy walking distances. This mixed use housing could possibly be made car free with the blue line spur and dedicated bus lanes. This may be a lot to request for but it would be a really nice addition to making Lebanon a nicer and less car filled city pace to live in	7/25/2024 11:31 AM
212	It would be nice to see apartments for low income housing to go up. There are so many families and single parents who can not afford to live in Lebanon due to the high rent.	7/25/2024 11:27 AM
213	This project is simply too large to be so close to the schools. It's already a busy place at all tunes of day. Adding hundreds of additional cars and mixing that with kids biking and walking to school is simply a bad idea.	7/25/2024 11:27 AM
214	I don't understand the purpose of this question. What would our comments be added to? It's hard to add anything to something we haven't seen. This seems like an attempt to claim there was public input when there really wasn't an opportunity to make informed comments.	7/25/2024 11:26 AM
215	Greenways, bikeways, and trail connections/ access from Lebanon to Hanover.	7/25/2024 11:25 AM
216	I hope that the development plan will not recommend a soulless strip mall/big box store wasteland a la the Plazas in West Lebanon. I think we have an opportunity to create an intentional community in this area that feels like a small residential area and not a commercial commuter destination or hotel and short-term rental farm. Also, for what it's worth, I think the city needs to fish or cut bait with the current development melodrama related to the River Park project that has been stretching on for more than a decade. As a resident of Crafts Avenue who doesn't have ties to Lyme Properties or the Clems, I'm disappointed in the Planning & Development Department's inability to be creative or flexible about getting this project completed.	7/25/2024 11:25 AM
217	Access to Lebanon High School is difficult for those traveling north on 120. Having to make a left hand turn onto Evans Dr is extremely dangerous with the amount of traffic. Also making a left at the light onto Heater Rd is difficult as the light duration is short and only allows for a few cars to make it through. Speeding on the 120 hill is also a huge issue.	7/25/2024 11:24 AM
218	There is a lot of traffic already on Route 120, especially during the times when people are going to or returning from work. It is important that any development take this into account and ensure to not make the situation worse. I was rear-ended a few years ago on Route 120 during a high traffic time.	7/25/2024 11:24 AM
219	The map of the study area does not look like the much promoted 3rd village. It looks like two parallel strips, one residential/institutional and one commercial/industrial with nothing tying the two together. There is no "center". To make maters worse, Rte 120 is a high speed commuter access to the interstate or Hanover. Lebanon is hobbled with two other strips, Rte 12A and the miracle mile. Do not make these mistakes a third time. The plan needs a focus point, such as a transportation interchange, that interrupts automobile traffic on Rte 120 and acts as a development magnate, similar to a train or subway station. I could not find any link to the powerpoint.	7/25/2024 11:22 AM
220	Bad idea	7/25/2024 11:22 AM
221	It is a very large wildlife corridor and that needs to be kept in mind for planning and development. It also holds a lot of area for water run off and with the climate changing flooding is becoming a very large issue in the area and costs for flood issues needs to be taken into consideration.	7/25/2024 11:22 AM
222	Please plan for a dog park	7/25/2024 11:21 AM
223	It would be nice if there were a road route between the middle of 120 (perhaps at Lahaye Drive)	7/25/2024 11:19 AM

	and North Main Street in West Lebanon. A limitation is that access to this growing area is restricted to directly north and south via Rt. 120.	
224	I'm concerned about taxes on residents. Will the city of lebanon keep on increasing our taxes? It rose 31% last year, atleast. How will this resolve costs for landlords increases wihtout increasing rental unit costs? We're struggling to find services employees for retail, local restaurant workers because rent is so high. A big factor is because of high taxes. And, the development of affordable housing takes almost a decade for any signs of approval. Unless this issue is addressed, I don't how having a third village center is good. High costs of rents will make it difficult to find workers.	7/25/2024 11:19 AM
225	Any development review should take a holistic view to ask what infrastructure might be needed as a result of additional growth. Fire, police, sidewalks, etc	7/25/2024 11:19 AM
226	Consider center barrier to prohibit left turns between Old Etna Rd intersection and Centerra light.	7/25/2024 11:17 AM
227	How will traffic be managed? Housing? School system already taxed	7/25/2024 11:16 AM
228	I wish the city would leave the area as it is and preserve the wildlife habitats that remain.	7/25/2024 11:13 AM
229	Factor in a way to do this so that it keeps Lebanon affordable. Im all for developing Lebanon if it drives taxes down!	7/25/2024 11:12 AM
230	Pedestrian and bike infrastructure is critically important for this area. Mixed use - residential and retail - is my preference. Traffic mitigation is also critical as is maintaining green space alongside development.	7/25/2024 10:53 AM
231	Don’t build for cars, build for people! So many people aren’t capable of driving and are left out of participating in our community. Make it bus, pedestrian, and bike friendly. We have such an opportunity here to change our city’s trajectory and be a place people can visit and thrive even if they can’t or don’t drive. Don’t overlook this!	7/25/2024 10:17 AM
232	I was minimally instrumental in “paving” the original Rte 120 corridor during summer construction work in 1964-5. Operated a jackhammer “ making little ones out of big ones”. I wish the whole venture never happened! My concern is for the confused wildlife, who have lived in that area for generations. Is this “progress”?	7/25/2024 10:11 AM
233	You will need to add a turn lane/divider to route 120 all the way from Old Etna Rd to the Hanover town line. There are going to be more turn cuts in the future so plan for it now. The current speed limit is not realistic. I'm going to estimate the average speed on that section of the road is 55 mph. A "real" speed limit of 50-55 mph would probably limit the discrepancy between slow and fast traffic.	7/25/2024 9:19 AM
234	How will it be maintained? Who will pay for the upkeep?	7/25/2024 9:16 AM
235	Traffic easing/visibility concerns around the Hanover Street School and Lebanon High School region, particularly where Evans Drive and Hanover Street intersect.	7/25/2024 9:08 AM
236	I hope something can be done to preserve the wetlands, which are precious to the ecology and character of Lebanon. It would be a shame if another chain/strip mall area were created here. I can imagine spaces with boardwalks and educational kiosks, which would be a lovely addition for the folks who choose to live here, as well as for the proximal schools.	7/25/2024 8:52 AM